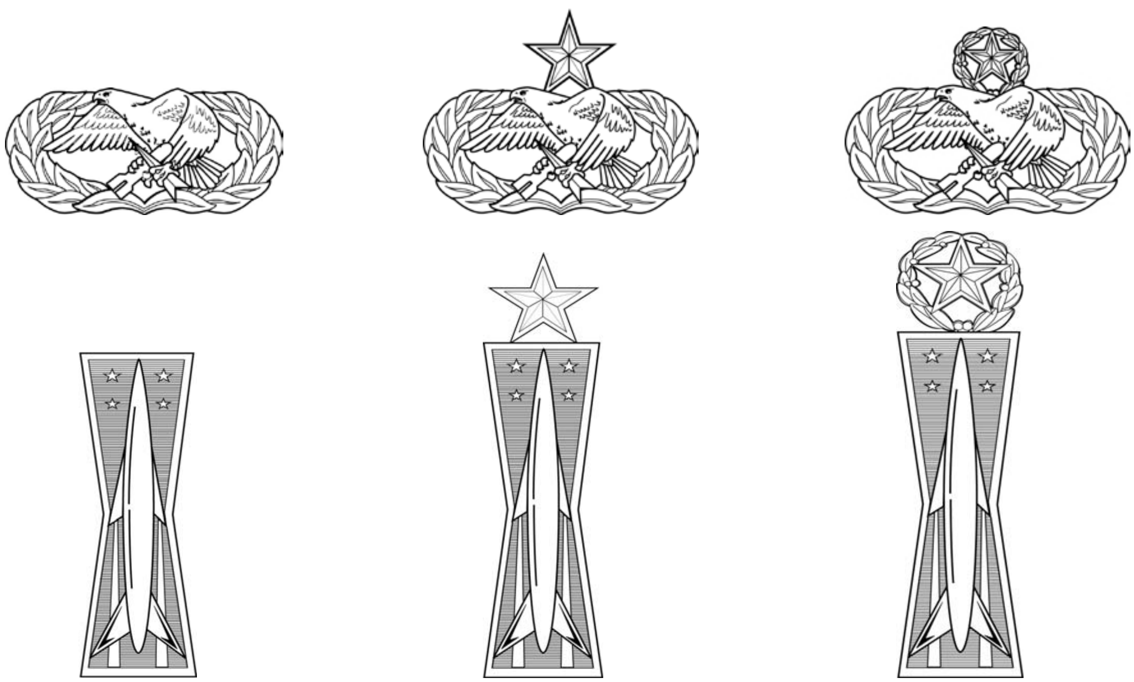
CDC 2M051A

Missile and Space Systems Electronic Maintenance Journeyman

Volume 1. Missile and Space Maintenance Orientation



Air Force Career Development Academy

Air University

Air Education and Training Command

2M051 01 1901, Edit Code 06

AFSC 2M051

Author: MSgt Jeffery D. Smith
532nd Training Squadron
381st Training Group (AETC)
532 TRS/DOMC
597 7th Street, Suite 109
Vandenberg Air Force Base, California 93437-5305
DSN: 276-6627
E-mail address: jeffery.smith.10@us.af.mil

Instructional Systems Specialist: Ronnie Hall

Editor: Evangeline K. Walmsley

Air Force Career Development Academy (AFCDA)
Air University (AETC)
Maxwell AFB-Gunter Annex, Alabama

Material in this volume is reviewed annually for technical accuracy, adequacy, and currency. For Weighted Airman Promotion System (WAPS) Specialty Knowledge Test (SKT) purposes, the examinee should check the *Enlisted Promotions References and Requirements Catalog* to determine the correct references to study.

This career development course (CDC) will help you obtain the knowledge required for upgrade and promotion. It is a self-study course that the Air Force intends for you to complete during your off-duty time. Satisfactory completion of this course satisfies the knowledge portion of the Air Force dual-channel, enlisted specialty training program and is a prerequisite for upgrade to the 5-skill level.

This course contains three volumes. The Air Force requires you to know the material contained within these volumes even though you may not be using all the information to perform your present job. Volume 1 contains basic information on career progression, maintenance management, and the Minuteman III intercontinental ballistic missile (ICBM) weapon system. Volume 2 introduces Spacelift rockets, lists the different types of publications to include the Air Force technical order system, gives general guidelines for common maintenance practices to include isolating faults, and describes the deficiency reporting, nuclear weapons related material, and integrated maintenance data systems. Volume 3 covers some specific areas of the ICBM weapons system to include access, security, power, and cooling systems as well as coding operations and communications.

Volume 1 introduces you to the weapon system you will be maintaining. The goal of this volume is to provide a basic understanding of the ICBM weapon system along with the maintenance organization and mission of the maintenance units. This volume is divided into four units.

Unit 1 introduces the career field, detailing some of the duty positions you will perform. Information is provided on how to progress in the career field as well as some education you can expect along the way.

Unit 2 introduces the missile maintenance organizational functions and responsibilities using a top down approach from Air Force Global Strike Command (AFGSC), 20th Air Force, wings, and groups, as well as the maintenance squadrons and civilian contractors.

Unit 3 describes the mission and strategic characteristics of the Minuteman III weapon system, how it is deployed and controlled, as well as the many functions and features of the missile support base, the missile alert facility, and the launch facility.

Finally, unit 4 provides information on what happens during a nuclear detonation and the importance of the hardness assurance program in maintaining the ICBM weapon system and its support equipment.

A glossary is included for your use.

Code numbers on figures are for preparing agency identification only.

The use of a name of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Air Force.

To get a response to your questions concerning subject matter in this course, or to point out technical errors in the text, unit review exercises, or course examination, call or write the author using the contact information provided in this volume.

NOTE: Do not use Air Force Instruction (AFI) 38–402, *Airmen Powered by Innovation and Suggestion Program*, to submit corrections for printing or typographical errors. For Air National Guard (ANG) members, do not use Air National Guard Instruction (ANGI) 38–401, *Suggestion Program.*

If you have questions that your supervisor, training manager, or education/training office cannot answer regarding course enrollment, course material, or administrative issues, please contact Air University Educational Support Services at http://www.aueducationsupport.com. Be sure your request includes your name, the last four digits of your social security number, address, and course/volume number.

For Guard and Reserve personnel, this volume is valued at 12 hours and 3 points.

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings and numbers. After reading the unit menu page and unit introduction, study the section, answer the self-test questions, and compare your answers with those given at the end of the unit. Then do the unit review exercises.

Please read the unit menu for unit 1 and continue ➔

Unit 1. Missile and Space Electronic Maintenance Career Field

WELCOME TO THE WORLD OF A 2M0X1, the missile and space electronic maintenance career field. Being new to this career field and more than likely to the Air Force, you probably have questions about how you climb the ranks as an "X1" and what different avenues and places this job may take you. You have already completed the first steps: completing technical training and being awarded the maintenance badge as a 2M031 missile and space systems electronic maintenance apprentice. The remainder of your career is in your hands.

This short unit will explore what type of duties your job as a 2M0X1 may entail and how you progress in skill level and rank during your Air Force career. First, we will discuss the other 2M0 missile maintenance career fields.

001. 2M0 Air Force specialty code description

Many systems comprise both the missile alert facility (MAF) and launch facility (LF) on which you will be working. Several agencies operate on the missile support base (MSB) that are manned by other 2M0s. There are four distinct career fields within the 2M0 Air Force specialty (AFS). People with your Air Force specialty code (AFSC), 2M0X1, do not work on every system at the LF and MAF as that would be far too many tasks to be qualified on and stay proficient at. In this lesson, we will briefly cover each of the other teams you work with to maintain the Minuteman III weapon system.

As you read through this lesson, you will notice that the fourth character of the AFSC is identified with an "X" (e.g., . 2M0X1, 2M0X2, and 2M0X3). The "X" is simply a place holder for a skill level code which will be discussed in an upcoming lesson. For now, focus on the character(s) following the "X" as we discuss the AFSCs within the 2M0 specialty.

2M0X1A and 2M0X1B

The 2M0X1 career field is split up into two different areas, and requires explanation. The United States maintains what is known as the *nuclear triad.* This triad consists of land-based intercontinental ballistic missiles (ICBM), air-launched cruise missiles (ALCM), and submarine-launched ballistic missiles (SLBM). The Air Force operates two legs of the triad which consists of the ICBMs and ALCMs. The Navy maintains the SLBMs.

The suffix, or "shred" as it is commonly called, delineates one Air Force X1 specialty from the other. For example: 2M0X1A is the ICBM electro-mechanical team (EMT), and 2M0X1B is the air-launched missile maintenance (ALMM) personnel. The A or B shred is only applicable to the 1- and 3-skill levels (the "X" previously mentioned). Once a 2M0X1 achieves his or her 5-level, the shred is dropped from the AFSC and a 2M0X1 can be assigned to either an ALCM or an ICBM unit.

2M0X1A

EMT works on the ICBM weapon system; however, they specialize in various systems. At an LF, EMT performs maintenance on the electronic racks, emergency storage batteries, security systems, the missile's guidance set, and personnel access systems (PAS). At an MAF, much work is underground in the launch control center (LCC) on the Rapid Execution and Combat Targeting Console (REACT), which is where the two missile combat crew (MCC) officers sit during alerts. EMT also maintains the MAF emergency storage batteries.

2M0X1B

The ALMM AFSC 2M0X1B, is a completely different career field. These technicians work on the ALCM.

2M0X2 missile maintenance

The 2M0X2s primarily support the overall Minuteman III maintenance and handling operations. Missile handling teams (MHT) ship and receive fully assembled ICBM downstages to and from the depot at Hill Air Force Base (AFB). MHT also operates highly specialized vehicles to transport the pre-assembled downstages from the MSB to the missile silo, placing the boosters inside the launch tube. The X2s can be assigned as a missile maintenance team (MMT) member also.

The MMT performs maintenance on the Minuteman III missile itself, once emplaced in the launch tube, to include the maintenance, repair, installation, and removal of sub-systems and support equipment that support the flight, navigation, and targeting of the re-entry vehicle. These activities include installation and removal of the missile guidance set (MGS), the propulsion system rocket engine (PSRE), and the re-entry system (RS). The MGS, PSRE, and RS are mated to and disconnected from the missile downstages. MMT not only picks up and delivers the assembled RS to and from the weapon storage area using another specialized vehicle, the teams also have the responsibility for opening and closing the launch tube for any maintenance or service test requiring access to the missile.

2M0X3 missile and space facilities maintenance

The 2M0X3s are the ICBM facility maintenance personnel responsible for maintaining components at the MAF and LF that ensure the health and survivability of assigned personnel. Like the X2 career field, 2M0X3s have the possibility of working on either of two teams – the facilities maintenance team (FMT) or the periodic maintenance team (PMT).

FMT personnel perform on-site troubleshooting and repair of the LF and MAF power generation and distribution systems, environmental control systems (ECS), wastewater systems, diesel fuel systems, as well as a variety of miscellaneous systems that comprise the facility. PMT personnel perform the scheduled periodic maintenance on the LF and MAF power generation and distribution systems, ECS, wastewater systems, diesel fuel systems, and all the miscellaneous systems on site.

002. Air Force specialty code 2M0X1 duties

This lesson focuses on the different work centers or “shops” to which you may be assigned as a 2M0X1, as well as the basics of each job. This list is not all encompassing; you can be assigned to a multitude of other positions throughout the maintenance organization as well as the Air Force, but this list serves as a start.

Electro-mechanical team section

In order to perform duties as an EMT technician, you will complete a team-training course. Team training is a controlled training environment where experienced Air Education and Training Command (AETC) field training detachment (FTD) instructors train students to the “go/no-go” level.

A student will be certified to perform all applicable maintenance tasks as an EMT technician to the “go” level. This means they have demonstrated they can perform all parts of the task as well as identifying why and when a task must be done and why each step is needed. Technicians graduating from team training are fully capable of performing nearly all tasks an EMT technician should be able to do. Qualified EMTs are generally composed of at least two 2M0X1 technicians, one of whom is identified as the team chief. As an EMT technician, you are responsible for a variety of systems and equipment such as the LF security system, PAS, operational ground equipment (OGE), and coding operations to name a few.

These tasks may include missile start up and loading of codes to bring the missile on strategic alert, or troubleshooting the security system to ensure proper security system resets and clearing of a security forces camper team. EMT teams also perform major maintenance tasks on LFs and MAFs, such as removing and replacing the storage batteries or the motor generator.

Missile communications section

One section X1s may be assigned to that is similar to the EMT composition of at least two technicians (a team chief and a technician), is as a missile communications technician. They are directly involved with troubleshooting, repairing, and maintaining the various communication systems used throughout the missile field and on the MSB. These systems include everything from your standard phone lines to advanced systems that communicate though satellite systems.

Electronics laboratory section

Another potential section to be assigned is the electronics laboratory (ELAB). Once assigned, you will receive in-house training and qualification on all associated ELAB tasks. As an ELAB technician, some of your responsibilities are inspecting, troubleshooting and repairing electronic and communication equipment as well as certifying and issuing electronic drawers and MGSs to dispatching maintenance teams.

Vehicles and equipment section

You might be assigned to the vehicles and equipment section (VES). As a VES technician, you are responsible for issuing vehicles and equipment to maintenance teams dispatching to the missile field. The VES ensures utility vans, payload transporters (PT), cranes, and other general-purpose vehicles, such as pickup trucks, are available. You will build different equipment loads that dispatching maintenance teams will thoroughly check out and put onto their vehicles prior to dispatching to the missile field.

Field training detachment instructor

After you have served a few years running the field as an EMT technician, you may have the opportunity to become a FTD instructor. As such, you will train all EMT technicians to perform maintenance at LFs and MAFs. As an instructor, you will be responsible for training new technicians, and ensuring lesson plans and curriculum are up to date.

Quality assurance evaluator

After you have worked in either EMT, VES, or communications, and possibly even have been an FTD instructor, you may have the opportunity to serve as a quality assurance (QA) evaluator (QAE). When assigned to the QA section, you will act as the “eyes and ears” of the maintenance group commander (MXG/CC) by evaluating technicians, technical orders, equipment, and other programs, as necessary, to ensure all technicians are performing their jobs safely and correctly. Having highly skilled technicians in QA is necessary since these personnel have the authority to evaluate the performance of other technicians.

Spacelift

Once you achieve your 5-skill level, you are eligible to take a Spacelift assignment. Spacelift duties can take you to either Vandenberg AFB or Cape Canaveral Air Force Station where you will perform duties as a mission assurance (MA) technician. As an MA technician, your job will be to observe contractors as they perform launch processing activities to ensure the mission is accomplished correctly and safely.

AETC technical training instructor

You can probably recall many of your technical school instructors from when you were a student in the 532d Training Squadron at Vandenberg AFB. As a 5-level technician, you may also have the opportunity to become a technical training instructor. Like an FTD instructor in your training section, technical school instructors belong to AETC. They deliver instruction as well as maintain lesson plans and curriculum.

576th Flight Test Squadron

Later in your career, you may also become a member of the 576th Flight Test Squadron (FLTS). Also located at Vandenberg AFB, the 576 FLTS belongs to Air Force Global Strike Command (AFGSC), and is staffed with 2M0X1s (EMT), 2M0X2s (MMT), and 2M0X3s (FMT).

At the 576th, each 2M0's job is similar to the ones they performed at the operational missile wings. However, the sole mission of the 576 FLTS is to conduct ICBM test launches. They do not keep MAFs and LFs on alert as they are brought on line for test launches only, which occur several times a year. You will learn more about the 576 FLTS in your 7-level career development courses (CDC).

003. 2M0X1 career field progression

Now that you have an understanding of some of the duties you may perform as an X1, let's examine how you achieve different skill levels in order to progress through the 2M0X1 career field. Note that a 3-, 5-, 7-, and 9-level are used interchangeably with the terms apprentice, journeyman, craftsman, and superintendent, respectively.

Career development courses

In order to understand the terminology used in this lesson, you need to be familiar with the scope and purpose of CDCs, and how training is documented.

A CDC is a formal correspondence course that provides personnel with additional knowledge necessary to advance to the next higher skill level. A CDC will not teach you task proficiency or give you all of the knowledge related to a specific task. CDCs contain information based on broad principles and common knowledge requirements of each Air Force specialty. Specific equipment or procedural knowledge is included only when used throughout the career field, or required to illustrate the application of a principle.

Completion of your CDCs is not only required to become a 5- or 7-skill level technician, but also to help you advance through the Air Force ranks. When you are a senior Airman (SrA) eligible to test for staff sergeant (SSgt), you will be competing for promotion through the Weighted Airman Promotion System (WAPS). One of the written tests you will take is called the specialty knowledge test (SKT), which is a 100-question test about your career field. This test is developed from the CDCs.

All your on-the-job training (OJT), CDC, and core task completion is documented in your training records. The Air Force uses the Training Business Area (TBA) to document all training. The TBA is a web-based server system that allows you, your trainer, your supervisor, workcenter supervisor, and unit training manager (UTM) access to certify task and CDC completion.

Skill level progression

Now that you have a basic understanding of skill level upgrade, let's look at each skill level and see what is required in order to be upgraded. Figure 1–1 illustrates career field progression in relation to ranks and duties associated with the different skill levels.

Apprentice (3-level)

You were awarded the 3-skill level for completing your initial skills training at Vandenberg AFB, and you are currently an apprentice. As an apprentice, you are learning your overall job. Your main goal at this point is to become familiar with the basics of the career field.

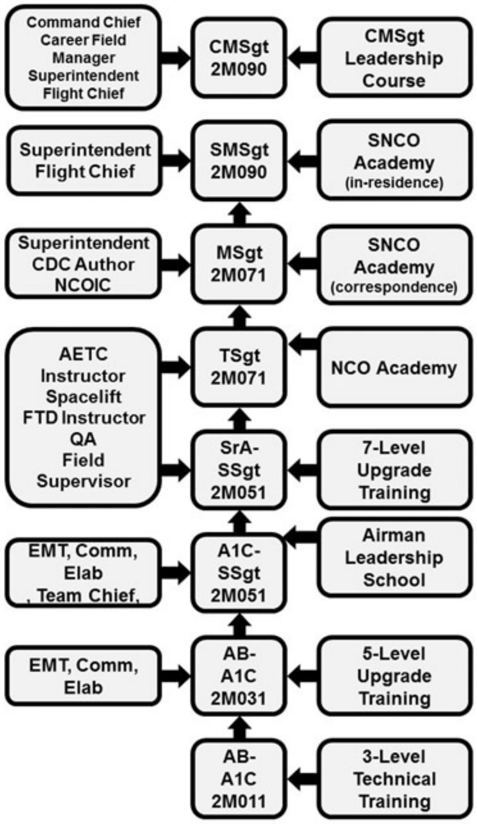


Figure 1–1. 2M0X1 career progression flow diagram.

Journeyman (5-level)

When you arrived at your first duty station, you were entered automatically into 5-skill level upgrade training. Depending on the work center you are assigned to, you will either begin your prerequisites to begin an FTD class or you will begin OJT to receive hands-on training on the required 5-skill level core tasks. To qualify for the 5-skill level, you must:

- Possess a 3-skill level.
- Be trained on all 5-skill level core tasks.
- Successfully complete this 5-skill level CDC.
- Be in upgrade training for a minimum of 12 months.

The 12-month period is the amount of time necessary to develop the knowledge and skills to be a 5-level technician. There is one exception to this rule–Airman who have retrained from another career field will complete a minimum of nine months in upgrade training. Once you have met all of these requirements, the final steps are to be recommended for your 5-skill level by your supervisor, and then approved by your commander.

As a journeyman (5-skill level), you will continue to progress in your Air Force career by completing both formal and informal training to broaden your technical and leadership skills. You may be assigned duties as a team chief, FTD instructor, evaluator, or AETC technical training instructor.

Craftsman (7-level)

Let’s assume you completed Airman Leadership School (ALS) and have been selected for promotion to SSgt. Just like your 5-skill level upgrade, you will be enrolled in your 7-level CDC; however, it is more technical in nature and will be written to the knowledge level you need as a craftsman. And, like the 5-level CDCs you will be trained and certified on the 7-skill level core tasks. The minimum time in upgrade training for your 7-skill level is 12 months. To be awarded your 7-skill level you must:

- Be at least a SSgt.
- Hold a 5-skill level.
- Be certified on all 7-skill level core tasks.
- Successfully complete the craftsman CDC.
- Complete a minimum of 12 months in upgrade training.
- Be recommended by your supervisor and approved by your commander.

Superintendent (9-level)

Upon promotion to senior master sergeant (SMSgt), you are awarded the 9-skill level, which means there are no core tasks, CDC, or upgrade training requirements. As a 9-level, are expected to fill superintendent positions, along with various other staff positions and other prestigious positions outside of the X1 career field. As a 9-level, you are given increased responsibilities, requiring an in-depth understanding of resources, organizational structure, and personnel management.

The rank of chief master sergeant (CMSgt) is the highest Air Force enlisted rank. CMSgts are superintendents and managers who provide senior enlisted leadership. Two common duties in the 2M0 career field include the maintenance superintendent and Air Force career field manager (AFCFM).

Maintenance superintendent

Maintenance superintendents are senior enlisted personnel who manage production and assigned resources in their group or squadron to achieve maximum war-fighting capability.

Air Force career field manager

The AFCFM ensures development, implementation, and maintenance of the Career Field Education and Training Plan (CFETP). Simply speaking, the AFCFM shapes and provides the direction for the entire career field.

Active duty CMSgt-selects with at least six months of retainability may attend the CMSgt Leadership Course (CLC). SMSgts selected for promotion to CMSgt are not required to complete CLC prior to sew-on; however, with few exceptions, they will attend within the year selected for promotion.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

001. 2M0 Air Force specialty code description

1. What team performs maintenance on the REACT console at a MAF?

2. What AFSC performs maintenance on the ALCM?

3. What team performs maintenance on the Minuteman III missile once emplaced in the launch tube?

4. What team performs ICBM facility maintenance?

002. Air Force specialty code 2M0X1 duties

1. To what level has a person been trained if he or she is able to perform all parts of a task and can identify when and why it must be done?

2. What section performs LF and MAF storage battery removal and replacement?

3. What section is responsible for maintaining the communication systems in the missile field?

4. What section ensures that dispatching maintenance teams have the needed equipment loads?

5. What section evaluates technicians, technical orders, and equipment, and acts as the "eyes and ears" of the MXG/CC?

6. What technicians observe contractors as they perform launch processing activities?

003. 2M0X1 career field progression

1. What contains information based on broad principles and common knowledge requirements of each Air Force specialty?

2. What system allows you and your supervisor to certify a task and CDC completion?

3. Why are you assigned to a FTD class or an OJT instructor, while completing your CDCs?

4. What CDC is more technical in nature, and will be geared toward the knowledge you will need as a craftsman?

Answers to Self-Test Questions

001

1. EMT.
2. 2M0X1B.
3. MMT.
4. 2M0X3s.

002

1. “Go” level.
2. EMT.
3. Missile communications.
4. VES.
5. QAE.
6. MA technicians involved in Spacelift missions.

003

1. CDCs.
2. TBA.
3. To receive hands-on training on 5-level core tasks.
4. The 7-level CDC.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field-Scoring Answer Sheet.

Do not return your answer sheet to the Air Force Career Development Academy (AFCDA).

1. (001) Which team installs the propulsion system rocket engine at a launch facility?
   a. Missile handling.
   b. Electro-mechanical.
   c. Missile maintenance.
   d. Facilities maintenance.

2. (002) Technicians in the vehicles and equipment section, issue items to
   a. mission assurance technicians.
   b. technical training students.
   c. Spacelift technicians.
   d. maintenance teams.

3. (002) The mission of the 576th Flight Test Squadron is to conduct
   a. missile test launches.
   b. missile component tests.
   c. simulated electronic launches.
   d. hardened intersite cable tests.

4. (003) What is a formal course that provides advancement to the next skill level?
   a. Core task course.
   b. Airman leadership course.
   c. Career development course.
   d. Noncommissioned officer academy course.

5. (003) Whose main goal is to learn the basics of their career field?
   a. 3-level apprentice.
   b. 3-level journeyman.
   c. 5-level journeyman.
   d. 7-level craftsman.

6. (003) Who is the approval authority for 5-, 7-, and 9-skill level upgrades?
   a. Supervisor.
   b. Commander.
   c. Wing command chief.
   d. Maintenance superintendent.

Please read the unit menu for unit 2 and continue ➔

Student Notes

Unit 2. Maintenance Management

AS A MISSILE AND SPACE ELECTRONIC MAINTENANCE JOURNEYMAN, you have an important role in the success of the Air Force mission. While preserving the peace and security of the United States is a very broad element of the Air Force mission, you should make a conscious connection between your "wrench turning" and the peace and security you enjoy as an American. You work in a proud maintenance organization that has an ongoing mission of keeping missiles on alert. In this unit, you will learn about the organizational structure and responsibilities that shape the ICBM maintenance mission.

You will soon understand your responsibilities within the vast missile maintenance organization of several hundred people. As you begin to understand the responsibilities, functions, and structure of the organization, you will grasp the purposes and roles of the people you work for and with. In the following lessons, you will learn about the different organizations in the ICBM world. We will start at the top of the organization with the AFGSC and work our way down to the individual maintenance technician.

2–1. Missile Maintenance Organizational Structure

Each level within a chain of command has its own functions and responsibilities. It is certainly no different within AFGSC and its subordinate organizations. In this section, we will examine the organizational structure of AFGSC, 20th Air Force, and the ICBM wings and groups, as well as the squadrons responsible for ICBM maintenance.

004. Air Force Global Strike Command

As an Air Force member, it is vital that you know and understand your chain of command. This will help you understand where you fit in the organization and define what your roles and responsibilities are in order to accomplish your duties effectively. Within this lesson, we will look at the mission and organization of the AFGSC. Then, we will discuss 20th Air Force as well as the different ICBM missile wings and groups.

Origins

AFGSC was activated on August 7, 2009, in order to consolidate all Air Force nuclear mission activities under one operational chain of command. AFGSC is a major command (MAJCOM), headquartered at Barksdale AFB, Louisiana, and is directly subordinate to Headquarters, United States (US) Air Force (HAF). ICBM forces were merged into AFGSC effective 1 December 2009, and the Air Force long-range bomber assets were incorporated 1 February 2010.

Mission

The AFGSC mission is to provide the president of the US and combatant commanders with strategic deterrence, global strike, and combat support. In support of that mission, AFGSC assets are poised to conduct strike operations anywhere on the globe, using land-based ICBM forces, as well as long-range bombers, such as the B–52, B–1, and B–2 bombers. In conducting its operations, AFGSC's mission has three specific areas of focus:

1. Safety.
2. Security.
3. Credibility.

Safety

The safety of our nuclear assets and the American people is critical to AFGSC's mission. As a technician, your actions could cause catastrophic failure if safety is compromised in any facet of your duties – a perfect reason to follow technical order guidance so you ensure not only your own safety, but also that of your co-workers. AFGSC maintains an aggressive inspection tempo that focuses on nuclear safety and task safety.

Security

The security of our nuclear assets is just as important as safety. Security forces Airmen are not the only ones responsible for security; we all are. As a missile technician, you will have a direct impact on the security of our nuclear weapon system by following proper security procedures as outlined in the technical orders. Being aware and remaining vigilant will enhance security.

Credibility

Credibility is a prime concern for AFGSC. This MAJCOM is entrusted with two-thirds of the nation's nuclear triad: land-based ICBMs and long-range bombers. As such, the American people must have faith that these weapons are secured properly and maintained in a safe manner. As a missile technician, your day-to-day actions reflect the pride and precision that people have come to expect from our military, which bolsters their support. A false step can damage the credibility of AFGSC, as well as the Air Force, and the US as a whole. For us to continue this mission, the American people must have confidence that we can maintain these weapons safely and securely, and, when it matters, launch them successfully.

Organization

AFGSC is responsible for 20th and 8th Air Force. We will look at 20th Air Force separately in a moment because they are tied more closely to our ICBM mission. But, for now let's discuss 8th Air Force and their role.

The 8th Air Force Headquarters, also located at Barksdale AFB, Louisiana is comprised of three bomb wings. The 8th Air Force plans and executes nuclear deterrence and global strike operations through the use of long-range bombers. The bombers operate from Barksdale AFB, Louisiana, Minot AFB, North Dakota, and Whiteman AFB, Missouri. There are also subordinate units directly reportable to AFGSC that do not fall under either 20th or 8th Air Force, such as the 576 FLTS and the missile engineer squadron (MES) (fig. 2–1).

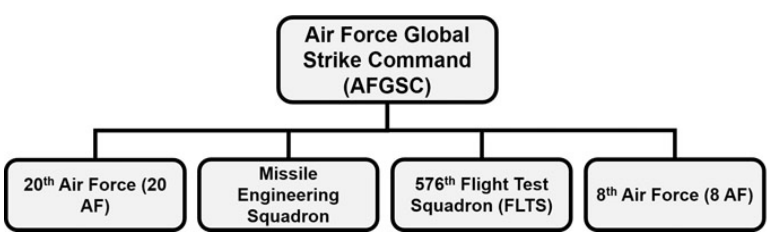


Figure 2–1. Air Force Global Strike Command organization.

005. 20th Air Force

Headquarters 20th Air Force is located at F.E. Warren AFB, Wyoming and is America's ICBM team that provides the front-line deterrence against any threat to the US. 20th Air Force is a numbered Air Force (NAF) that reports directly to AFGSC. As in this case, a NAF reports to a MAJCOM and usually is not structured to perform operational or war fighting missions. A NAF is often oriented to a specific geographic region and structured with wings, groups, and squadrons. 20th Air Force carries out its mission through a team of approximately 10,600 Airman and civilians based at three operational missile units – Malmstrom, Minot, and F.E. Warren AFB. As a missile and space electronic maintenance journeyman, you are likely beginning your maintenance career at one of these missile units.

Mission

20th Air Force is unique in that it supports dual missions: one to AFGSC and the other to US Strategic Command (USSTRATCOM). 20th Air Force is responsible to AFGSC to maintain and operate the Air Force's ICBM forces. Its mission is to prepare the nation's ICBM force to execute – *Safe–Secure–Effective* nuclear strike operations and support worldwide combatant commander requirements. When ICBMs are required to support real world missions, 20th Air Force reports directly to USSTRATCOM to provide on alert, combat ready ICBMs to the president and the commander of USSTRATCOM. This exchange of roles may happen several times a day depending on the mission.

For example, let's say on a particular day, you have maintenance you need to do at a LF; meanwhile, somewhere out in the Pacific Ocean a navy nuclear submarine is positioned in a secure location to react to any potential crisis in that region. As you go to the field, the MCC will monitor your site access as part of their AFGSC role in maintaining the weapon system. Within that same day, the MCC may be tasked with re-targeting a specific LF asset to cover the region the submarine was monitoring because the ship was being directed to another location. In this instance, the MCC is providing real world alert operations to support national security objectives under the direction of USSTRATCOM.

Organization and responsibilities

The 20th Air Force command section consists of several divisions (fig. 2–2). Since ICBM maintenance falls under the 20th Air Force Logistics Division, we will focus our discussion there. The logistics division consists of the command section (not shown), facilities, missile maintenance, electrical, communications, ICBM readiness, and support sections. As we go through the next few lessons, remember that we are discussing evaluators that work at 20th Air Force, not the local evaluators who perform your maintenance evaluations.

Command section

The 20th Air Force director of logistics has many responsibilities. One of the most important is the role of team chief for the missile potential hazard (MPH) system. A MPH is a condition in the missile complex that could potentially cause serious personnel injury or damage to equipment or facilities that the unit cannot correct because of limitations in technical orders, personnel, or hardware.

For example, during an LF motor generator replacement, as the motor generator is lowered down the personnel access hatch (PAH), it gets wedged in the access hatch and becomes stuck. This is an issue because, one, it is not supposed to happen and, two, there is an EMT team in the launcher equipment room (LER) with no way to get out with the motor generator blocking the exit. There is no technical order procedure to handle this situation. This would be an MPH as it is an unusual situation that could cause damage to equipment where no technical order procedures exist to direct recovery.

The MPH system is designed to put a knowledgeable team of weapon system experts at the disposal of a unit in need of assistance. An MPH generates an emergency response team for ICBM maintenance.

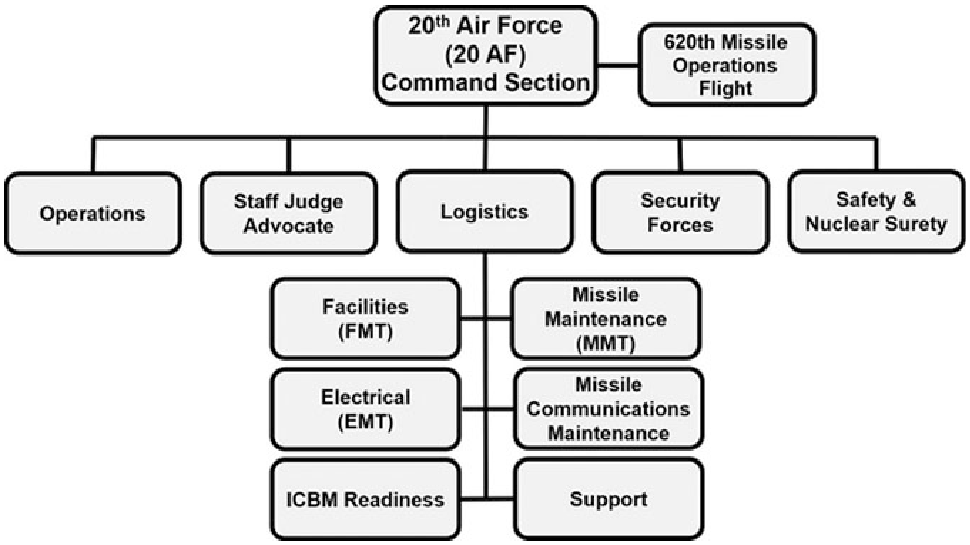


Figure 2–2. 20th Air Force command section.

Electrical section

The electrical section contains the 2M0X1 EMT and ELAB evaluators. This section manages ICBM modification programs. Their role in the process is to perform design reviews, verifying that new equipment operates as designed. They also develop procedures and ensure the modification kits sent to the missile wings are complete.

2M0X1 personnel evaluate and inspect ICBM maintenance programs, facilities, equipment, vehicles, and technical orders assigned to missile maintenance units. They review QA reports from each wing and provide feedback as necessary. Other responsibilities include processing and validating requests from wings for depot assistance, technical order waivers, and technical order improvement recommendations and changes. Additionally, they are subject-matter experts for issues presented by the units.

The 20th Air Force trainer maintainer/technical engineering evaluator can also work in the electrical section. The trainer maintainer/technical engineer oversees modification and maintenance on all 20th Air Force missile maintenance trainers and facilitates. He or she also oversees the resolution of weapon system anomalies not covered in technical orders. Additionally, 20th Air Force trainer maintainers ensure the maintenance trainers are kept up-to-date with the newest modifications so the missile unit instructors can maintain as much operational realism as possible in a training environment.

Missile maintenance section

The missile maintenance section consists of the 2M0X2 evaluators. This section includes evaluators from MMT, mechanical and pneudraulics section (MAPS), and MHT. Their role is the same as the electrical section: to manage current and future ICBM modification programs, as well as evaluating and inspecting ICBM maintenance programs, facilities, equipment, vehicles, and technical orders assigned to missile maintenance units.

Facilities maintenance section

The facilities maintenance section (FMS) is where the 2M0X3 personnel are assigned primarily as the power, refrigeration, and electrical (PREL), and hardened intersite cable system (HICS) evaluators.

Communications section

The communications section contains the 2M0X1 evaluators responsible for the missile communications maintenance programs and evaluations.

Support section

The support section serves as the focal point for all supply and technical order issues.

ICBM readiness section

This section is the interface point between the missile wings and the 20th Air Force Logistics Division. When taskers or other data are transmitted to and from 20th Air Force, the ICBM readiness section ensures the validity and accuracy of the data before it is disseminated to the appropriate 20th Air Force Logistics Division.

The ICBM readiness section is a key component of the command and control (C2) structure of 20th Air Force as well. This section compiles maintenance data analysis reports and generates weapon system metrics for 20th Air Force and USSTRATCOM leadership to ensure they have the right information to make decisions. Additionally, they keep leadership informed of modification and sustainment program completion rates.

Lastly, ICBM readiness ensures the three missile wings' maintenance efforts are consistent with USSTRATCOM's operational orders for the strategic employment of the ICBM fleet. While under the logistics division of 20th Air Force, this section has a pivotal role in the 20th Air Force structure. Within ICBM readiness is technical order and supply responsibilities.

Technical orders

The technical order library oversees the entire ICBM technical order process. Some responsibilities include managing the technical order improvement program.

Supply

The supply shop is responsible for all ICBM supply-related issues. They monitor acquisition of parts affecting the mission capability of the weapon system. If a problem prevents an LCC or LF from putting missiles on alert, and the part needed to fix the problem is not available, the site's mission capability is affected. The supply area uses the mission capability (MICAP) program to put a high priority on getting the needed part and restoring the capability of the weapon system.

620th Missile Operations Flight

The 620th Missile Operations Flight is a subdivision of 20th Air Force reporting directly to the commander. The flight commander also serves as the director of safety and nuclear surety for 20th Air Force. This flight operates the ICBM center of excellence (ICE), which is primarily responsible for providing evaluator and instructor training. This center ensures all ICBM instructors and evaluators receive the high quality, standardized training necessary to perform their critical roles. During combat capability evaluations, ICE personnel augment their counterparts in the logistics and operations divisions to assist with the inspections.

006. Intercontinental ballistic missile wing

Now that we have discussed AFGSC and 20th Air Force, our next level down the chain is the ICBM missile wing (MW). As a 3-level technician studying this CDC to advance to your 5-level, this is where you come in. You have been assigned to one of the three MWs; Malmstrom (341st MW), Minot (91st MW), or F.E. Warren (90th MW) (fig. 2–3).

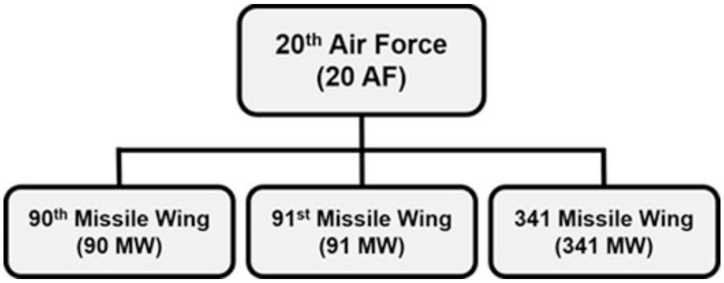


Figure 2–3. Organization of missile wings under 20th Air Force.

Operational wing

A wing is a level of command below a NAF (i.e., 20th Air Force) and has an operations group (OG) and a related operational mission activity assigned to it. The wing is the first level of command where all of the subordinate levels of command are located on the same installation.

For example, if you look at the NAF structure, you will see that its subordinate wings are not located together. In the case of 20th Air Force, its subordinate wings are located in three different states; Montana, North Dakota, and Wyoming. However, at the wing level, each of the subordinate groups is located on that installation. If you needed to see a finance technician in the mission support group, for instance, you would travel a short distance to another part of the installation.

Intercontinental ballistic missile wing mission

The mission of an ICBM MW is to provide combat ready forces for 20th Air Force and USSTRATCOM by safely operating, maintaining, and securing ICBMs. A typical ICBM MW is comprised of approximately 3,000 people in various organizations that mirror a typical Air Force wing structure. Each of the three ICBM MWs is responsible for keeping 150 Minuteman III missiles on alert throughout their respective areas of responsibility. Each MW is listed and described in the following table:

20th Air Force Missile Wings	
MW	**Description**
90th	Located at F.E. Warren AFB, Wyoming. Responsible for maintaining 150 Minuteman III missiles on alert, located over a 12,600-square mile area throughout Wyoming, western Nebraska, and northern Colorado.
91st	Located at Minot AFB, North Dakota. Responsible for maintaining 150 Minuteman III missiles on alert located in an 8,500-square mile area of North Dakota.
341st	Located at Malmstrom AFB, Montana. Responsible for maintaining 150 Minuteman III missiles on alert throughout a 13,800-square mile area in Montana.

007. Intercontinental ballistic missile group

Now that we have discussed the three MWs under 20th Air Force, let’s discuss ICBM missile groups. A typical ICBM MW is comprised of four groups (fig. 2–4):

1. Maintenance group (MXG).
2. Operations group (OG).
3. Mission support group (MSG).
4. Medical group (MDG).

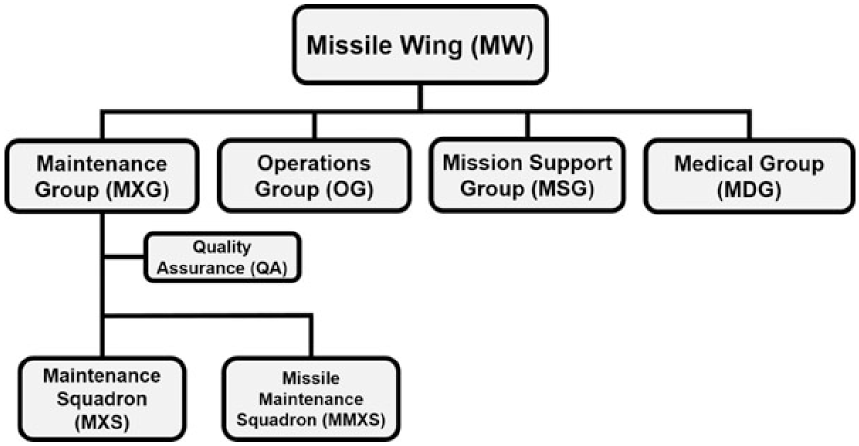


Figure 2–4. Organization of groups within a missile wing.

Each group plays a different, but equally important role in carrying out the wing's mission. Group commanders report directly to the wing commander. A group usually has two or more subordinate units and is a level of command directly below the wing. In this lesson, we will focus on the mission of the MXG and the OG.

Maintenance group

A MXG in an ICBM missile wing contains two squadrons—the maintenance squadron (MXS), and the missile maintenance squadron (MMXS). The structure of both squadrons is broken down into flights and sections. The MXG's mission is to support the wing's mission of keeping missiles on alert by using available materiel, resources, and data. The majority of ICBM maintenance personnel will spend most of their career in the MXG.

QA is a separate entity in the MXG. Administratively, this flight falls under the MXS for personnel administration, but operationally their office works directly for the MXG/CC. QAEs are responsible for conducting evaluations on field technicians and field training detachment instructors, and are the "eyes and ears" of the MXG/CC. QA is responsible for periodically reviewing technical orders and conducting technical reviews of time compliance technical orders (TCTO) and other modifications in the missile field. QAEs are chosen from among the best of each missile career field.

Operations group

The OG consists of three squadrons. Each squadron is responsible for monitoring and controlling 50 LFs and 5 MAFs. Other major responsibilities of the OG include the following:

- Provide facility managers and food service personnel (chefs) to maintain the MAF.
- Provide MCC members, whose main responsibility is to launch the missile and monitor the remote LFs.
- Maintain a codes section that is the focal point for weapon system coding material and code handler training.

008. Maintenance squadron

The responsibilities of the MXS are as follows:

- Maintain the status of all assigned LFs and MAFs.
- Coordinate training for missile maintenance personnel.
- Function as the centralized manager for manpower, mission support equipment facilities, and long-range planning.
- Centrally store, issue, inspect, and repair ICBM support equipment, guidance systems, and special purpose vehicles.

- Perform off-equipment maintenance on electrical, environmental, power generation, pneumatic and hydraulic systems associated with the ICBM weapon system.

The MXS is broken down into three flights; maintenance operations, training, and resources flight. These flights are then broken down into various sections (fig. 2–5).

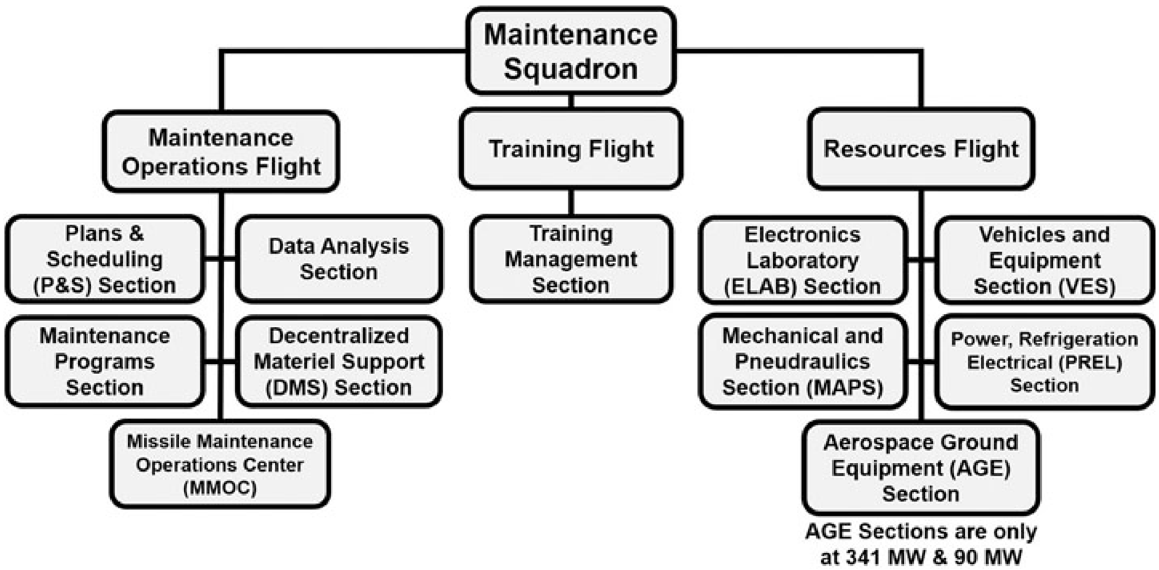


Figure 2–5. Maintenance squadron organization.

Maintenance operations flight

The responsibilities of the maintenance operations flight include the following:

- Maintain the status of all LFs and MAFs.
- Function as the resource advisor for appropriate responsibility center manager.
- Provide the MXG/CC and MMXS/MXS supervision with key information to assist in determining maintenance requirements and priorities.
- Act as the centralized manager of manpower, supply, mission support equipment (MSE), facilities, and long-range plans for all areas of maintenance.

The maintenance operations flight consists of the following:

- Plans and scheduling (P&S) section.
- Missile maintenance operations center (MMOC).
- Maintenance programs section.
- Data analysis section.
- Decentralized materiel support (DMS) section.

Plans and scheduling section

There are a lot of resources and coordination required to perform maintenance in the missile field and in the back shops. P&S serves as the focal point for the planning and scheduling of known maintenance requirements. The P&S section must coordinate with the OG, the MSG for security forces support, as well as many other sections in the MXG to create an accurate maintenance forecast. To accomplish this, it uses two distinct functions: planning and scheduling.

Planning function

The planning function includes all aspects of intermediate-range planning required to manage the MXG's workload. The planning function is responsible for the following:

- Developing, coordinating, and publishing maintenance forecasts.
- Developing and managing the unit TCTO, master change log (MCL), modifications, and time change programs.
- Ensuring periodic maintenance scheduling includes all requirements and the date completed does not deviate by more than 60 days each year from the last periodic maintenance inspection.
- Providing a monthly TCTO and MCL status to AFGSC logistics and missile engineering sections, the ICBM system program office engineering section, base missile engineering, and OG standardization and evaluation section.

Scheduling function

The scheduling function includes all aspects of short-range planning required to manage the MXG's workload. The scheduling function is responsible for the following:

- Coordinating the commitment of wing and group resources via the daily maintenance plan.
- Interfacing with missile engineering for depot assistance on real-property installed equipment (RPIE).
- Developing, coordinating, and publishing the maintenance schedule and holding daily meetings to coordinate the next day's actions.

As you can see, the planning function projects what maintenance will be required in the coming weeks or months. The scheduling function typically plans the next day's activities.

Missile maintenance operations center

MMOC serves as the focal point for priority 1 through 4 discrepancy reporting and is responsible for coordinating with the appropriate agencies to ensure mission accomplishment and execution of the daily maintenance schedule. Maintenance technicians working on- or off-base coordinate all maintenance activities with the MMOC. The MMOC operates 24 hours a day, 7 days a week, 365 days a year monitoring the status of each LF and MAF. Furthermore, MMOC tracks a maintenance team's arrival and departure times and monitors their timelines to ensure they are not exceeded.

Maintenance programs section

This section serves as the single point of contact in the maintenance complex for the management of personnel authorizations, unit finances, facilities, and MSE. The maintenance programs section prepares weapon system budgets and provides financial management to the maintenance organization. They also act as the single point of contact for overall guidance on mission support plans and support agreements.

Data analysis section

The data analysis section provides central oversight of all Integrated Maintenance Data System (IMDS) related functions within the MXG. This section consists of a combination of military and contractor personnel performing maintenance data functions. This section also establishes and leads the data integrity team. The purpose of the data integrity team is to evaluate, isolate, and eliminate documentation errors in IMDS.

The data analysis section maintains a site file for each LF and MAF which must include an Air Force Technical Order (AFTO) Form 95, Significant Historical Data, an inventory sheet that tracks all serially-controlled items, and forms that track LF and MAF emergency storage battery data. The data analysis section provides a central collection point for all maintenance data forms.

Decentralized materiel support section

The DMS provides central oversight of all supply and support related functions within the MXG. The section can consist of Department of Defense (DOD) civilian, military, and/or contractor personnel. The DMS stores or "bins" all the parts that are awaiting installation at an LF or MAF. The DMS is where a technician goes on the morning of a dispatch to gather all of the items they will need to complete their assigned work orders for that day. DMS also orders and processes parts that are ordered in IMDS.

Training flight

Now that you are familiar with the maintenance operations flight, let's take a look at the training flight. It has the responsibility to conduct, direct, monitor, and schedule all training that is not managed by a FTD. Also, the training flight is tasked with monitoring metrics regarding technicians that are awaiting training. Both civilians and military members make up the training flight which is comprised of the training management section and FTD.

Training management section

The training management section provides classroom training. As a newly assigned technician, you may already be scheduled for, or may have already completed, your training. As the name implies, training management manages all unit training programs. They also play a large part in the recurring technical training (RTT) that you and other technicians that dispatch receive every six months.

The UTM, who is responsible for managing all training within the MXG, is assigned to this section. Training management is responsible for managing the learning center's resources and equipment. Typically, the learning center is where you will go to fulfill your ancillary training.

Field training detachment

The FTD is where technicians go for training once a team-training slot becomes available. As we discussed earlier, the FTD falls under AETC, and is populated with experienced instructors who train young Airman to be competent field technicians. The instructors that teach the special purpose vehicle operations (SPVO) courses also fall under the FTD. If you are chosen to be a crane operator, or the tractor-trailer driver for your PMT team, SPVO provides the necessary training to operate these and other vehicles. Remember, the FTDs are *organizationally* located under AETC, but are *physically* located in your training flight.

Resources flight

The resources flight is the largest flight in MXS. These personnel perform off-equipment maintenance on electrical, environmental, power generation, and hydraulic systems associated with the weapon system. They also provide limited on-site repair of LF and MAF subsystems. Resources flight personnel centrally store, issue, inspect, and repair ICBM support equipment and special purpose vehicles. Resources flight consists of the following sections:

- ELAB.
- MAPS.
- PREL.
- VES.
- Aerospace ground equipment (AGE) (341 and 90 MWs only).

Electronics laboratory section

The ELAB shop consists of 2M0X1 (EMT) personnel who inspect, troubleshoot, and repair missile electronic and communication components and test equipment. They prepare electronic drawers for dispatch to LFs and MAFs, and they track spare MGSs by serial and part number. ELAB maintains a 24 hours per day, 7 days a week, 365 days a year maintenance capability.

Mechanical and pneudraulics section

The MAPS consists of 2M0X2 (MMT) personnel who inspect, troubleshoot, and repair hoists, mechanical support equipment, pneumatic and hydraulic components, support equipment, and special purpose vehicles. This section also conducts tests to ensure that weight-bearing items, such as lifting slings, will safely support their rated weight loads. They are responsible for operating and maintaining the proof-load test facility.

Power, refrigeration, and electrical section

The PREL section consists of 2M0X3 personnel who inspect, troubleshoot and repair weapon system ECS, power systems, electrical systems, support equipment, test equipment, and special purpose vehicles. PREL personnel also prepare and process LF and LCC emergency storage batteries, and prepare a variety of the chemicals that are used in the missile field.

Vehicle and equipment section

The VES manages assigned vehicles and equipment to meet scheduled and unscheduled missile maintenance requirements. In managing vehicles, the VES is responsible for ensuring maximum availability of safe and reliable, general and special purpose vehicles, and cranes to meet mission requirements. If there are vehicle discrepancies, the VES must coordinate with the logistics readiness squadron to correct them, and then complete inspection requirements.

In managing equipment, the VES must maintain a record of inspections and calibration of equipment owned by the unit. Therefore, this section must coordinate with the precision measurement equipment laboratory (PMEL) on items requiring calibration. Accountability is vital, so the VES personnel use load lists when checking items out to a maintenance team and then inspect the load for completeness upon return from a dispatch. As an equipment user, it is also vital you inform the VES personnel of any problems noted with equipment you used.

Aerospace ground equipment section

This section tracks and manages AGE inspection and maintenance requirements for the wing. Agencies throughout the wing have equipment items, such as portable lighting, portable heaters, and so forth that the AGE section maintains and inspects. The AGE section falls under the maintenance groups at the 341 MW and 90 MW, and under the 5th Bomb Wing at the 91 MW.

009. Missile maintenance squadron and contracted functions

Now that you are familiar with the many facets of the MXS, let’s take a look at the MMXS. Its mission is to maintain the launch readiness of the 150 LFs and 15 MAFs that comprise the missile field. The flights in MMXS have different roles, with each one covering a specific portion of the weapon system to ensure the ICBMs are on alert at all times. The MMXS consists of a facilities and generation flight (fig. 2–6).

Facilities flight

The facilities flight performs actions required to maintain the LFs and MAFs in optimal condition. This flight ensures operational readiness by troubleshooting and repairing power and environmental control systems, as well as performing periodic inspections, corrosion inspections, and other preventative maintenance.

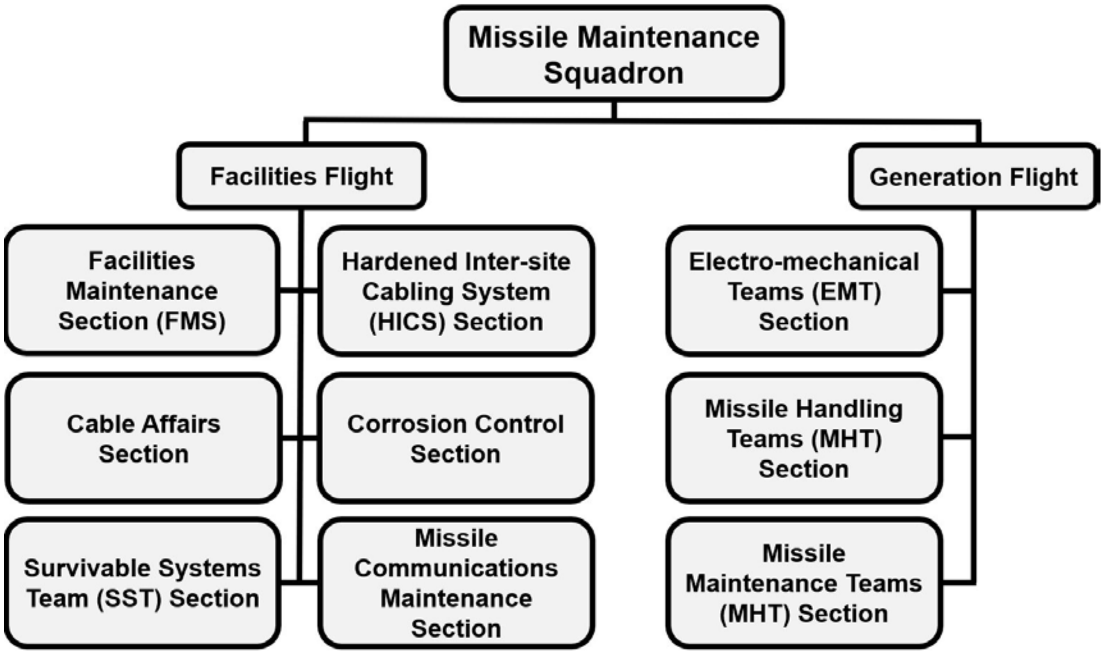


Figure 2–6. Missile maintenance squadron organization.

The facilities flight consists of the following sections:

- FMS.
- Corrosion control section.
- HICS section.
- Cable affairs section.
- Survivable systems team (SST) section.
- Missile communications maintenance (MCM) section.

Facilities maintenance section

The FMS consists of 2M0X3 personnel who are responsible for performing preventive maintenance in accordance with the scheduled periodic maintenance program, as well as performing on-site repair of LF and MAF power systems and ECS. The two major functions of the FMS are to perform periodic and facilities maintenance. This section also performs shotgun custodian duties for the missile complex.

Installed in each LF are two shotguns for added security when the secondary door is lowered and personnel are in the launcher. These weapons must be inspected and inventoried annually with the help of combat arms personnel. The FMS appoints a shotgun custodian to ensure these weapons are maintained properly and 100 percent accountable at all times.

Periodic maintenance

As mentioned, one of key responsibilities of the FMS is the periodic maintenance program. There are periodic inspection requirements on the LFs and MAFs that are performed on an annual, biennial, and triennial basis. Periodic maintenance is important to prevent future problems and ensure the weapon system is operating in optimal condition. The PMTs consist of at least five individuals—a team chief and four technicians—who dispatch as a team weekly.

Facilities maintenance team

An FMT typically consists of two individuals; a team chief and a team member. These teams also perform repair actions at the LFs and MAFs. However, their primary job is to respond to an alarm on the power, ECS, wastewater, and fuel systems. They perform other priority maintenance as required to maintain the missile on-alert status. FMT also performs on-site removal and replacements of major items, such as a brine chiller unit and diesel electric unit.

Corrosion control section

Corrosion control personnel perform corrosion treatment and repair of most items that would need corrosion control in the maintenance complex. They dispatch to the missile field and perform preventative corrosion treatment on the LFs and MAFs, but also treat support equipment, special purpose vehicles, and some facilities. A corrosion control team consists of four civilians.

Hardened intersite cabling system section

To connect all of the LFs together with other LFs and their parent LCCs causes an extensive network of underground cables that must be maintained. The HICS section personnel inspect, troubleshoot, and repair buried cables and spliced cable assemblies, as well as the cable air dryers that keep moisture from entering the system. HICS personnel operate heavy machinery necessary to excavate HICS cable sections, as well as to correct erosion issues along the cable path.

HICS personnel also maintain a cable yard which contains all of the spare cables that could be used in the missile complex. This cable is no longer manufactured, so they must be maintained as active cables, by using a pressure system and performing periodic inspections. A HICS team consists of at least two 2M0X3 technicians, one of which is designated the team chief.

Cable affairs section

The LFs and MAFs are spread out over thousands of square miles of land that the Air Force does not own. Buried HICS cables run through private land, and cable affairs personnel are responsible to engage with landowners and utility companies that own or operate the areas the HICS cables are buried on. Landowners must be notified in advance of any planned cable work on their property to prevent confrontations that could occur because of perceived trespassing. Railroads, utility companies, contractors, farm agencies, and highway and road departments must all contact cable affairs if any projects they plan might affect HICS. Cable affairs must contact these agencies at least every two years to ensure they understand their requirements. The cable affairs section consists of at least two 2M0X3s or trained civilian personnel.

Survivable systems team section

The SST section maintains the operational readiness of systems that provide LCC and LF hardness, enabling the MCC to survive and operate through a nuclear blast, shock, vibration, and thermal effects. The SST is responsible for maintaining LCC blast valves, LCC blast doors, LCC and LF shock isolation systems, and operator chairs. An SST team typically consists of two to four 2M0X2 technicians.

Missile communications maintenance section

The MCM section is a diverse section covering many duties that formerly were divided among three different communication career fields. These personnel perform preventative maintenance, troubleshooting, and repair on nearly all the communications infrastructure in the missile field. They perform maintenance on the communications infrastructure on site, but also in the missile wing command post. When one of the secure lines that is used for voice communications from the LF to the LCC malfunctions, an MCM team will be dispatched to troubleshoot and repair it. An MCM team normally consists of at least two 2M0X1 personnel.

Generation flight

The generation flight is responsible for maintaining assigned ICBM forces and generating missile sorties to alert status. This includes the transportation, removal, installation, and storage of Minuteman III boosters, RSs, and MGSs. Generation flight personnel perform coding operations on the weapon system and troubleshoot and repair ICBM communications, security, electrical, and certain power systems. The generation flight consists of the following sections:

- EMT.
- MHT.
- MMT.

Electro-mechanical maintenance team section

These teams perform electronic, security, and electrical system troubleshooting and repair, and coding of the weapon system. Additionally, an EMT repairs the emergency storage batteries on site, and troubleshoots and repairs all PAS components. An EMT consists of at least two 2M0X1 personnel.

Missile handling team section

MHT personnel have the responsibility to remove, install, and transport the Minuteman III missile downstages. They are also responsible for the on-base storage of missiles. Additionally, they operate the fleet of transporter erectors and are the primary custodian of the portable air conditioners (PAC). An MHT team consists of at least four 2M0X2 technicians.

Missile maintenance team section

MMT personnel remove, install, and transport the aerospace vehicle equipment, such as the re-entry vehicles (RV), MGSs, and PSREs. MMT also performs maintenance on the missile umbilical cable, missile suspension system, and the launcher closure system. MMT always assists MHT in the removal and installation of the missile. An MMT team consists of at least five 2M0X2 technicians.

Due to the critical nature and inherent danger involved in connecting, disconnecting, and hoisting the different stages of the missile, each technician is trained for only one position on the team. A technician must stay in that position unless they are trained specifically to perform in another position. It goes without saying that team integrity for MMT is critical. Generation flight leadership must approve any MMT substitutions.

Contracted functions

Within many organizations in the Air Force today, military members often work closely with civilian contractors. As a result, the Air Force and civilian corporations have developed rules and regulations that govern how they will work with each other. Civilians have their own set of maintenance requirements that must be fulfilled. In this lesson, we will discuss those maintenance requirements and the role they have in managing ICBMs.

Technical order distribution office

Technical orders are constantly changed or revised. As a maintenance technician, you rely on accurate technical orders to perform maintenance. If you are working on base your technical orders will be in your work center; and if you are dispatching to the field, you will pick up your technical order kits before you depart base. The technical order distribution office (TODO) function is tasked with managing the technical orders. As with other contracts, this one is command managed. The TODO establishes and maintains technical order accounts and subaccounts at the request of work-center supervisors.

Precision measurement equipment laboratory

Unlike command-managed contracts, the PMEL contract is a wing-level managed contract which is why it does not appear in figure 2–6. PMEL performs maintenance, calibration, and certification of test equipment. We rely on the test equipment to provide accurate readings. Torque wrenches must tighten fasteners to the torque to which they are set. In order to ensure that meters read accurately and torque wrenches provide the correct amount of torque, these items must be periodically calibrated. For example, a PMEL technician uses a known reference voltage, let’s say 120 volts alternating current (VAC), to ensure that the meter being calibrated reads within a small margin of error the 120

VAC reference voltage. If the meter does not show the correct reading, the technician will calibrate it. If it cannot be calibrated, or brought within the proper tolerance, the meter is removed from service.

010. Related intercontinental ballistic missile organizations

There are a few ICBM organizations and units, outside of the ones already discussed, with missions and responsibilities that support the ICBM mission. As an ICBM maintenance technician, you should be knowledgeable of these organizations and their role in the ICBM community. It is likely you will be assigned to one of these units during your career. In this lesson, we will discuss these organizations and their missions.

576th Flight Test Squadron

As we discussed earlier, the 576 FLTS provides overall day-to-day management of AFGSC's force development and evaluation program. Located at Vandenberg AFB, California, the 576 FLTS plans and performs ground, flight, and space system tests in a simulated operational environment. From these tests the test squadron collects, analyzes, and reports performance accuracy, reliability, aging, and surveillance data. If problems occur during an evaluation, the 576 FLTS assesses the problem and reports that information as well.

The 576 FLTS is primarily responsible for operational test launches (OTL) and simulated electronic launch of Minuteman (SELM) ICBMs. The following table describes each type test.

576 FLTS Responsibilities	
Type Test	**Description**
OTL	For an OTL a missile is shipped from one of the missile wings to Vandenberg AFB and is actually launched. During this process, squadron personnel are tasked with assembling all test components, testing, and launching unarmed ICBMs. This includes installing telemetry equipment and command-destruct packages on the test missiles. Once an ICBM is launched from Vandenberg AFB, the 576 FLTS refurbishes the missile site to be used again.
SELM	A SELM is conducted on ICBMs in their deployed LFs at their operational units without launching the missile. The test stops before first stage ignition, the 576 FLTS personnel oversee the complete simulated process. Again, during a SELM, the missile stays at its LF and undergoes a "simulated" launch.

Technical engineering flight

There is a technical engineering (TE) flight at each MW, but they do not belong to the MXG. They belong to the 526th ICBM Systems Group (ICBMSG) at Hill AFB, Utah, and are a part of Air Force Materiel Command (AFMC). The TE flight provides the technical expertise necessary to resolve abnormal weapon system problems. This is the team you will turn to when an issue arises that is outside of the normal scope of your shop. They review data, conduct studies, and develop changes required to improve the weapon system. The TE flight personnel also perform the following:

- Maintain the capability to perform maintenance.
- Direct maintenance teams to use procedures that are in technical orders or civil engineering manuals (CEM).
- Maintains the capability of using all weapon system technical orders, including depot level technical orders, contractor data, depot instructions, CEMs, as-built drawings, and other engineering data.
- Direct qualified technicians to take readings from approved test points using approved test equipment, while referenced in the technical orders, CEMs, schematics, or diagrams.

- Maintain qualifications on ground, missile, and nuclear safety requirements; security requirements, missile potential hazard procedures, emergency war order support, critical component control, and other appropriate tasks.

381st Training Group

The 381st Training Group (TRG) is an AETC organization located at Vandenberg AFB, California. The three squadrons that make up the group provide qualification training for ALCM and ICBM maintenance, space operations, and ICBM operations.

While three squadrons make up the 381st TRG, only the 532nd Training Squadron (TRS) is responsible for maintenance training. When you attended technical training at Vandenberg AFB, you were assigned to the 532nd TRS. Qualified instructors provide students with thorough classroom and realistic hands-on training using a wide range of trainers, including a Minuteman III LF trainer. Graduates from the 532nd TRS courses receive assignments to AFGSC in either ICBM maintenance for 20th Air Force or cruise missile maintenance in 8th Air Force.

In addition to the entry-level courses, the 532nd TRS conducts advanced training for maintainers who have field experience. The verification and checkout equipment (VACE) and TE courses are for personnel hand selected to perform specialized duties.

The ALCM that your 2M0X1B comrades work on must be tested to ensure they perform as expected while in flight. Specialized equipment is required to simulate an in-flight environment as well as gather data from the MGS to ensure that it is functioning properly. The instructors of the VACE course provide the training necessary to operate this specialized test equipment.

As stated earlier, TEs troubleshoot abnormal problems with the weapon system. The TE course instructors at the 532nd TRS provide advanced troubleshooting knowledge and techniques. To accomplish this, the students are provided electronics principles and circuit building, as well as extensive knowledge of how individual circuits in the weapon system perform their functions. Students in the TE course also learn how to interpret complicated technical manuals and contractor data.

The squadron is also responsible for the ICBM maintenance officer course. Maintenance officers in the 21M career field spend time learning about each missile maintenance discipline, to prepare them to be well-rounded senior leaders of tomorrow.

Lastly, the CDC authors are assigned to the 532nd TRS. They are responsible for developing and maintaining CDCs for the 2M0X1A and B, 2M0X2, and 2M0X3 career fields. Enlisted personnel use CDCs to upgrade to higher skill levels, and the CDC information is used to develop specialty knowledge tests used for promotion. CDCs satisfy the knowledge portion of your upgrade training, so they do not contain detailed information about how to perform certain tasks.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

004. Air Force Global Strike Command

1. Why was AFGSC established?

2. What capability do long-range bombers and land-based ICBMs give AFGSC?

3. What NAFs comprise AFGSC?

005. 20th Air Force

1. What is the mission of 20th Air Force?

2. What kind of limitations could prevent a missile unit from resolving a situation, leading to a MPH?

3. What section of the 20th Air Force Logistics Division would 2M0X1 personnel with EMT experience assigned to?

4. What does the supply area of the 20th Air Force support section use the MICAP system for?

006. Intercontinental ballistic missile wing

1. What is the mission of an ICBM MW?

2. For what is each ICBM MW responsible?

007. Intercontinental ballistic missile group

1. List the groups the ICBM missile wing is comprised of.

2. What is the MXG’s mission?

3. What are QA evaluators responsible for conducting technical reviews on?

4. What is the responsibility of MCC members?

008. Maintenance squadron

1. Match the section in column B with their functions in Column A. Items in Column B may be used once, more than once, or not at all.

Column A

____ (1) Develops, coordinates, and publishes a maintenance forecast.
____ (2) Monitors the status of each LF and MAF.
____ (3) Provides central oversight of all supply and support related functions within the MXG.
____ (4) Manages the learning center resources and equipment.
____ (5) Inspect, troubleshoots, and repairs hoists, mechanical support equipment, support equipment, and special purpose vehicles.
____ (6) Prepares and processes LF and LCC storage batteries.
____ (7) Uses load lists to checkout items to maintenance teams.

Column B

a. Missile maintenance operations center
b. Plans and scheduling
c. Training management
d. Field training detachment
e. Mechanical and pneudraulics
f. Power, refrigeration, and electric
g. Vehicles and equipment
h. Aerospace ground equipment
i. Decentralized materiel support

009. Missile maintenance squadron and contracted functions

1. Match the section in column B with their functions in Column A. Some items in Column B may be used more than once.

Column A

____ (1) Performs on-site repair of LF/MAF power and environmental systems.
____ (2) Maintains a cable yard.
____ (3) Responsible for maintaining LCC blast valves, LCC blast doors, LCC/LF shock isolation systems, and operator chairs.
____ (4) Responsible for performing preventative maintenance, troubleshooting, and repair on nearly all the communications infrastructure.
____ (5) Performs repair actions on emergency storage batteries on site.
____ (6) Removes, installs, and transports Minuteman III missile downstages.
____ (7) Removes, installs, and transports aerospace vehicle equipment.

Column B

a. Facilities maintenance
b. HICS
c. Electro-mechanical team
d. Missile handling team
e. Missile maintenance team
f. Survivable systems team
g. Missile communications maintenance

2. What action does the PMEL section perform to ensure items like multimeters and torque wrenches provide accurate readings and torque values?

010. Related intercontinental ballistic missile organizations

1. What are 576 FLTS personnel tasked with during an OTL?

2. What does TE provide?

3. What qualification training does the 381st TRG provide?

2–2. General and Specific Responsibilities

The US government and the American people have entrusted you and your organization with the awesome responsibility of maintaining the nation's ICBM fleet. There are special responsibilities that come along with this task with which you and your management team must understand and comply. This section will focus on some general responsibilities that all personnel who work in the ICBM business must know and understand as well as some specific responsibilities of the different duty titles to which you or your leadership may be assigned.

011. General responsibilities

All maintenance actions and management efforts must be directed towards maximum availability of ICBMs in support of USSTRATCOM requirements and directives. All maintenance supervisors are required to use all resources in the most effective and efficient way with emphasis on safety and welfare of the technician. Maintenance activities will ensure quality maintenance and absolute compliance with technical data, safety, and security standards.

Maintenance supervision

The maintenance mission is *missile and equipment readiness.* All levels of your supervision place emphasis on safety, security, quality, and timeliness of the maintenance you perform. Your maintenance ensures that the equipment and the fleet of ICBMs you maintain are safe, serviceable, and properly configured to meet mission needs.

Preventive maintenance

The purpose behind everything you do is to sustain the capability to support the mission. Have you ever heard the phrase "a stitch in time saves nine"? It is an old proverb that refers to boat sails. It was much easier to periodically stitch up a tear in a sail than it was to wait until the wind tore a large hole in the sail. This also applies to our ICBM weapon system. Your primary focus should always be to put maximum effort toward preventive maintenance rather than corrective maintenance. Keep this in mind while you are performing maintenance on a MAF, LF, or on the support base.

Find-and-fix maintenance

One of the most effective ways we can be proactive rather than reactive, is to comply with the *find-and-fix concept.* While each maintenance team dispatches to an LF or a MAF for a specific purpose, they must still be attuned to their surroundings. If a technician discovers a discrepancy, and if it can be repaired within their timelines and capabilities, they should fix it on the spot. If a team's timeline does not allow it or a team is incapable of fixing it due to lack of qualifications, parts, or other circumstances, that team must ensure it is documented properly. Proper care of the weapon system is critical to successful mission accomplishment.

Technical order usage

The use of approved technical orders is mandatory when performing maintenance on the weapon system. There is even a technical order for performing checkouts on some vehicles and equipment. For this reason, always submit technical order recommended changes when you find technical order deficiencies. You will find that as time goes on, you will become very familiar with the tasks you perform. Continually ask yourself "why are the steps in this task out of order?" or "why is this task missing a step?" Then complete an AFTO 22, Technical Manual (TM) Change Recommendation and Reply, if necessary. Your actions will make the technical orders more accurate for you and other technicians down the road.

Safety

Safety should be at the forefront of maintenance planning and execution. The Air Force outlines the following key factors when it comes to safety when working with the ICBM weapon system:

- Each unit is required to develop plans and supplements to outline the roles and responsibilities of maintenance personnel during missile or nuclear mishaps and disaster control situations.
- The MCC is in command of both the LF and MAF at all times. The MCC has full authority to stop any task before it begins, or to terminate a task that has already been started.
- The maintenance team chief is responsible for safe operations on site and can stop any task before it begins, or terminate a task that has already been started.

Adequate rest is a prime concern for technicians driving long distances or working long hours in the maintenance complex. Crew rest requirements can be found in Air Force Manual (AFMAN) 21–200, *Munitions and Missile Maintenance Management.* Crew rest rules are established as follows:

- The maximum duty period for dispatching personnel is 16 hours in any combination of on- or off-base duties.
- The official duty time or "timeline" starts when personnel report for duty or start their standby period, if on call.
- The duty period ends when personnel turn in all equipment and vehicles or release these items to another individual or team.
- All personnel receive an uninterrupted 12-hour rest period upon completion of an off-base dispatch. Technicians who remain overnight at a MAF receive 10 hours of crew rest.

Remember, whether you are a technician on an EMT team, an instructor in the training flight, or a squadron commander, safety should always be at the forefront of your mind. ICBM maintainers spend tens of thousands of miles behind the wheel of various vehicles, and work in many different and extreme weather conditions. If something does not seem right, call it out. Take a step back and review the procedure you are using, or make a phone call to get clarification.

012. Specific responsibilities

Now that we have discussed general responsibilities that all technicians adhere to, let's talk about specific responsibilities. This lesson provides an overview of specific responsibilities of each level in the MXG. This lesson will help you understand how your leadership teams make their decisions. Keep in mind going through this information that not all requirements will be listed for all individuals. You can find a detailed listing of specific responsibilities for all levels in Air Force Instruction (AFI) 21–202, Volume 1, *Missile Maintenance Management.*

Maintenance group commander

The MXG/CC is responsible for providing maximum warfighting capability to the Wing/CC by properly managing the maintenance complex. Some of these responsibilities include the following:

- Ensure development of QA and training programs.

- Ensure compliance with environmental requirements.
- Ensure sections use IMDS to issue and receive equipment and vehicles.
- Ensure a program is in place for corrosion control and detection on all equipment and facilities.

Maintenance group superintendent

The maintenance group superintendent (MXG/SUPT) will ensure consistent maintenance practices according to technical data, ICBM weapon system safety rules (WSSR), and established management procedures throughout the group. In addition, the MXG/SUPT will perform the following:

- Serve as the technical advisor to the MXG/CC.
- Serve as the MXG's focal point for enlisted manning.
- Advise the MXG/CC on personnel, morale, and welfare issues.

Squadron commanders

The squadron commanders (SQ/CC) provide maximum warfighting capability to the MXG/CC. The SQ/CC is responsible for overall squadron management and mission accomplishment.

Maintenance operations officer and superintendent

The MXS and MMXS each have their own maintenance operations officer (MOO) and superintendent (SUPT). Collectively known as the SQ/MOO and SUPT, these individuals manage maintenance production and assigned resources to achieve maximum war fighting capability. Additionally, they are responsible for the following:

- Ensure flights have all required tools and equipment.
- Certify all newly assigned ICBM maintenance team chiefs.
- Periodically review unit production indicators, such as incomplete work orders, late dispatches, and technicians in training status.

Flight commanders and flight chiefs

Flight/CCs and flight chiefs are responsible for the overall management and supervision of personnel in the flight. This includes the overall planning and execution of all daily maintenance. Additionally, the flight CC and chief perform the following:

- Emphasize safety, security, technical order usage, and nuclear surety.
- Commit flight resources via the daily maintenance schedule.
- Ensure maintenance teams do not exceed established timelines.
- Ensure subordinate work centers effectively manage workloads.
- Establish a tool control program that prevents fraud, waste, abuse, and loss.

Section officer in charge and noncommissioned officer in charge

The section officer in charge (OIC) and noncommissioned officer in charge (NCOIC) are responsible to the flight/CC and chief for the effective management, supervision, and training of assigned maintenance technicians. The section OIC/NCOIC performs the following:

- Verify that teams are qualified to perform tasks using TBA.
- Provide equipment load lists to VES for known maintenance dispatches.
- Ensure team chiefs and task supervisors keep MMOC informed of job status.
- Notify QA monthly of team structure and notify them in advance when using technicians that were not identified previously.
- Notify MMOC and flight supervision of any change to availability of resources that were committed to the maintenance schedule.

- Ensure 100 percent task coverage. There must be qualified technicians available to perform any task the work center is responsible to perform.
- Ensure personnel are current on ground, missile, explosive, and nuclear safety training; Air Force two-person concept; no-lone zone requirements; security requirements; personnel reliability program (PRP); and MPH requirements as applicable.

Task/site supervisor

The task/site supervisor ensures safe, secure, and reliable nuclear weapons and systems maintenance. They also ensure safe large maintenance vehicle and crane operations and they must be knowledgeable of the assigned maintenance tasks. Additionally, the task/site supervisor will perform the following:

- Ensure maintenance technicians follow approved technical orders.
- Assist with developing and executing the maintenance schedule.
- Recommend sub-standard performers to the section NCOIC for decertification and remedial training.

Team chiefs

Team chiefs are responsible for work accomplished by the technicians they supervise on site or on in-shop tasks. All team chiefs must possess a minimum of a 7-skill level; however, the MXG/CC (576 FLTS/CC at Vandenberg AFB) may waive this requirement if warranted. Team chiefs will perform the following:

- Ensure technical orders are available and used to complete the tasks.
- Comply with Environmental Protection Agency requirements.
- Ensure checkout, inspection, safe operation and care of vehicles, equipment, tools, and parts.
- Ensure vehicles for field dispatches have all necessary equipment to include emergency and survival kits.
- Review work residue file for other work orders that can be accomplished during scheduled maintenance.
- Comply with applicable ground, missile, explosive, and nuclear safety requirements; two-person concept and no-lone zone requirements; security requirements; PRP; MPH procedures; and code handling requirements.

Technicians

You will soon be operating at the technician level. The technician is responsible to the team chief or task supervisor in performing the following tasks:

- Use technical orders to accomplish tasks.
- Ensure all items required to perform the tasks are available.
- Perform checkout, inspection, safe operation, and care of vehicles.
- Maintain, control, properly use, and care for assigned tools and equipment.
- Inspect the site or support equipment and fix or document any discrepancies.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

011. General responsibilities

1. What must a team or technician do if a discrepancy is discovered on site and they have the time, but are not qualified to correct the discrepancy?

2. What two personnel have the authority to prohibit the commencement and direct the termination of tasks on LFs?

3. When does a team or technician timeline officially start?

012. Specific responsibilities

1. What is the MXG/CC responsible to ensure sections use IMDS for?

2. Who serves as the technical advisor the MXG/CC?

3. Who certifies all newly assigned ICBM maintenance team chiefs?

4. Why must the section OIC or NCOIC ensure 100 percent task coverage?

5. What must team chiefs ensure technical orders are available and used?

6. What must a technician do with discrepancies discovered during an inspection of the site or support equipment?

Answers to Self-Test Questions

004

1. To consolidate all Air Force nuclear mission activities under one operational chain of command.
2. Ability to conduct strike operations anywhere on the globe.
3. 20th and 8th Air Force.

005

1. Operate, maintain, secure, and ensure the safety and combat readiness of the nation's ICBM force.
2. Technical orders, personnel, or hardware.
3. Electrical.
4. To put a high priority on getting the needed part.

006

1. Provide combat ready forces for 20th Air Force and USSTRATCOM by safely operating, maintaining, and securing ICBMs.
2. Keeping 150 Minuteman III missiles on alert throughout their respective areas of responsibility.

007

1. Maintenance, medical, operations, and mission support.
2. Provide maintenance support of the wing's mission of keeping missiles on alert with materiel, resources, and data.
3. TCTOs and other missile field modifications.
4. To launch the missile and monitor the remote LFs.

008

1. (1) b.
   (2) a.
   (3) i.
   (4) c.
   (5) e.
   (6) f.
   (7) g.

009

1. (1) a.
   (2) b.
   (3) f.
   (4) g.
   (5) c.
   (6) d.
   (7) e.
2. Periodic calibration.

010

1. Assembling all test components, then testing and launching unarmed ICBMs.
2. Technical expertise to resolve abnormal weapon system problems.
3. Provide qualification training for ALCM and ICBM maintenance, space operations, and ICBM operations.

011

1. Ensure it is documented properly.
2. MCC and the maintenance team chief.
3. When they report for duty or start their standby period.

012

1. To issue and receive equipment and vehicles.
2. MXG/SUPT.
3. MOO and SUPT.
4. Because there must be qualified technicians available to perform any task the work center is responsible to perform.
5. All necessary parts, tools, equipment, and technical orders.
6. Fix or document them.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

Do not return your answer sheet to AFCDA.

7. (004) Which two weapon assets merged to form the Air Force Global Strike Command?
   a. Intercontinental ballistic missiles (ICBM) and long-range bombers.
   b. Cyberspace forces and long-range bombers.
   c. Space launch and cyberspace forces.
   d. ICBMs and space launch.

8. (004) The Air Force Global Strike Command's mission supports the
   a. secretary of state and combatant commanders (COCOM).
   b. secretary of the Air Force and the president.
   c. president and the chief of staff.
   d. president and COCOMs.

9. (004) The 8th Air Force plans and executes nuclear deterrence for
   a. intercontinental ballistic missiles.
   b. space launch nuclear assets.
   c. short-range bombers.
   d. long-range bombers.

10. (005) Which combatant command does the 20th Air Force fall under to support real world missions?
    a. US Central Command (USCENTCOM).
    b. US Strategic Command (USSTRATCOM).
    c. US Northern Command (USNORTHCOM).
    d. US Transportation Command (USTRANSCOM).

11. (005) Who serves as the team chief for the missile potential hazard system?
    a. Commander, Air Force Global Strike Command.
    b. Maintenance operations flight commander.
    c. 20th Air Force Director of Logistics.
    d. Maintenance group superintendent.

12. (005) Select the 20th Air Force logistics division section that compiles maintenance data analysis reports and generates weapon system metrics.
    a. Support.
    b. Facilities.
    c. Communications.
    d. Intercontinental Ballistic Missile Readiness.

13. (006) Identify the first level of command where all of the subordinate levels of command are located on the same installation.
    a. Numbered Air Force.
    b. Major command.
    c. Squadron.
    d. Wing.

14. (007) A typical missile wing is comprised of maintenance,
    a. operations, mission support, and medical groups.
    b. transportation, mission support, security forces, and operations groups.
    c. operations, communications, mission support and security forces groups.
    d. training operations, missile operations, communications, and security forces groups.

15. (008) Up to how many days can the periodic maintenance schedule deviate by from the last periodic maintenance inspection date?
    a. 30.
    b. 60.
    c. 90.
    d. 120.

16. (008) The missile plans and scheduling section holds daily meetings to
    a. provide status on all new 1 through 4 discrepancies.
    b. coordinate training for maintenance personnel.
    c. provide status updates on launch facilities.
    d. coordinate the next day's actions.

17. (008) Which missile wing center tracks the maintenance team's arrival and departure times?
    a. Plans and scheduling.
    b. Technical engineering.
    c. Maintenance programs.
    d. Missile maintenance operations.

18. (008) The unit training manager (UTM) is responsible for
    a. training 5-level core tasks.
    b. providing recurring team training.
    c. managing all training within the maintenance group.
    d. training technicians to be competent field technicians.

19. (008) The electronics laboratory section tracks spare missile guidance sets by
    a. referencing the significant historical data form.
    b. maintaining a record of inspections.
    c. using specially prepared load lists.
    d. serial and part number.

20. (008) The mechanical and pneudraulics section is responsible for operation and maintenance of the
    a. vehicles used in the missile field.
    b. on-base training launch facility.
    c. test equipment used on base.
    d. proof-load test facility.

21. (009) Each year the shotguns installed on each launch facility must be
    a. inventoried and cleaned.
    b. inspected and inventoried.
    c. disassembled and cleaned.
    d. disassembled and inspected.

22. (009) A facilities maintenance team will
    a. replace emergency storage batteries.
    b. perform periodic maintenance.
    c. maintain the cable air dryers.
    d. replace brine chiller units.

23. (009) An electro-mechanical maintenance team
    a. repairs a missile downstage.
    b. installs a diesel electric unit.
    c. installs the missile guidance set.
    d. repairs the emergency storage batteries.

24. (009) Which task would a missile maintenance team perform at a launch facility?
    a. Emergency storage battery reconditioning.
    b. Launcher closure system maintenance.
    c. Emplacement of a missile downstage.
    d. Installation of a brine chiller unit.

25. (010) Which is a function of the 576th Flight Test Squadron?
    a. Develops changes required to improve the weapon system.
    b. Provides technical expertise to troubleshoot abnormal problems.
    c. Conducts simulated electronic launches of the Minuteman missile.
    d. Conducts studies of the Minuteman weapon system in an effort to improve its performance.

26. (010) Technical engineering flight personnel will *only* direct technicians to
    a. take readings from unapproved test points using approved technical order procedures.
    b. reference a technical order schematic to take readings from approved test points.
    c. take readings from approved test points without referencing a technical order.
    d. use unapproved test equipment to take readings from approved test points.

27. (010) The Verification and Checkout Equipment course provides training on how to
    a. operate a wide range of air-launched cruise missile (ALCM) flight simulators.
    b. operate specialized equipment that gathers data from the ALCM guidance set.
    c. maintain a record of inspections and calibration of equipment owned by the unit.
    d. verify and assign equipment to meet scheduled and unscheduled maintenance requirements.

28. (011) A maintenance team should fix a discrepancy on the spot if they are within their timelines and have
    a. a rest day the next day.
    b. the documentation.
    c. the capabilities.
    d. permission.

29. (011) Upon return to base, your duty period ends when you turn in all equipment and vehicles or
    a. you depart for your residence.
    b. you release these items to another individual or team.
    c. the vehicles and equipment section supervisor releases you.
    d. the team chief notifies the missile maintenance operations center.

30. (012) Who serves as the maintenance group's focal point for enlisted manning?
    a. First sergeant.
    b. Flight commander.
    c. Maintenance group commander.
    d. Maintenance group superintendent.

31. (012) Identify the person responsible to ensure flights have all required tools and equipment.
    a. Training superintendent.
    b. Section officer-in-charge.
    c. Maintenance superintendent.
    d. Maintenance operations flight commander.

32. (012) What must the section noncommissioned officer in charge provide to the vehicles and equipment section for known maintenance dispatches?
   a. Pre-task briefings.
   b. Projected schedule.
   c. Equipment load lists.
   d. Team composition letter.

33. (012) Who is responsible for work accomplished by the technicians they supervise on site or on in-shop tasks?
   a. Maintenance group commander.
   b. Officer in charge.
   c. Flight chief.
   d. Team chief.

Please read the unit menu for unit 3 and continue ➔

Unit 3. Weapon System Features

TO NEUTRALIZE AGGRESSIVE ACTIONS of foreign countries, the US maintains a peace-seeking counterforce. A major part of this counterforce is its land-based missile force consisting of the Minuteman III ICBMs, which the Air Force is responsible for maintaining. As a facilities maintenance technician, you have an important role in keeping this weapon system on alert. This unit focuses on the mission of ICBMs, features of the weapon system, and a general overview of the facilities.

3–1. Weapon System Characteristics and Deployment

You play a key role in the success of the ICBM mission, so it is only fitting you comprehend the importance of the weapons you maintain. The following paragraphs will give you an understanding of the mission, strategic characteristics, and how the Minuteman III weapon system is deployed and controlled.

013. Intercontinental ballistic missile mission

At the end of World War II, clashes between American and Soviet interests sparked the beginning of the Cold War. Over the next thirty years, both superpowers built up large arsenals of nuclear weapons to deter the other from attacking. The mid 1980s saw the economic collapse of the Soviet Union and the end of the Cold War as the US became the world's only superpower. Remember, though, the Soviet arsenal and stockpile of nuclear weapons still exists. During the Cold War, numerous countries developed the technology to build nuclear weapons; even today, unfriendly nations are secretly working to develop both nuclear weapons and other weapons of mass destruction (WMD).

Mission

The events of September 11, 2001 caught the attention of the world, brought about the global war on terrorism, and changed the role of ICBMs. Traditionally, the mission of ICBMs was deterrence of aggression through the threat of massive retaliation. In other words, knowing the US could unleash the destructive power of its nuclear ICBM arsenal is enough to discourage any potential enemy from launching a nuclear attack against the US.

Recent world events further expanded the ICBM mission to deter regional adversaries from employing WMD against our deployed forces. Additionally, ICBMs deter nations from supporting or sponsoring terrorist organizations that may employ WMD in a terrorist attack against our nation. This deterrence also prevents our adversaries from taking aggressive actions that threaten our national security interests, allies, partners, or friends. However, if this deterrence should fail, the mission of the Air Force's ICBM fleet is to deliver thermonuclear warheads to preselected strategic targets. If required, the order to launch an ICBM attack will come from our nation's top leadership position and filter down to the officers who will execute the launch order. Ultimately, the authority to launch an

ICBM attack rests with the president of the US; however, the means of delivering such an attack rests with AFGSC. The president's order will pass down through several levels of command before reaching the ICBM launch crews for verification. Once the launch crews authenticate the order, they will proceed to launch their ICBMs as ordered.

Strategic characteristics

Before we continue our discussion, you should understand what the term *weapon system* means. A weapon system includes all of the related equipment, material, services, and personnel required to maintain a self-sufficient unit in its intended operational environment.

The Minuteman III weapon system is an offensive system that uses ballistic missiles with intercontinental range. The LFs are located in low-population areas of the continental US. The following list shows the five major strategic characteristics of the Minuteman weapon system:

1. Rapid reaction.
2. Thermonuclear striking power.
3. High accuracy.
4. Low vulnerability to attack.
5. High in-commission rate.

Rapid reaction

The rapid reaction characteristic of ICBMs is the capability to launch less than one minute after the launch crews receive and verify their orders. The following features contribute to the rapid reaction characteristic:

- ICBM stage motors use solid propellant as fuel; therefore, the missile is always ready to launch.
- ICBMs have an on-board guidance system which is pre-targeted and capable of quick transition from in-place monitoring mode to flight control mode.
- LFs are tied to LCCs by a multipath HICS and radio network, allowing the missiles to launch immediately after launch crews initiate the launch command.

Thermonuclear striking power

The thermonuclear striking power of the ICBM weapon system separates it from other military weapon systems. Although the Minuteman III ICBM is capable of delivering up to three independently targeted warheads, the Strategic Arms Reduction Treaty (START) limits the USs' land-based ICBM fleet to only one warhead per missile.

High accuracy

The ICBM high accuracy characteristic is due greatly to its on-board guidance system. The exact coordinates for each LF are established and entered into the guidance computer of the missile. The on-board guidance system is designed to reference its launch point, update and compute flight data, and control all critical missile functions during flight. This accurate and efficient guidance system gives the ICBM the capability to deliver its payload precisely to the designated target.

Low vulnerability

The ICBM low vulnerability characteristic includes features that protect the weapon system from potentially harmful or catastrophic events. These events include damage from enemy attacks, intrusions into weapon system facilities by unauthorized personnel, and losing the ability to transmit the commands necessary for missile launch.

The LFs and LCCs are hardened to withstand attack. This hardening includes measures to resist blast, heat, and radiation. Additionally, LFs and MAFs are built far enough apart that no two would sustain damage from the same attack. Security is maintained by site hardness, inner and outer zone security systems, and security forces response teams. The capability to launch missiles is assured by *redundant control*. That is, each squadron of 50 missiles and five LCCs are interconnected. Each LCC is capable of controlling all missiles within its squadron. Additionally, the missiles can be launched by radio link from airborne launch control centers (ALCC) if the missiles cannot be launched from an LCC. The MGS makes the missile independent of outside control after launch, and thus immune to attack while in flight. Furthermore, penetration aids confuse target defense systems so the warhead arrives as intended.

High in-commission rate

Historically, the Minuteman III weapon system has maintained an incredible 99 percent missile alert rate. This means nearly the entire fleet is ready for launch at any given time. The high in-commission characteristic of the ICBM weapon system exists for several reasons, including the following:

- The weapon system was designed to operate for long periods with minimal maintenance.
- All LFs are monitored remotely by the LCCs with launch crews on duty 24 hours a day, 7 days a week. Launch crews can quickly report any fault indication from the LF or LCC to the MMOC located at the MSB.
- MMOC personnel then coordinate with other MSB work centers to dispatch the appropriate maintenance team to the LF or LCC reporting the fault.
- The team takes the necessary equipment, replacement spares, and technical data to fix the fault. Once at the facility, the team troubleshoots, repairs, or replaces the faulty item(s), placing the facility back on alert status.
- Faulty items that can be repaired are returned to the MSB or depot level function for repair. This remove-and-replace maintenance performed at the LCC and LF minimizes the ICBM weapon system downtime.

014. Deployment and control

When the Minuteman ICBM was designed originally, a great deal of effort went into determining the best way to deploy and control the weapon system. This resulted in radical changes to the “old way” of thinking as it pertained to ICBMs. More than 60 years have passed since then, and the system is still operating. In the next few paragraphs, we will discuss how the weapon system is deployed and controlled.

Deployment

When referring to the Minuteman III weapon system, the word “deployment” refers to the arrangement or placement of the various components that make up the weapon system. The basic component of the ICBM weapon system is the missile; however, the missile alone does not make the weapon system. The missile needs support in the form of power, environmental support, security, and so on. This support is provided by various systems at the LF. Prior to launch, each Minuteman missile is held in a readiness condition at an unmanned, underground-hardened LF. These LFs are dispersed over large, relatively unpopulated areas in the US (fig. 3–1).

Control

While the LFs are unmanned, some form of supervision and control is still required. The crew located in the LCC satisfies this requirement. The LCC is a hardened facility located underground at the MAF. MAFs are located at least three nautical miles from any LF. At least two launch officers man the LCC. The reason for this is to maintain compliance with the *two-person concept* (TPC), which is designed to prevent a lone individual from accidentally or maliciously launching a missile.

Figure 3–1. Intercontinental ballistic missile deployment.

The LCCs and LFs are organized into a system of Air Force levels in flights, squadrons, groups, and wings, as follows:

- One LCC and ten LFs make up one *flight*.
- Five flights (5 LCCs, 50 LFs) make up one *missile squadron*.
- Three missile squadrons (15 LCCs, 150 LFs) make up an OG.
- At Malmstrom AFB and F.E. Warren AFB, the OG, combined with all of the supporting units (MXG, mission support group (MSG), MDG, and others) at the MSB makes up the MW. At Minot AFB, the MW is a tenant organization on the base, so the host unit (5th Bomb Wing) handles various support aspects of the base's mission (MSG, MDG, etc.).

The C2 of the weapon system are achieved through a squadron-wide, buried HICS network. As mentioned earlier, this system interconnects each squadron's flights and provides the capability for any one LCC to control all LFs in its squadron. Interconnectivity also allows command and status information from each of the five flights to be transmitted throughout the entire squadron. Data processing equipment, located in each LCC and LF, performs the various C2 system functions that include squadron-wide status monitoring, missile launch, operational tests, and remote targeting. Squadrons are not interconnected with each other; however, other types of communication systems and networks exist to provide wing-wide and force-wide contact. Figure 3–2 illustrates how a typical MAF is interconnected to its associated LFs using HICS.

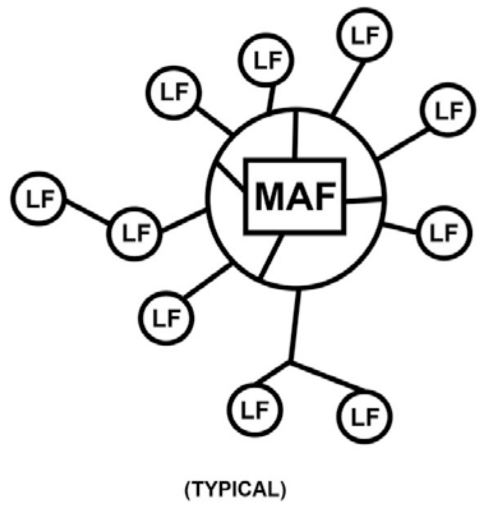


Figure 3–2. Hardened intersite cabling system layout (typical).

Additionally, the following ICBM distribution table shows how the different missile wings are structured.

ICBM Distribution				
Wing	**Location**	**Squadrons**	**Weapon System**	**Wing Designator**
341 MW	Malmstrom AFB Montana	10 MS 12 MS 490 MS	WS–133AM/CDB	Wing 1
91 MW	Minot AFB North Dakota	740 MS 741 MS 742 MS	WS–133AM/CDB	Wing 3
90 MW	F. E. Warren AFB Wyoming	319 MS 320 MS 321 MS	WS–133AM/CDB	Wing 5

015. Nuclear weapon system safety

Nuclear weapons are important politically and militarily, and even a detonation that occurred in peacetime, whether by accident or not, could be misinterpreted as an act of war. It is because of these reasons, as well as many others, that nuclear weapons require special safety considerations known as WSSR. In this short lesson, we will not be covering every single WSSR, but will discuss the rules that will apply to you in the near future.

When you begin dispatching to MAFs and LFs in your respective complex, there are two WSSRs that you will be especially concerned with—TPC and PRP.

Two-person concept

The need for the TPC is highlighted in the following WSSR:

> At least two authorized technicians must be present during any operation with a nuclear weapon or nuclear weapon system. They must be able to detect incorrect or unauthorized procedures in the task being performed. They must also have knowledge of and understand applicable safety and security requirements.

As a 2M0X1, you likely will *not* be working directly on the nuclear weapon. However, the key to remember is that you will be working on or near certain parts of a nuclear weapon system. The places where you will be exposed to parts of the nuclear weapon system can be broken down into two specific areas—the LER and the LCC.

Launcher equipment room

You may remember the training LF (LF-08) from your 3-level training at Vandenberg AFB. Once you opened the PAH, and went down the ladder into the circular room with the electronic racks on the suspended floor, you were in the LER. The LER is considered a no-lone zone, and is one of the places you must adhere to the TPC. When you are in this room, you must always be with another qualified technician. The LER is large, and has two floors, so it can be easy to lose sight of whomever you are keeping the TPC. The key to remember is that you must be close enough to "detect incorrect or unauthorized procedures." You and your TPC member should be near one another when in a no-lone zone.

Launch control center

The next place where you will need to adhere to the TPC is when you are at a MAF. The entire MAF is not a no-lone zone, so you will not adhere to TPC the whole time you are there. However, the underground LCC is a no-lone zone, so you must be sure to adhere to the TPC while you are inside it.

Personnel reliability program

You are likely already familiar with the PRP from your 3-level technical training. The need for technicians to be on PRP is highlighted in the following WSSR: "Personnel that have physical access to nuclear weapons must be qualified under PRP." In a nutshell, PRP ensures that only the most trustworthy individuals have access to nuclear weapons. It is important at your level to ensure that you are "up" on PRP if you are going to dispatch to the missile field. Individuals that are not on PRP can also go to the field, but they require an escort, and the visits to the field are usually brief.

You will take a deeper look at WSSRs when it is time to complete your 7-level CDC. In the meantime, remember what you have just learned about the TPC and PRP.

016. Nuclear certified equipment

Due to the nature of the maintenance we perform and the destructive capabilities of the weapon system we perform this maintenance on, it is very important that any equipment that is used for nuclear operations is certified and closely tracked. This equipment can range from vehicles that transport nuclear weapons or nuclear weapon systems all the way to individual pieces of handling equipment. In this lesson, we will discuss the certification, identification, and restrictions that can be placed on the equipment.

Description

The Air Force policy is that equipment, software, and procedures used for nuclear operations will be properly certified. In order for a piece of equipment to become nuclear certified, it must undergo nuclear certification. Nuclear certification is the process for determining that equipment meets nuclear surety standards, and is capable of performing nuclear weapon functions and missions. The PT (a vehicle that carries missile components), as well as the missile handling gear that MMT teams use to move and maneuver the missile's RS around are examples of nuclear certified equipment (NCE).

Identification

Nuclear certified items will not be marked in any way to indicate nuclear certification status. A list of every item of NCE, hardware, and software is located in a document called the master nuclear certification list (MNCL). The MNCL is web-based: meaning it will be located at and printed from a website. A new copy of the MNCL does not need to be printed each day; however, when using a printed copy, ensure that the print date of your paper copy is *newer* than the "last update" date on the main page of the web-based MNCL. If your copy is out of date, you can print a new copy from the website. Remember, always verify you have the newest version if you or your fellow technicians are tasked with identifying NCE you need to use on the job.

Once you have the latest copy of the MNCL, make a positive identification of NCE by comparing the letters and/or numbers on the MNCL to all possible NCE identification elements, such as the label, data plate, markings, or by official documents. Verification of the label, data plate, or markings is sufficient; however, if a discrepancy exists between the information on the MNCL and the identification elements you are comparing against (e.g., characters do not match), the item is considered *not certified* until the discrepancy can be resolved.

Restrictions

A piece of NCE may be restricted from use at any time, and for any reason. Examples of why this may happen are the NCE is damaged, is undergoing a modification, or changes are being made to its intended use. A restricted item in the MNCL must not be used for nuclear operations. However, if a PT appears as restricted on the MNCL, it can still be operated for non-nuclear tasks, such as moving it around in the parking area, or using it to train special purpose vehicle operations. It cannot be used to take a missile component to an LF though. Items listed in the MNCL having restrictions apply to nuclear operations only. If you are tasked with identifying NCE, and you are unsure of how the process works or unsure whether your MNCL is up to date, be sure to ask your supervisor or shift supervisor.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

013. Intercontinental ballistic missile mission

1. Describe the mission of ICBMs.

2. With whom does the authority to launch ICBMs ultimately rest?

3. What organization possesses the means of delivering an ICBM attack?

4. List the five strategic characteristics of the ICBM weapon systems.

5. What strategic characteristic does the ICBM stage motor solid propellant support or give the capability of?

6. Devices to aid in warhead penetration and confuse target defense systems, are examples of what strategic characteristic?

7. What strategic characteristic is exemplified by preforming remove-and-replace maintenance on site?

014. Deployment and control

1. Define the term deployment.

2. Why must there be a minimum of two AFGSC launch officers manning each LCC?

3. What Air Force organizational level is made up of ten LFs and a controlling LCC?

4. At Minot AFB, why does the 5th Bomb Wing handle various support aspects of the base's mission?

5. How does interconnectivity of the HICS affect command and status information?

015. Nuclear weapon system safety

1. What are the two WSSR that you need to be aware of as a 5-level technician?

2. As a 2M0X1, you will *not* be working directly on the nuclear weapon, so what will you work on that requires the use of the TPC?

3. When you are working at a MAF, where will you need to adhere to the TPC?

4. An individual that dispatches to the missile field, who is *not* on PRP, requires what?

016. Nuclear certified equipment

1. According to Air Force policy, what items will be certified before being used for nuclear operations?

2. The date on the printed copy of the MNCL must be newer than what date?

3. A piece of NCE can be restricted from use for what reasons?

3–2. Intercontinental Ballistic Missile Facilities

As a maintenance technician, you will spend most of your time working on equipment located at the MSB, MAF, and LF. This section will familiarize you with the features of those facilities. It is vitally important you understand the layout and the functions of the different facilities you will be working on. You will also find it helpful to refer to the figures as you read the material.

017. Missile support base features

All maintenance is conducted on, or begins and ends at the MSB. Whether you are dispatching to the field or performing maintenance on support equipment, the MSB is the center of it all. Keep in mind, each topic must be discussed in very general terms since each MSB is different from others in layout and numbers of facilities. Also, keep in mind existing facilities were used and then modified as necessary to serve the needs of the ICBM program as changes occurred.

Missile support base

The base you are stationed at is the MSB (Malmstrom, Minot, or F.E. Warren AFB). There are two areas of support on an MSB. One area contains the normal support facilities you would find at most Air Force installations, regardless of the base's mission. They include such things as housing, security, medical, and administrative facilities. The other area supports the mission, and in our case, the ICBM mission. This area is known on a missile base as the missile support area, which contains the maintenance facility building, transient storage area, missile transfer building, weapons storage area (WSA), and the proof-load test facility. It is here that we will focus our attention.

Missile support area

Technicians using the missile support area facilities are responsible for maintenance of the ICBM weapon system and its associated equipment. The facilities of the missile support area are not always in a single location. Sometimes the facilities are used jointly by missile maintenance and other organizations on the support base. Every effort is made to locate the missile maintenance facilities as close together as possible; however, this is not always possible.

Maintenance facility building

When several maintenance facilities are in the same building, the facility is called the maintenance facility building. This building may house the EMT, FMT, and MMT missile maintenance sections. It may also contain many back shops that work on support equipment, who perform intermediate maintenance on weapon system equipment. These may include the ELAB, MAPS, VES, or PREL, as we have already discussed.

Missile transfer building

The missile transfer building is used for transferring the missile's downstage from its shipping container to the transporter erector (TE). *Downstage* refers only to the missile's first, second, and third stage boosters. The missile is never transported as a complete assembly, and as you will learn later, the missile is assembled in its final configuration only at the LF. There are three methods for shipping the missile downstage from the depot to this facility. The primary method of shipping is by road or highway in a TE. Alternate methods are in special rail cars or specially equipped aircraft. If a downstage does not arrive in a TE, the missile transfer building is used to cross-load the downstage into a TE.

Transient storage area

This area provides storage and parking for loaded TEs. This area is typically located in close proximity to the missile handling section. While parked in the storage area, a PAC maintains the TE's container at 60–100 degrees Fahrenheit (°F). Periodically, a missile handling technician must verify the temperature inside the TE container to ensure that it is within established parameters.

Weapons storage area

The WSA is usually by itself at an isolated area on the base. The WSA is a heavily guarded area protected by a security fence, guard towers, a gatehouse, and a variety of intrusion detection systems. The munitions facility inside the WSA, operated by munitions maintenance personnel, is where the technicians receive, handle, and checkout re-entry vehicles (RV), RS, and pyrotechnic components.

The WSA storage warehouse can process and store RV containers, RS components, spare parts, and mobile crew equipment. There is a building that provides individual storage bunkers for spare warheads, RVs, and pyrotechnic components.

Proof-load test facility

This facility houses the equipment necessary to proof-load test many items. Proof-load testing determines whether equipment or vehicles designed to suspend a load, such as slings, pulleys and cables, are safe for use within designed load capacities. Some of these items include the load-carrying components of the TEs, maintenance vans, PTs, and guided missile maintenance platforms (GMMP). If an item fails proof loading, it is not safe for use in the missile field.

018. Missile alert facility features

The MAF is a remote manned facility. The primary purpose of the MAF is to house the two MCC officers on alert so they are prepared to launch the missiles in their flight immediately upon receiving an authentic command to do so. The MAF also houses many other Airmen that support this mission, such as the facility manager, security forces personnel, chefs, maintenance personnel, and other MCCs not on alert. There are 15 MAFs at each missile wing. Each MAF has primary control of a flight of 10 LFs, but under certain circumstances, can take control of the LFs in other flights.

There are some features that are common to all MAFs, regardless of whether you are at Malmstrom, Minot, or F.E. Warren AFB. We will discuss these features first, and then move into the specifics of each configuration. The main difference between the Wing 1 MAF and the Wing 3 or 5 MAF is that the ECS equipment and diesel generator are located topside (above ground) at a Wing 1 MAF, while this same equipment is located underground at Wing 3 and 5 MAFs. Remember this concept as you study the following information. First, we will cover features that are common at every MAF, no matter what wing you are at, then we will discuss the differences. Remember that these common features are located at all MAFs, but are not located in the same physical locations.

Common missile alert facility features

There are many features that are common to all MAFs, but we will only cover some of them. We will discuss personnel support areas, the service area, the security control center (SCC), the elevator shaft, the clean room, blast valves, and the LCC.

Personnel support area

The personnel support area includes sleeping quarters for the facility manager, chef, maintenance teams in “remain overnight” status, and MCC members that are not on alert. There is a kitchen, dining area, computer area, bathrooms with shower stalls, and a recreation area. The recreation area typically has a television and a pool table, but different MAFs may contain other amenities.

Service area

The service area is the parking lot within the fenced area of the MAF. This area can accommodate large vehicles, such as the PMT tractor-trailer. The service area also includes a fuel service station capable of providing unleaded gasoline and diesel fuel for government owned vehicles. At some MAFs, the fueling service station is located outside the fenced area, alleviating the need to go through the security procedures to process onto the MAF.

Security control center

The SCC is the entry control point for the MAF. This is also the office you will contact over the radio to gain access to an LF. This above ground room is manned 24 hours a day, 7 days a week by security forces personnel. The SCC has a very-high frequency (VHF) two-way radio for communication of non-sensitive information and direct telephone communication with the LCC. The main purpose of the SCC is to provide controlled access to the elevator shaft that leads down to the LCC. All personnel requesting access to the LCC must be positively identified and authorized access by security forces personnel in the SCC.

Elevator shaft

The elevator shaft is how personnel and maintenance equipment get to the underground LCC. If the elevator is inoperative, there is a fixed ladder that can also be used to get downstairs. The elevator at a Wing 1 MAF is only large enough to transport personnel and small equipment. The elevator at a Wings 3 and 5 MAFs is much larger due the diesel generator and brine chiller unit are underground. The elevator is the only means of removing or replacing these large items.

Clean room

The clean room filters all air entering the LCC. The air is filtered by a chemical, biological, radiological (CBR) filter. Air is then filtered by a particulate air filter before actually flowing into the LCC. The clean room is pressurized so that no air can enter the room unless it has passed through the CBR filter. The Wing 1 clean room is located above ground, next to the ECS equipment room. The Wing 3 and 5 clean rooms are located underground in the launch control equipment building (LCEB).

Blast valves

A blast valve is used in the weapon system to isolate certain areas in the event of an attack. The instant the blast valve senses even the slightest overpressure, it snaps shut. This keeps the harmful pressure from a nuclear detonation or other explosion from entering the facility and causing damage to sensitive equipment or harm to personnel. The Wing 1 MAF has two blast valves, one on the intake coming from the topside clean room, and the other on the return duct that goes from the LCC back to the clean room.

The Wing 3 and 5 MAFs have four blast valves:

1. One on the air supply duct between the clean room and the LCC.
2. One on the air return duct between the LCC and the clean room.
3. One on the air intake duct between the topside and the LCEB.
4. One on the air exhaust duct between the LCEB and the topside.

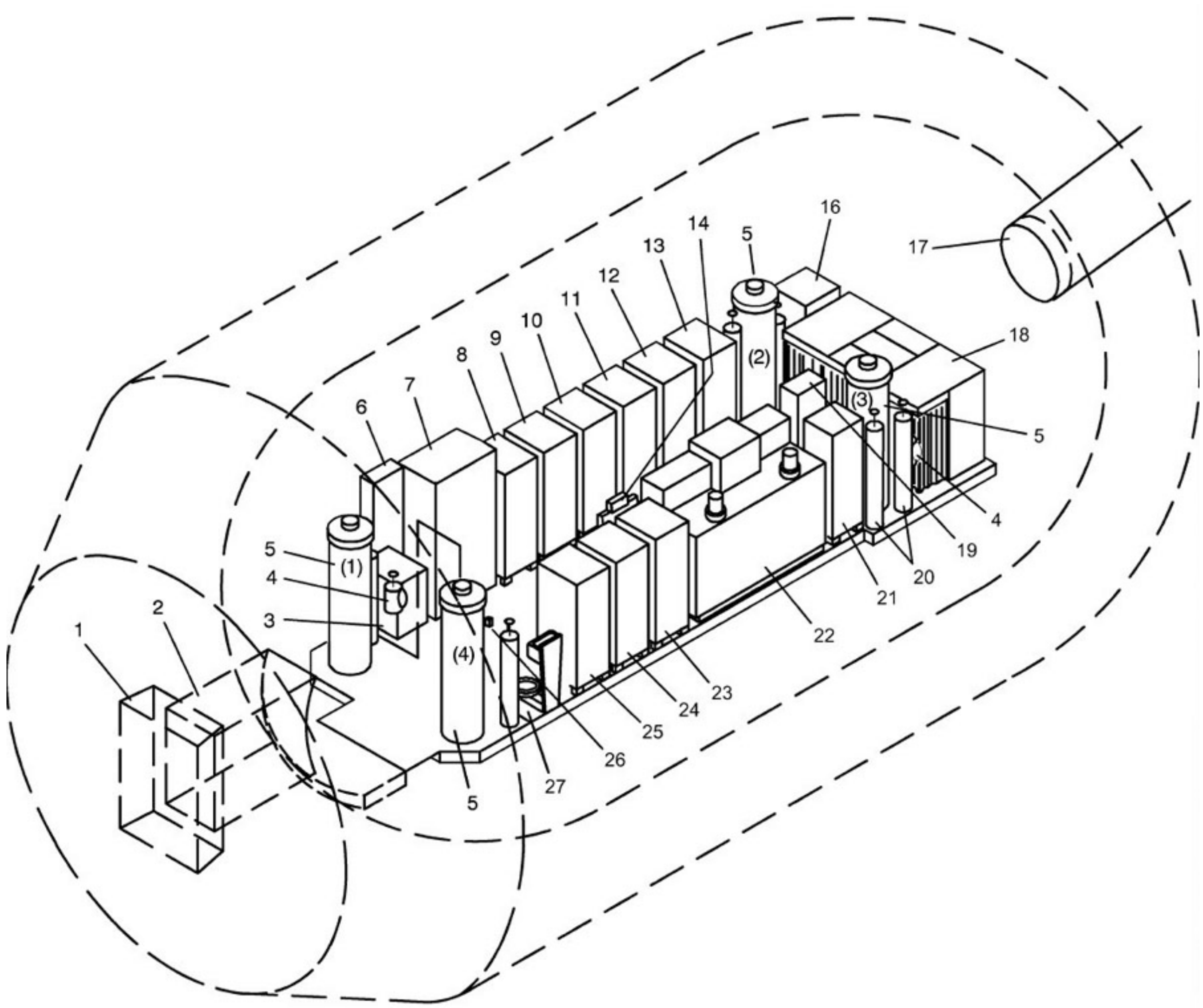
If the LCEB diesel generator is running when the blast valves close, the generator automatically shuts down. This is because the exhaust gasses from the running generator are expelled through the exhaust shaft. If the shaft’s blast valve is closed, the exhaust gasses would have no way to escape, and would begin to contaminate the air supply.

Launch control center

The LCC (fig. 3–3) is an underground structure of reinforced concrete and steel of sufficient strength to withstand all nuclear weapon effects. The main purpose of the LCC is to house the MCC and the equipment required to control, monitor, and launch the missiles within its squadron.

The LCC outer structure is cylindrical with semicircular ends. The walls are approximately 4½ feet thick. A blast door allows entry into the LCC from the tunnel junction. Essential LCC equipment, along with the MCC, is located in a shock-isolated room suspended within the blast-proof outer structure.

The LCC blast door (fig. 3–3, item 1 and fig. 3–4) provides an environmental seal, and provides protection against the overpressure and electromagnetic pulse (EMP) produced by a nuclear blast. A latch aligns the door before extending the twelve lock pins into recesses in the doorframe. The lock pins are extended and retracted by a manually operated hydraulic pump from inside the LCC.



LEGEND

1. BLAST DOOR
2. HORIZONTAL TUNNEL
3. OXYGEN REGENERATION UNIT
4. FIRE EXTINGUISHER (TYPICAL LOCATION)
5. SHOCK ISOLATORS (4 PLACES)
6. LCPA PANEL
7. EMERGENCY AIR CONDITIONING UNIT
8. COMMAND MESSAGE PROCESSING GROUP
9. TELEPHONE SET REPEATER
10. SACDIN K RACK
11. SACDIN M RACK
12. KITCHEN SERVICES GROUP
13. RADIO SET GROUP
14. OPERATORS SEAT
16. POWER SUPPLY GROUP
17. ESCAPE HATCH
18. BED
19. FILE CABINET
20. SHOCK ISOLATOR AIR CYLINDERS
21. DIGITAL DATA GROUP
22. CONSOLE
23. SACCS U RACK
24. EHF AND VLF/LF HAC SYSTEMS EQUIPMENT RACK
25. AFSATCOM GROUP
26. LIGHT SWITCH
27. TOILET AND WASHBASIN

Figure 3–3. Launch control center (typical).

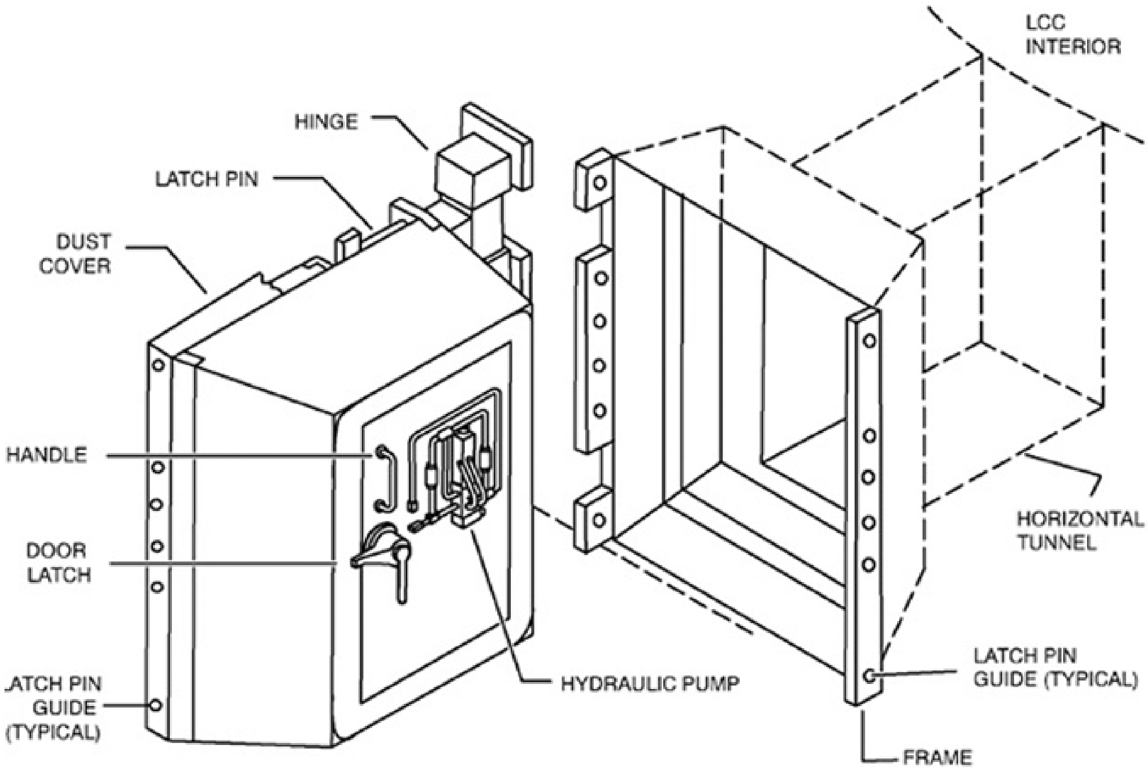


Figure 3–4. Launch control center blast door.

Basic design features

The design and construction of every LCC is basically the same; however, since the responsibilities may vary between the LCCs, there are slight differences in the electronic equipment installed. The LCC has a short entrance tunnel leading into the main section of the capsule called the acoustical enclosure. Once inside the LCC, you will see a variety of electronic equipment. To prevent unauthorized tampering, this area is a no-lone zone, meaning at least two personnel, PRP certified and able to detect an unauthorized act must be present at all times. The acoustical enclosure contains all of the equipment required for a missile combat crew to monitor and operate the weapon system. This room also contains the emergency air handling unit and an oxygen regeneration unit.

To prevent trapping the missile combat crew inside the LCC, an emergency escape hatch and tunnel are located at the far end of the capsule. The tunnel is a corrugated steel tube which slopes upward from the LCC toward ground level. The tunnel stops five feet from the surface, therefore, the MCC must dig the rest of the way out. The tunnel is filled with sand to keep it from collapsing.

Special designations and missions

As stated earlier, some LCCs have additional electronic equipment that others do not, depending on their responsibilities; consequently, there are three different LCC configurations. It is easier to understand if you think of each of them as being part of a chain of command (fig. 3–5). On the first tier is the primary LCC. There are four primary LCCs in each squadron and they report to the next tier which is the squadron command post (SCP). Only one LCC in each squadron is designated the SCP. One of the SCPs within each wing is designated as the alternate command post (ACP). The ACP LCC reports directly to the wing command post (WCP) and serves as the backup should anything happen to the WCP.

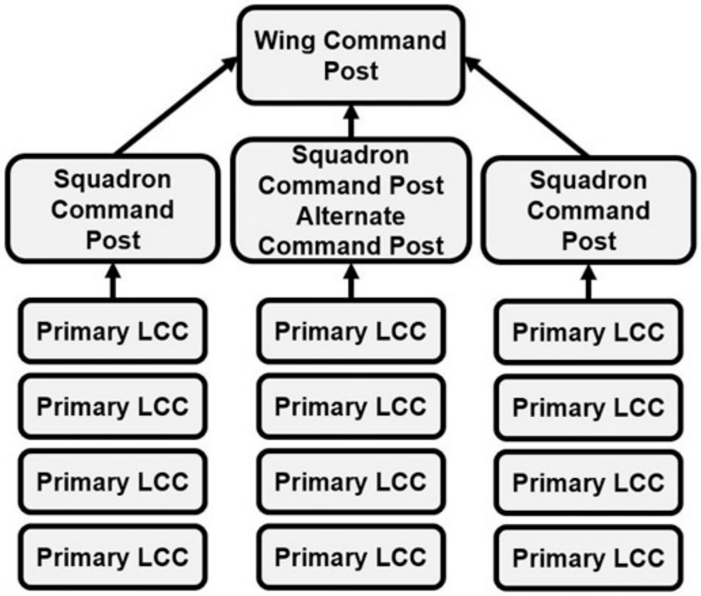


Figure 3–5. LCC designations.

Wing 1 missile alert facility specifics

Now that we have covered the features that are common between all MAFs, let's discuss the structures that are specific to each wing. The Wing 1 MAF configuration is found only at the 341 MW (Malmstrom AFB) (fig. 3-6). Notice the elevator shaft and the LCC are the only structures that are underground at the Wing 1 MAF.

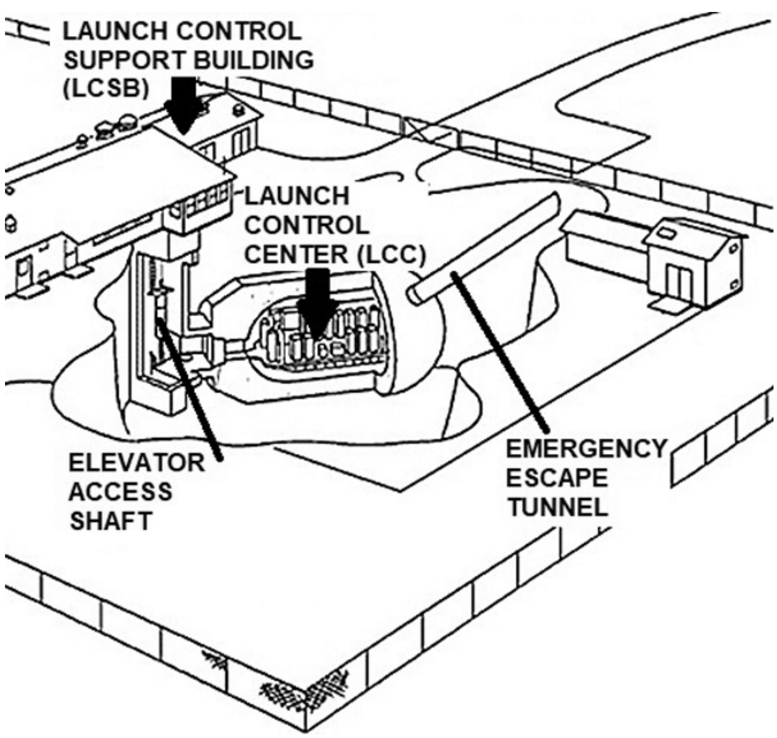


Figure 3–6. Wing 1 missile alert facility.

The launch control support building (LCSB) at a Wing 1 MAF is an above ground structure located on the opposite side of the personnel support area. The LCSB includes an ECS equipment room, a clean room, a diesel generator room, and a telephone communications equipment room (fig. 3–7).

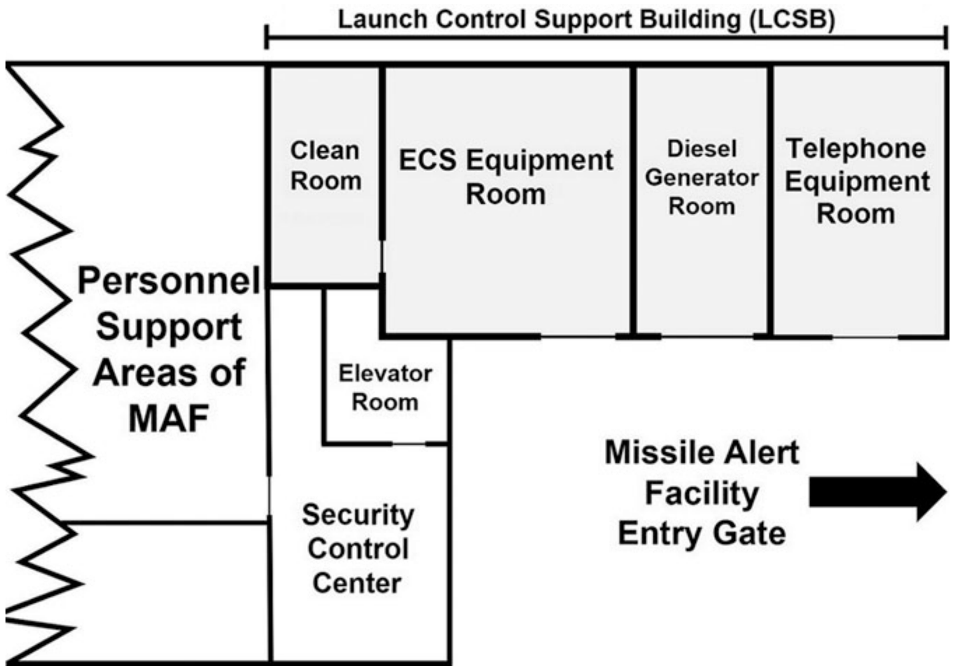


Figure 3–7. Top-down view of a Wing 1 launch control support building.

Environmental control system equipment room

The ECS equipment room houses the brine chiller unit and associated panels, the CBR air filter and makeup air fan, and the cable air dryer. The brine chiller unit sends chilled brine through a set of supply and return pipes into a coil inside the air handler unit which is located in the clean room. A large blower fan in the clean room pulls air through the air handler coil which cools the air. The cooled air is then sent down to the LCC through a long duct. This cool air is used for removing heat from electronic equipment as well as maintaining a comfortable temperature for the MCC. The cable air dryer keeps moisture from entering the HICS by keeping the lines filled with dried, compressed air. Unlike the Wing 3 and 5 MAF, the equipment in this room can be removed and replaced through a set of double doors because the LCSB is at ground level.

Diesel generator room

The LCSB diesel generator room houses a diesel generator that powers the entire MAF, including the LCC, in the event of a loss of commercial power. The generator will start automatically if commercial power is lost. The automatic switching unit (ASU) is also located in the LCSB. The ASU houses the Minuteman power processor (MPP), which is responsible for switching between commercial and standby (diesel generator) power when necessary.

Telephone equipment room

As the name implies, this room contains telephone equipment for the support information network (SIN) line which provides communications between the MAFs and LFs. Every time you pick up the phone or use a headset at the LF to talk to the LCC, you are using the equipment in this room. It also enables the MSB to interface with the ECS Remote Monitoring System (ERMS) at each LF.

Wing 3 and 5 missile alert facility specifics

Now that we have covered the Wing 1 MAF specifics, let's discuss the specifics of the Wing 3 and 5 MAFs, 91 MW (Minot AFB) and the 90 MW (F.E. Warren AFB) respectively.

Launch control equipment building

Notice the large structure adjacent to the LCC (fig. 3–8). This is the LCEB which is a buried structure of reinforced concrete, strong enough to withstand some of the effects of a nuclear detonation.

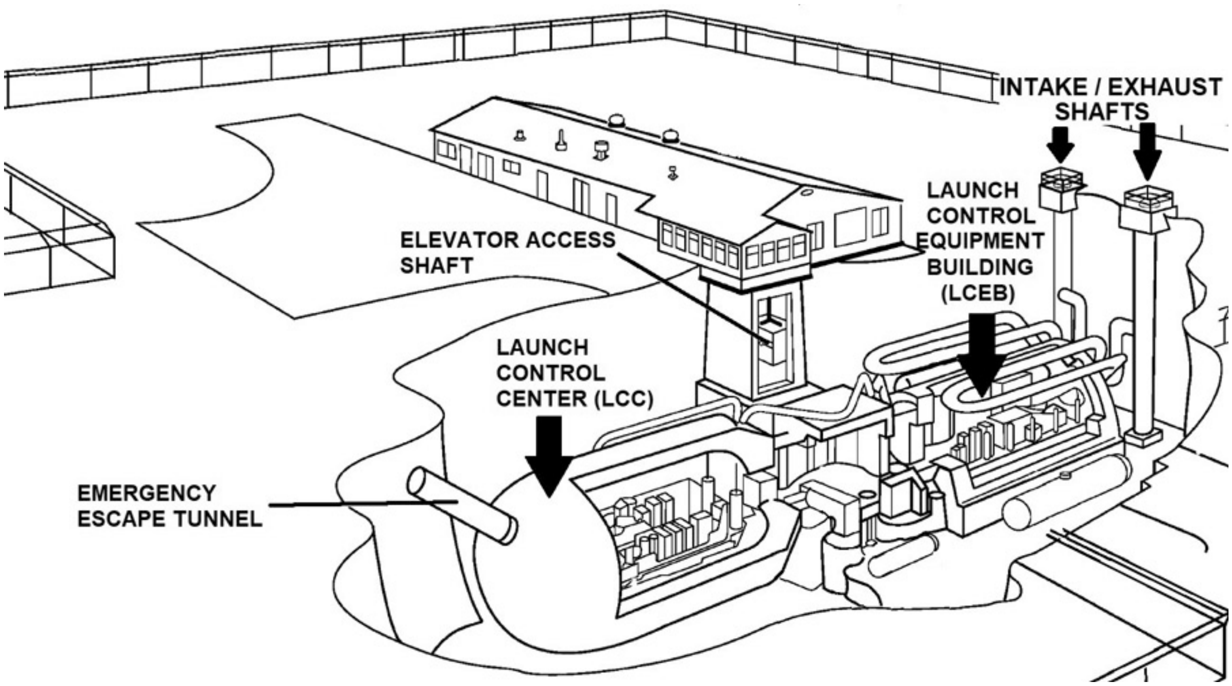


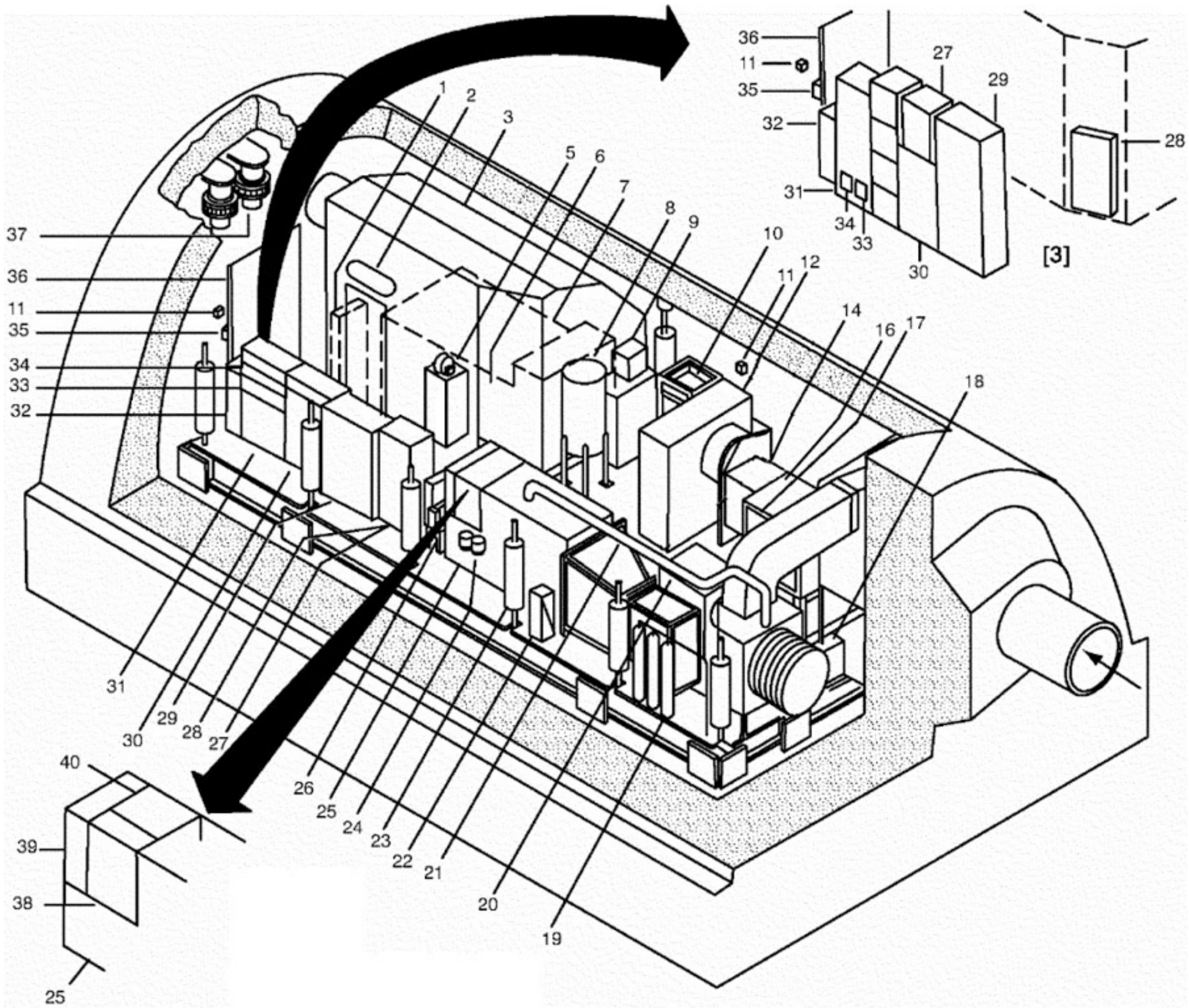
Figure 3–8. Wing 3 and 5 missile alert facility.

The LCEB floor is suspended by shock isolators. It contains the ECS and other equipment necessary to make the LCC self-sufficient while isolated for a period of time. Figure 3–9 shows the general layout of the LCEB used at Wings 3 and 5. Some equipment in the LCEB is used for normal operation of the LCC, while other equipment is used only during periods of isolation or commercial power failure.

Equipment inside the LCEB includes the normal environmental control equipment, a clean room, a standby diesel generator, a blast valve hydraulic control unit, electrical controls, and distribution panels. At a Wing 3 and 5 MAF, the diesel generator in the LCEB starts automatically when commercial power is lost, and only powers the LCC and LCEB. A separate diesel generator (listed below) powers the topside portion of the MAF.

Intake and exhaust shafts

Since the wing 3 and 5 MAF ECS equipment is all underground in the LCEB, air must be drawn in and exhausted out through the intake and exhaust shafts. The exhaust shaft is also where the exhaust from the diesel generator is expelled.



LEGEND

1. AIR HANDLER CONTROL PANEL
2. EXPANSION TANK
3. CLEAN ROOM
5. CBR FILTER AND MAKEUP AIR FAN
6. CBR FILTER AND FAN SWITCH
7. AIR HANDLER
8. DIESEL FUEL DAY TANK
9. SCN HARDENED CABLE AIR DRYER COMPRESSOR AND FLOWMETER PANEL
10. (SIN) TELEPHONE CONNECTING AND SWITCHING SET
11. J-BOX
12. VENTILATION SUPPLY FAN
14. LCEB EMERGENCY WATER SHUTOFF VALVE
16. BRINE CHILLER UNIT
17. BRINE CHILLER CONTROL PANEL
18. BLAST VALVE HYDRAULIC PUMPING UNIT
19. COMPRESSED AIR CYLINDERS
20. VENTILATION EXHAUST PIPE
21. DIESEL EXHAUST PIPE
22. LUBE OIL BYPASS FILTER
23. PLATFORM SUPPORT (12)
24. LUBE OIL FILTERS
25. STANDBY DIESEL GENERATOR
26. LCC SHOCK ISOLATOR AIR COMPRESSOR
27. BUCK-BOOST TRANSFORMER
28. VENTILATION CONTROL PANEL
29. AUTOMATIC SWITCHING UNIT
30. LCDS DISTRIBUTION PANEL AND LCLA LIGHTING PANEL
31. LCDN DISTRIBUTION PANEL
32. RFI FILTER
33. FIRE ALARM CONTROL PANEL
34. LCEB EQUIPMENT MONITOR PANEL
35. LIGHT SWITCH
36. ENTRANCE WAY
37. BRINE LINE SHOCK ATTENUATORS
38. BATTERY CHARGER PANEL
39. ENGINE CRANKING AND MONITOR ALARM PANEL
40. GENERATOR CONTROL PANEL

Figure 3–9. Launch control equipment building.

Topside diesel generator

If a wing 3 or 5 MAF loses commercial power, the diesel generator in the underground LCEB will not provide power to the personnel support areas of the MAF. There is secondary diesel generator located in a room topside that provides power to all above ground portions of the MAF. This diesel generator will not start automatically; it must be started manually by the facility manager.

These lessons have covered a lot of information about the MAF. You have learned that there are some key differences between the Wing 1 and Wing 3 and 5 configurations. The Wing 1 and Wing 3 and 5 LFs are much more similar. So, let’s take a look at the features of the LF.

019. Launch facility features

The LF (fig. 3–10) is a remote, unmanned missile site placed in relatively unpopulated areas. The LF includes the launcher, launcher support building (LSB), security system, and service area.

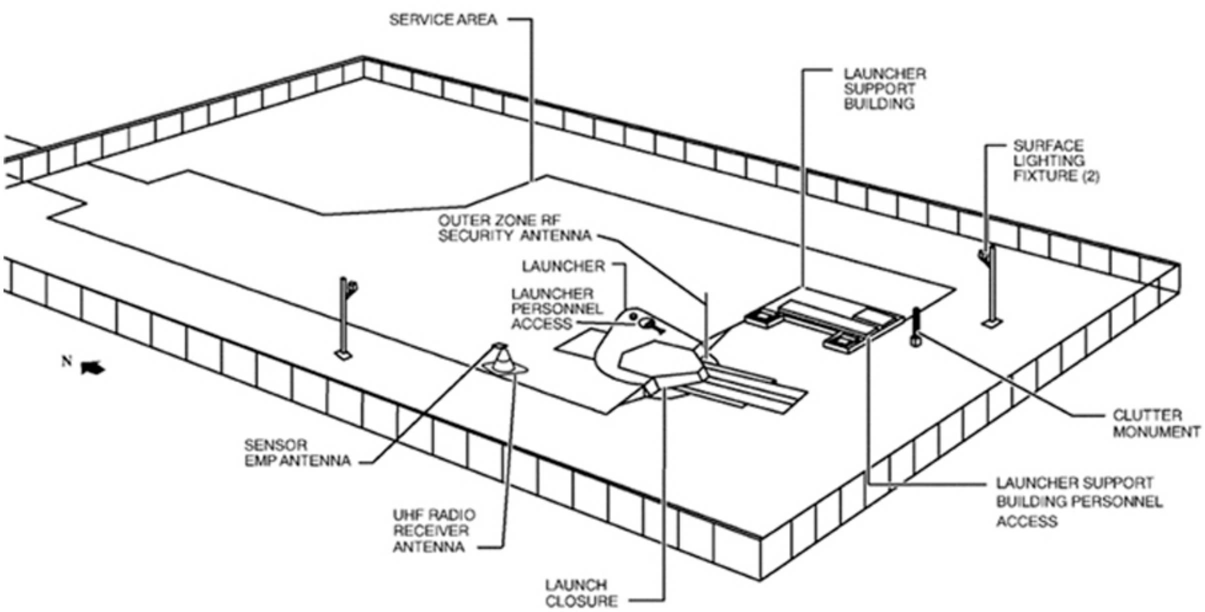


Figure 3–10. Launch facility (typical).

Launcher

The launcher (fig. 3–11) includes the launch tube, launcher closure, dual-level LERs, and PAS. The launcher is designed to survive a relatively high-yield nuclear blast.

Launch tube

The launch tube (fig. 3–11, item 27) is the underground cylinder where the missile is stored and will launch from. A steel liner provides electromagnetic shielding and protection for the missile. A sump pump, in a pit at the bottom of the launch tube, keeps ground water from accumulating within the launch tube and damaging the solid propellant boosters. When the water level in the sump pit reaches a certain point, the pump is energized, and the water is pumped out of the above ground drain line.

A missile suspension system provides shock isolation and a support platform for the missile. It also permits the missile to be rotated for accurate missile alignment.

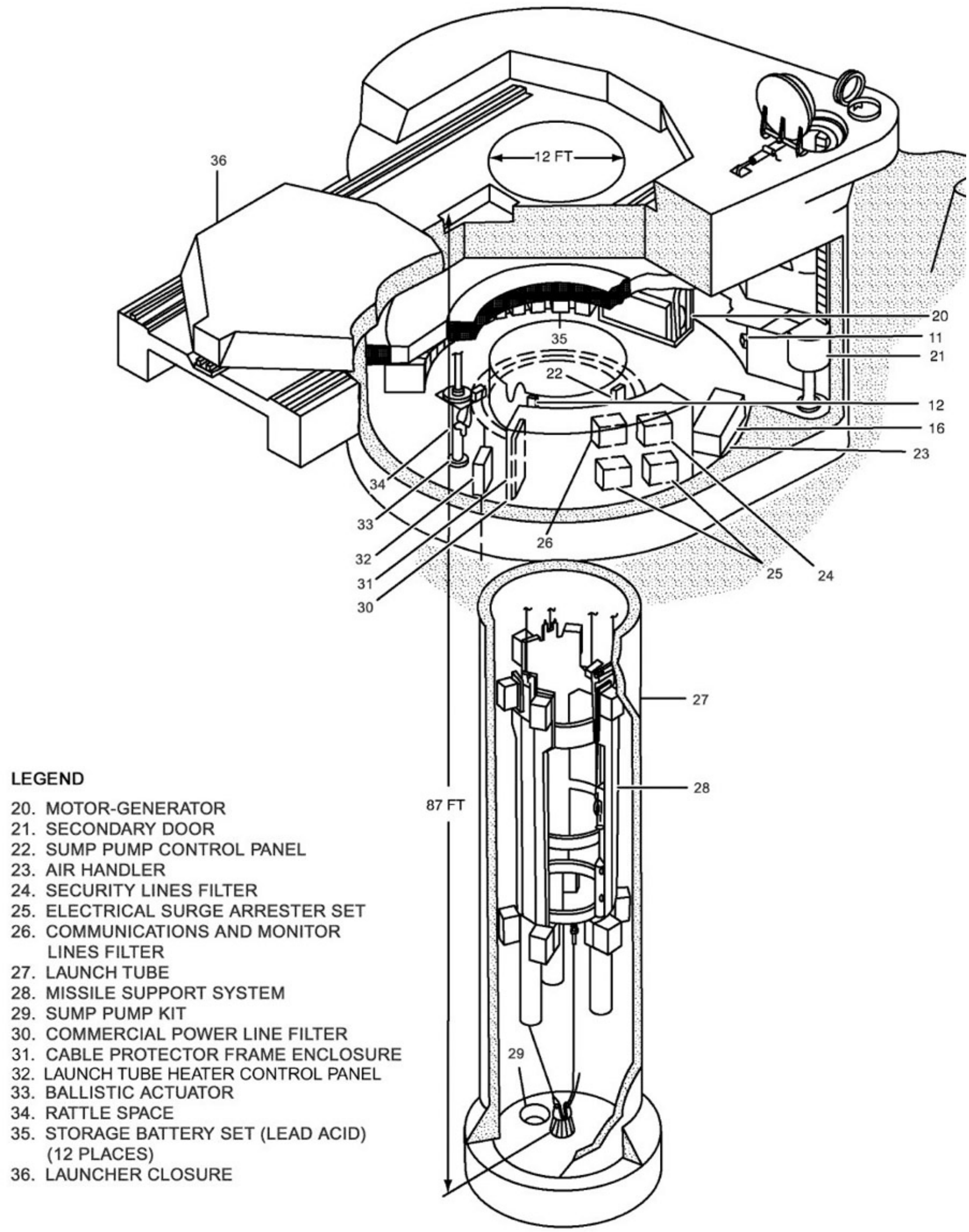


Figure 3–11. Launcher (typical).

Launcher closure

The launcher closure (fig. 3–12) is a steel-reinforced concrete slab about 4 ½ feet thick that is above ground, resting directly on top of the launch tube. Vertical movement of the launcher closure door is prevented by its sheer weight (110 tons) and mated beveled edges on the closure sides and launcher roof. A lock pin assembly prevents the launcher closure from being rolled open by unauthorized means.

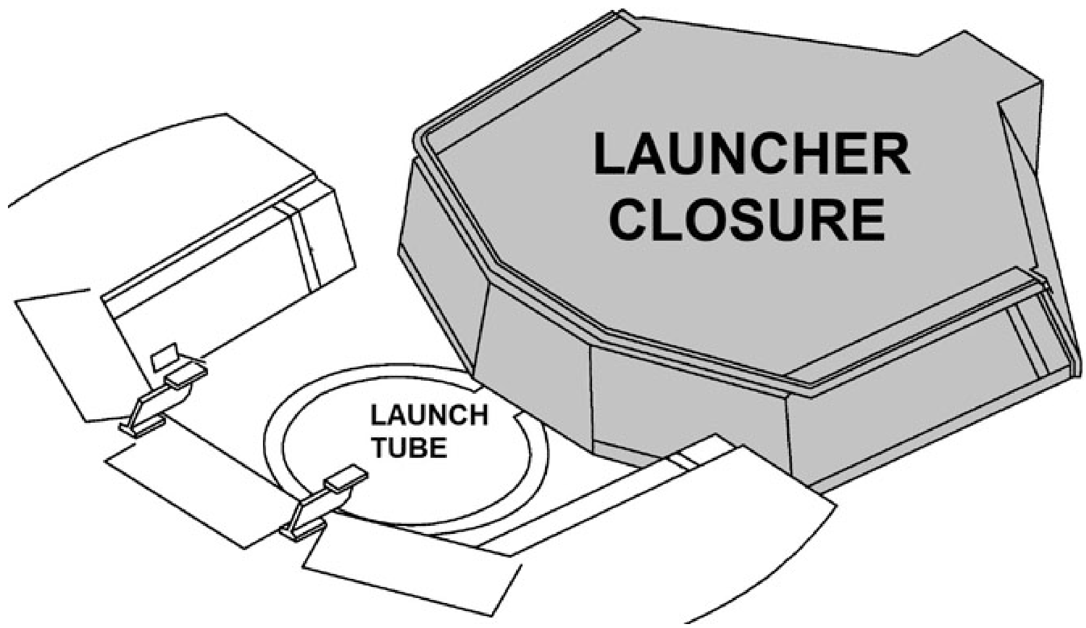
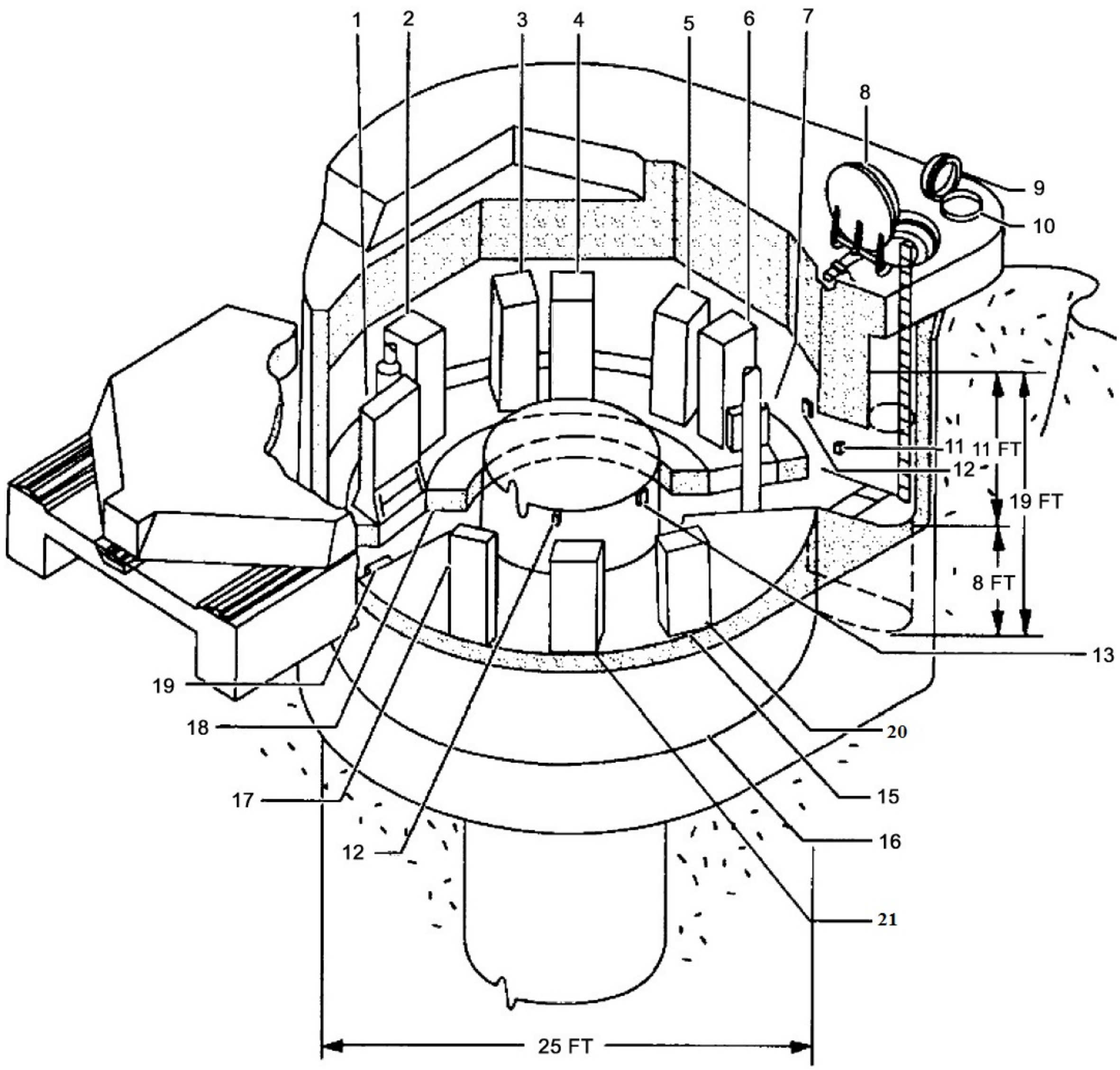


Figure 3–12. Launcher closure (open position).

The main purpose of the launcher closure is to protect the missile from weapons effects and act as an environmental seal. The closure rolls on four 18-inch diameter steel wheels seated on two steel guide rails. Spring-loaded debris bins are attached to the launcher closure. When the door opens for launch, the bins spring open to form a container to prevent debris from falling into the launch tube and onto the missile. Prior to launch, four ballistic gas generators (BGG) fire with enough force to quickly roll the 110-ton mass of concrete along its steel rails and out of the way. For maintenance purposes, technicians roll the closure open and closed with a hydraulic pusher set.

Launcher equipment room

The LER (fig. 3–13) is a two-level, cylindrical, steel reinforced structure that completely encircles the upper part of the launch tube. A 6- to 8-inch gap, or *rattle space*, between the equipment room foundation and the launch tube, permits limited motion between the launch tube and LER without the danger of structural damage. Approximately half of the upper-level LER is shock isolated to protect the launch-critical equipment from ground shock damage produced by a nuclear blast. Major equipment items found in the LER include the guidance and control chiller unit, motor generator, emergency storage battery set, launch tube heater, BGGs, and air handler unit.



LEGEND

1. DISTRIBUTION BOX
2. GUIDANCE SECTION LIQUID COOLER
3. PROGRAMMER GROUP
4. POWER SUPPLY GROUP
5. UHF RADIO RECEIVER GROUP
6. BATTERY CHARGER-ALARM SET GROUP
7. INTERCONNECTING BOX
8. PRIMARY DOOR
9. SECURITY PIT WEATHER COVER
10. SECURITY PIT
11. LIGHT SWITCH
12. JACK BOX
13. PERISCOPE MOUNT
15. 1ST LEVEL FLOOR
16. 2ND LEVEL FLOOR
17. LDB PANEL
18. SHOCK MOUNTED 1ST LEVEL FLOOR
19. LADDER TO 2ND LEVEL FLOOR
20. MOTOR DRIVE CABINET
21. ENERGY STORAGE SYSTEM

Figure 3–13. Upper launcher equipment room (typical).

Personnel access

Entry into the upper-level LER is accomplished first by a security forces member unlocking and removing the security pit vault door (fig. 3–14, item 3). Maintenance team technicians will then raise the primary door (Item 1), and then unlock and lower the secondary door (Item 9). The secondary door is commonly referred to as the “B-plug,” since it is a very large and heavy cylindrical object that essentially “plugs” the access hatch. After the secondary door (B-plug) is lowered, a combination of fixed and telescoping ladders provides access to the upper-level LER. Access to the lower-level LER is provided by a fixed ladder on the opposite side of the upper-level LER. When penetrating the sight, there is a 64 +/- 4-minute timer built into the B-plug lowering system. This delay is designed to give security forces enough time to respond in the event that someone is trying to gain unauthorized entry into the LER. Even a team that has been granted authorized entry must wait out the timer, it cannot be bypassed.

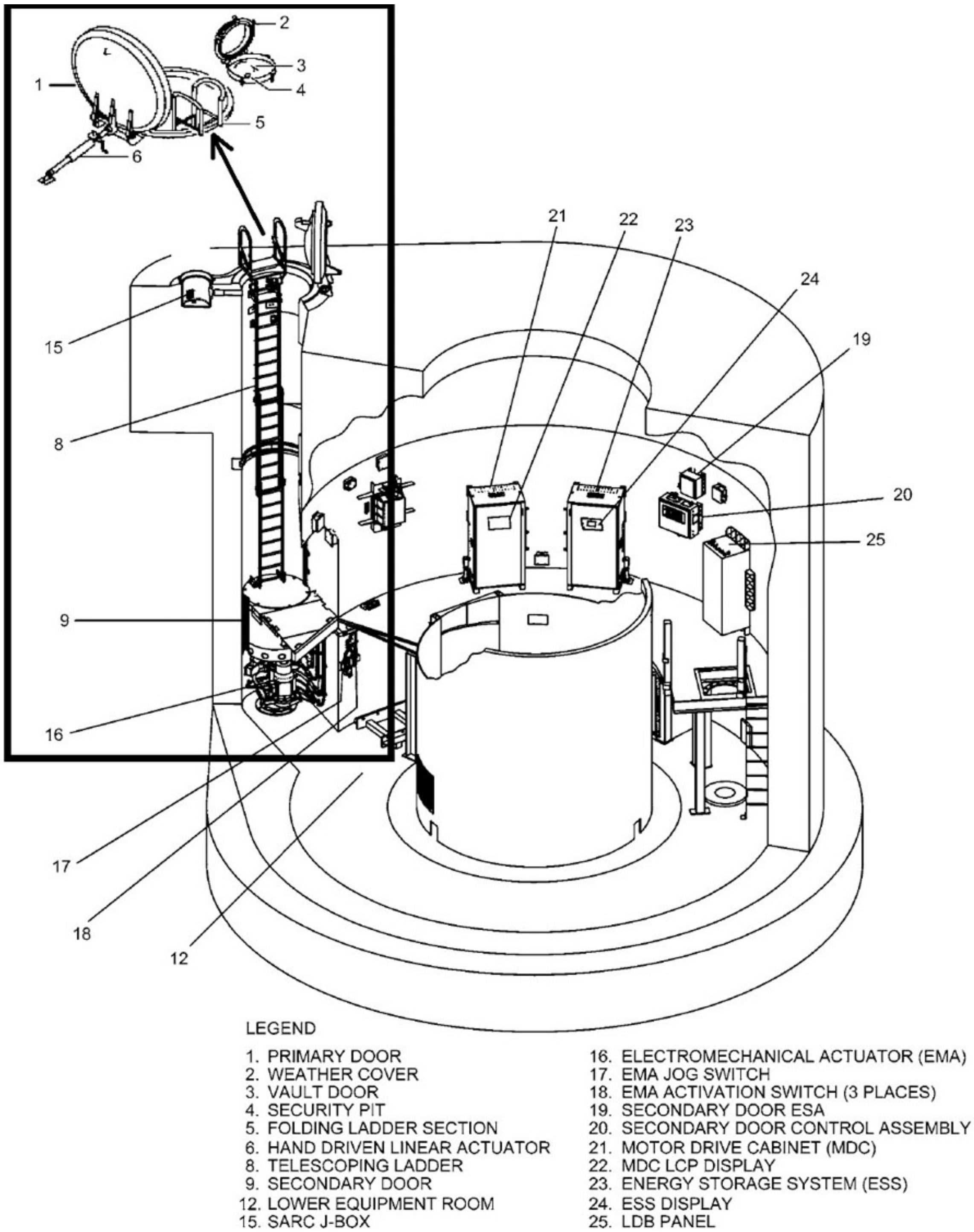


Figure 3–14. Personnel access system (typical).

Launcher support building

The LSB is an underground facility near the launcher that houses most of the equipment you will be working with. The LSB's roof is at ground level. A key difference to remember is that the Wing 1 LSB is not shock mounted. It is essentially just a concrete cube that sits in the ground.

The Wing 3 and 5 LSB floors are shock mounted. Two removable steel hatches in the roof permit the removal and emplacement of the brine chiller unit and diesel generator. Entry is gained through an access hatch at one end of the building. While the layouts of the Wing 1 LSB and Wing 3 and 5 LSB are different, they both contain the same equipment:

- Electric room heater.
- SIN telephone headset.
- Diesel fuel oil day tank.
- Brine chiller unit to supply cooled brine to the air handler in the LER.
- Cable air-dryer compressor to prevent moisture from entering the HICS cables.
- Diesel generator to supply standby power to the launcher in case of a commercial power failure.
- Automatic switching unit which houses the MPP to provide automatic switching between commercial and standby power.

Figure 3–15 shows a Wing 1 LSB; figure 3–16 shows a Wing 3 and 5 LSB.

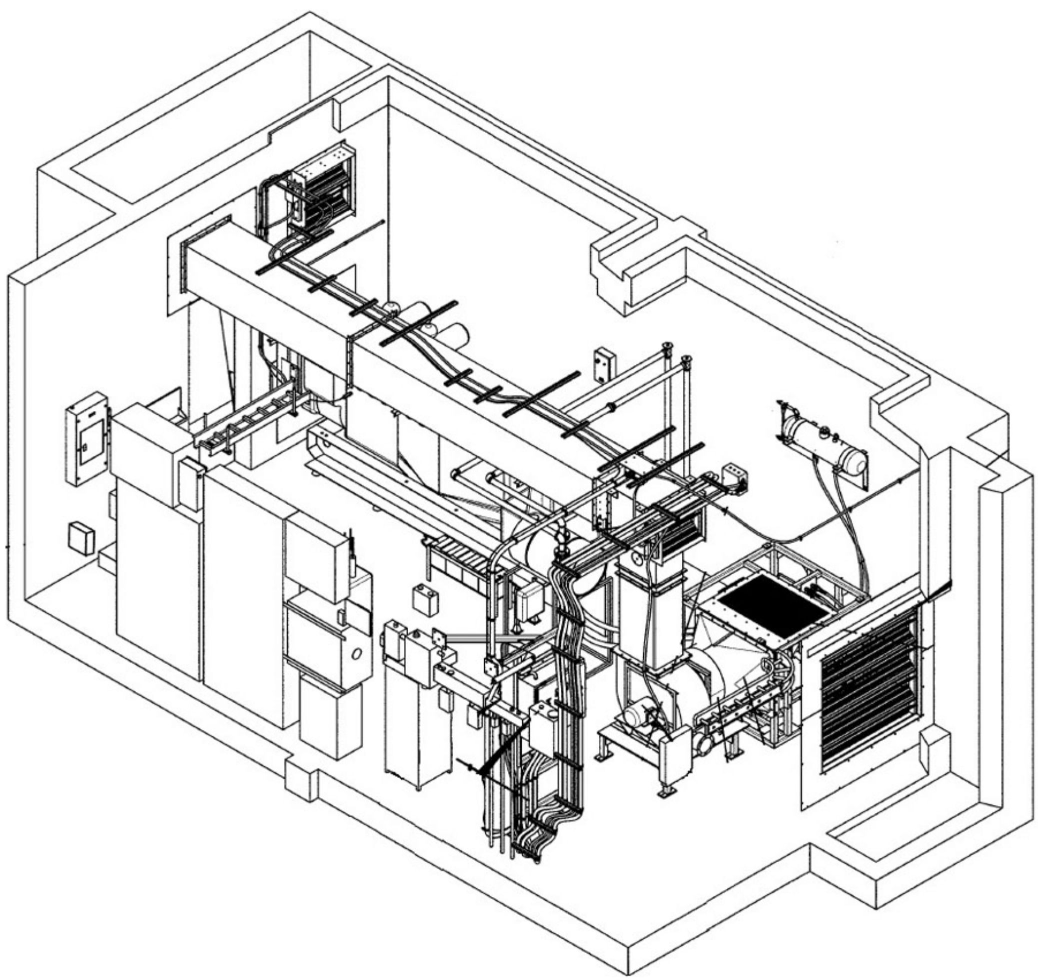


Figure 3–15. Wing 1 launcher support building.

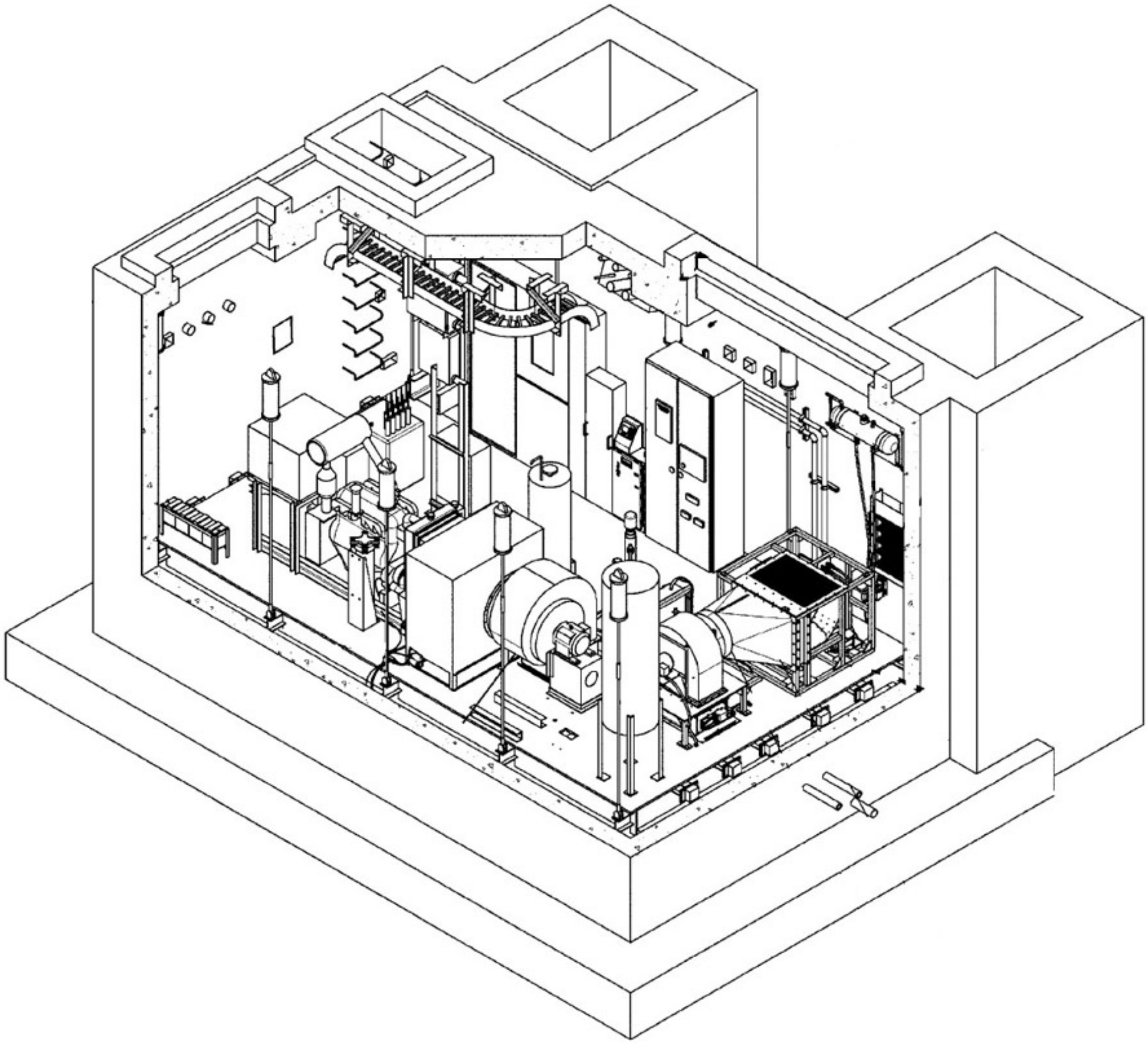


Figure 3–16. Wings 3 and 5 launcher support building.

Launch facility security system

Remember, the LF is unmanned the majority of the time, meaning there are no security teams on site. Therefore, the function of the LF security system is to detect unauthorized activity at an LF. The system is divided into the outer zone (OZ) and inner zone (IZ) security systems. The OZ system monitors the above ground area and the LSB, and the IZ system monitors the launch tube below ground level and the entrances to the launcher.

All detected security violations are displayed on the console in the LCC. That information is passed to the SCC, where security forces personnel will be dispatched to determine the cause of the alarm. If you set off the security system without prior authorization, you will be confronted by security forces personnel who will put you at a disadvantage, or “jack you up”, until your identity can be verified.

Outer zone

The outer zone security is the first system you will encounter upon entering the site. This system uses a radar surveillance system, centered on the Improved Minuteman Physical Security System (IMPSS) pole. Objects moving inside the surveillance area are detected by the IMPSS pole and an OZ alarm will be generated by the electronic security drawer in the LER. The system is able to distinguish precipitation (rain, snowfall, etc.) and small animals from intruders which helps to limit the number of nuisance alarms.

At Wing 1 LFs, the OZ surveillance extends to the LSB. These LFs are equipped with a continuity loop on the LSB entry door. A switch is installed on the LSB entry door, so when the door opens, the continuity loop is broken. The security drawer in the LER will then sense an open circuit and will generate an OZ alarm.

Inner zone

The IZ security system is divided into a continuity loop and a network of vibration-sensitive transducers. The IZ continuity loop contains switches on the launcher closure door, launcher closure door lock pin, primary door, and combination locks on the security pit vault door and secondary door. When the site is secured and no IZ alarms are reporting, the switches are all closed and the continuity loop is complete (closed). Any movement of the combination dials, lock pin, primary door, or launcher closure opens the continuity loop, breaking the circuit to the security drawer in the LER sending an IZ alarm to the LCC.

The second part of the IZ alarm system includes a set of vibration-sensitive transducers located within the walls of the LER and launch tube. The transducers detect attempts to tunnel into the launcher by turning vibrations into electrical signals that the security drawer looks for. This prevents attempts to dig or drill into the launcher, circumventing the OZ system. This portion of the IZ alarm is typically set off by technicians in the LER by bumping the umbilical cables running into the launch tube or by earthquakes which can occur frequently at northern tier bases.

Remote visual assessment

The remote visual assessment (RVA) is a camera system mounted on a pole just outside the fence on the southern side of the LF. The video feed is sent to the MAF, where it can be seen on monitors in the SCC. This video feed is useful for monitoring the height of snow accumulation topside at the LFs, as well as visual verification of OZ and IZ alarms.

Service area

The last portion of the LF to cover is the service area which is the level, topside area within the security fence of the LF. The area is used primarily for maintenance and support vehicle maneuvering and parking. Pylons are located near the launch tube along with tie downs and jack pads that are used to support the transporter-erector during a missile downstage emplacement or removal. There are also antennas in the service area, but are protected from vehicle damage by barrier poles.

020. Minuteman III missile features

So far we have discussed the MSB, MAF, and LF. Now, let’s discuss the reason for all these facilities—the missile! The Minuteman III ICBM consists of a three-stage, solid-propellant booster (called the downstage), a liquid-propellant post-boost propulsion system (called the Propulsion System Rocket Engine [PSRE] as introduced earlier), an inertial-type guidance system, and a RV. The assembled missile rests upright in the launcher. While studying the following paragraphs, refer to figure 3–17.

Downstage

The missile downstage consists of three solid-propellant rocket motors that provide the necessary thrust to accelerate the missile very high up into the atmosphere. Each stage has the ability to control the direction of the missile. The first two stages provide thrust until their propellant is completely used up. The third stage has the ability to terminate thrust, if necessary. The MGS controls all of the functions that occur with the three motors in the downstage.

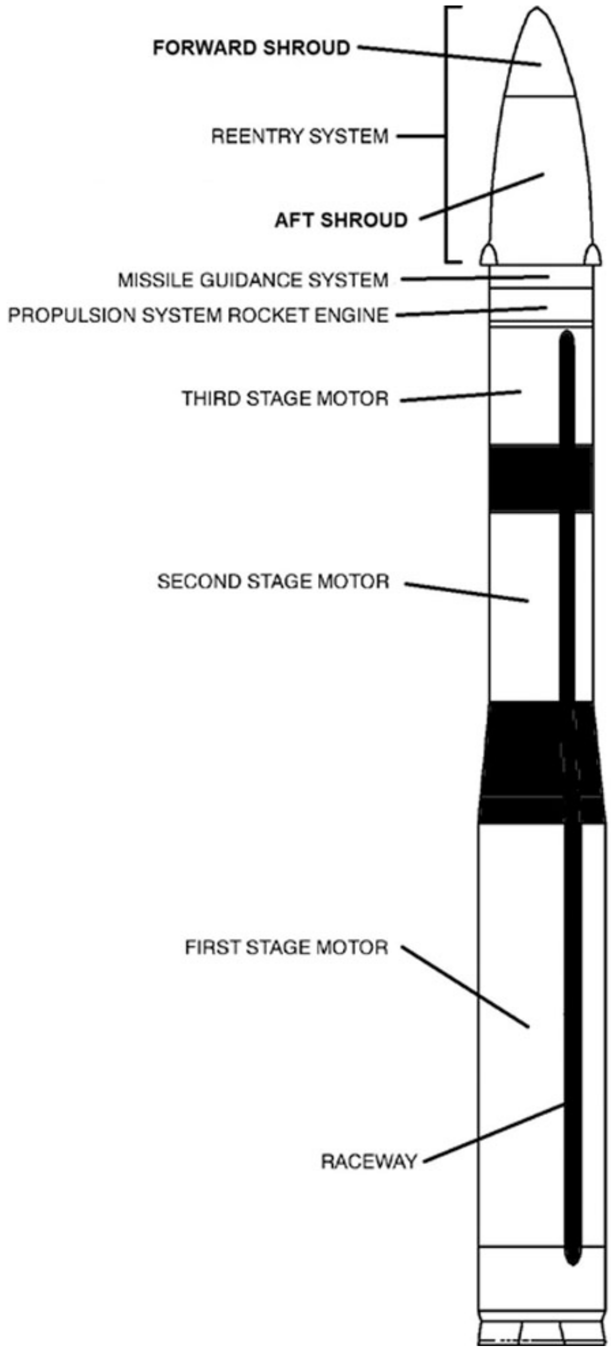


Figure 3–17. Minuteman III missile.

First-stage motor

The first-stage motor is located at the bottom of the missile, and is the largest and most powerful of the three stages. This stage must provide the tremendous amount of thrust required to propel the missile out of the launch tube from a complete standstill. The first-stage motor consists of a steel motor case with four movable thrust nozzles. The high-performance solid propellant is cast into the motor case. The very center of the propellant is hollow, in the shape of a six-point star. This is to allow the propellant to burn evenly vertically from top to bottom, and also evenly from the inside to the outside. The propellant is ignited from the top of the stage by an igniter. Once the propellant has been ignited, it cannot be stopped, and will burn until the propellant is completely used up.

The movable nozzles control missile attitude during first-stage boost flight. Each nozzle can pivot through an angle of ±8°, meaning they can move a total of 16°, from –8 through +8°. A low-temperature insulation protects the motor case exterior from the heating caused by the friction between the case and the air surrounding it (this friction is called *aerodynamic heating*). The first-stage motor burns for roughly 60 seconds. At the instant that the first-stage motor is no longer providing thrust, the MGS commands it to jettison from the rest of the missile. This is when the second-stage motor takes over.

Second-stage motor

The second-stage motor is not quite as large or as powerful as the first-stage motor because it does not need to be. The missile is already 60 seconds into its flight at this point. The second-stage motor has a titanium alloy case filled with more solid propellant. The thrust of the burning propellant is output through a single nozzle. To keep the missile pointed in the desired direction, the second stage uses a gas injection system. The gas is injected directly into the exhaust as it exits the nozzle, causing the exhaust to deflect in the opposite direction. The deflection of the exhaust causes the missile to slightly change direction.

Cork insulation protects the exterior of the motor case from aerodynamic heating. It is during the second-stage burn that the shroud covering the warheads is jettisoned. Because there is little wind resistance in the high atmosphere, the shroud is not necessary for aerodynamic reasons anymore. The second-stage motor also burns for about 60 seconds. Once all of the propellant has burned, and the motor is no longer providing thrust, it is jettisoned just like the first stage.

Third-stage motor

The third-stage motor is the smallest of the three. The missile is moving extremely fast at this point, and is so high above the earth that it has nearly escaped gravity's pull. This motor has a fiberglass case, and uses solid propellant like the first- and second-stage motors. To keep the missile headed in the right direction, the third-stage motor uses a gas deflection system similar to the second-stage motor. Depending on where the missile is targeted, the third-stage motor may not need to provide thrust all the way through its propellant burn. Therefore, the third stage is equipped with the option to terminate thrust if commanded to do so by the MGS. We know that the propellant will burn until it is completely used up, so in order to terminate the thrust, small explosive charges cause six ports on the sides of the case to blow open. This allows the exhaust gasses to escape out of the sides of the stage instead of the bottom nozzle, which causes forward thrust to halt. Like the first and second stages, a full burn of the third-stage motor can last up to about 60 seconds. Once the third stage is no longer providing thrust, it is jettisoned away like the first and second stages.

Propulsion system rocket engine

What is left of the Minuteman III missile after the downstage has burned and been jettisoned is called the *post-boost vehicle.* The PSRE (pronounced "piz-ree") provides the thrust required after the downstages have gotten the post-boost vehicle up into the atmosphere. The PSRE has its own fuel and oxidizer storage tanks that are needed because there is no oxygen to be used for the burning process due to altitude.

The fuel storage tank contains the liquid rocket engine fuel, *monomethyl hydrazine*. The oxidizer tank contains liquid *nitrogen tetroxide*. These two chemicals form a *hypergolic* mixture, meaning that they instantly ignite when they come in contact with each other. No ignition device is necessary; they can simply be mixed together to provide the needed thrust. There are 11 rocket engines that enable the post-boost vehicle to maneuver itself into position to deliver the payload. The MGS controls small valves that open and close as necessary to maneuver the post-boost vehicle.

Missile guidance set

The MGS is a cylindrical missile body section that is between the PSRE and the RS. The MGS houses the missile guidance computer and the gyro-stabilized inertial platform. This component is responsible for maintaining the missile's trajectory, and ultimately getting the payload to its destination. It is worth noting that while the missile is in the launcher, the MGS is powered by *ground power.* After the missile leaves the silo, the MGS battery is activated which provides power to the parts of the missile that require power for the duration of the missile's flight. The battery powers all missile components with the exception of the first stage exhaust nozzle control hydraulics. The MGS is cooled in the launcher by a liquid coolant supplied through the missile's umbilical cable which also supplies the ground power mentioned above.

Re-entry system

The Minuteman III re-entry system consists of a *shroud assembly* and RV (fig. 3–18).

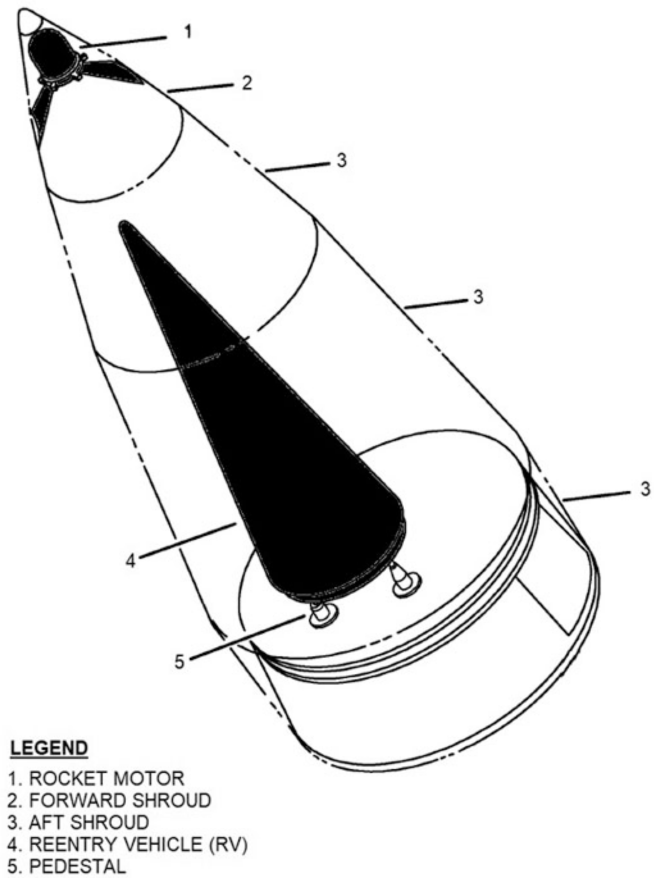


Figure 3–18. Re-entry vehicle.

Shroud assembly

The shroud assembly is made of titanium, and consists of a forward section and an aft section that are joined together by 12 fasteners. It provides environmental protection for the re-entry system payload during flight. A rocket motor located in the very tip of the forward shroud helps to separate the entire shroud assembly during the second-stage burn, exposing the payload. The shroud assembly is attached to the deployment module by a V-band clamp which is ejected right before the rocket motor in the forward shroud ignites.

Re-entry vehicle

The RV is an advanced ballistic re-entry vehicle that contains a Department of Energy provided payload. The RV is thermally and structurally protected by a heat shield. The RV consists of a forward section, body section, and a rear cover that provides an interface with the payload support. A spin generator assembly, located on the rear cover, causes the RV to spin much like a football in flight. This spinning action ensures that the RV does not wobble (like a poorly thrown football), and remains stable during flight. When the proper signal is provided, pressure cartridges jettison the RV away from the pedestal.

Raceway

The raceway (fig. 3–17) runs the entire length of the downstage. The raceway houses the missile guidance control cable which extends from the umbilical receptacle in the missile skirt all the way up to the MGS. Pull-away connectors at the stage separation joints permit cable separation during missile staging. Seals are provided, in the raceway at the aft end of each stage, to prevent base heat and staging pressure from entering the raceway. The exterior of the raceway is protected by cork insulation. As you may have guessed, the missile guidance control cable contained inside the raceway is what allows signals to transmit back and forth between the different components in the downstage.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

017. Missile support base features

1. Match the areas or facilities in column B with their functions in column A. Items in column B may be used once, more than once, or not at all.

Column A	*Column B*
____ (1) Area or facility responsible for intermediate maintenance on weapon system equipment.	a. Missile transfer building.
____ (2) Area or facility where the missile is transferred between the shipping container and the transporter-erector.	b. Proof-load test facility.
____ (3) Where storage and parking is provided for a loaded transporter-erector.	c. Weapons storage area.
____ (4) Area or facility for checking out re-entry vehicles.	d. Missile support area.
____ (5) Where storage is provided for spare warheads and pyrotechnic components.	e. Transient storage area.
____ (6) Area or facility for determining if equipment is safe to use within designed load capacities.	f. Maintenance facility building.
	g. Missile support base.

018. Missile alert facility features

1. What is the main difference between Wing 1 and Wing 3 or 5 MAF?

2. What is the main purpose of the MAF's SCC?

3. What does the LCC blast door provide?

4. What prevents unauthorized tampering within the LCC?

5. What is the purpose of the ACP LCC?

6. What is the purpose of the MAF cable air dryer?

7. What is the purpose of the topside diesel generator at a Wing 3 and 5 MAF?

019. Launch facility features

1. What is the purpose of the sump pump at the bottom of the LF's launch tube?

2. What is the main purpose of the LF's launcher closure door?

3. Why is approximately half of the upper-level LER shock isolated?

4. Why are there two removable steel hatches in the roof of the LSB?

5. What area of the LF does the IZ security system monitor?

6. What is the purpose of the vibration-sensitive transducers in the IZ security system?

7. What is the purpose of the service area on an LF?

020. Minuteman III missile features

1. Match the missile components in column B with their functions in column A. Items in column B may be used once, more than once, or not at all.

Column A	*Column B*
____ (1) Has movable nozzles that can pivot through an angle of ±8°.	a. Spin generator.
____ (2) Has a titanium alloy case filled with solid propellant.	b. Third-stage motor.
____ (3) Its thrust can be terminated before all propellant is exhausted.	c. Second-stage motor.
____ (4) Has 11 rocket engines used for maneuvering.	d. PSRE.
____ (5) Houses the gyro-stabilized inertial platform.	e. Raceway.
____ (6) Allows signals to be transmitted between the different components in the downstage.	f. First-stage motor.
	g. MGS.

Answers to Self-Test Questions

013

1. Deterrence of aggression through the threat of massive retaliation. Deter adversaries from employing WMD against our deployed forces. Deter nations from supporting or sponsoring terrorist organizations that may employ WMD in terrorist attack against our nation.
2. The president of the US.
3. AFGSC.
4. Rapid reaction, thermonuclear striking power, high accuracy, low vulnerability to attack, and high in-commission rate.
5. Rapid reaction.
6. Low vulnerability.
7. High in-commission rate.

014

1. Arrangement or placement of the various components that make up the weapon system.
2. To comply with the TPC.
3. A flight.
4. Because the missile wing is a tenant unit.
5. It allows command and status information from each of the five flights to be transmitted throughout the entire squadron.

015

1. The TPC and PRP.
2. By working on or near certain parts of a nuclear weapon system.
3. Inside the LCC.
4. An escort.

016

1. Equipment, software, and procedures.
2. The "Last Update" date on the main page of the web-based MNCL.
3. For any reason.

017

1. (1) f.
   (2) a.
   (3) e.
   (4) c.
   (5) c.
   (6) b.

018

1. The ECS equipment and diesel generator are located topside at the Wing 1 MAF, while this same equipment is located underground at the Wing 3 or 5 MAF.
2. To provide controlled access to the elevator shaft that leads down to the LCC.
3. An environmental seal and protection against overpressure and EMP produced by a nuclear blast.
4. The area is a no-lone zone.
5. Reports to the WCP and serves as the backup should anything happen to the WCP.
6. To keep moisture from entering the HICS.
7. To provide power to the topside portions of the MAF.

019

1. It keeps ground water from accumulating within the launch tube and damaging the solid propellant boosters.
2. To protect the missile from weapons effects and act as an environmental seal.
3. To prevent the launch-critical equipment from ground shock damage produced by a nuclear blast.
4. To permit the removal and emplacement of the brine chiller unit and diesel generator.
5. The launch tube below ground level and the entrances to the launcher.
6. Detects attempts to dig or drill into the launcher.
7. Provides maintenance and support vehicle maneuvering and parking.

020

1. (1) f.
   (2) c.
   (3) b.
   (4) d.
   (5) g.
   (6) e.

Complete the unit review exercises before going to the next unit.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter.

Do not return your answer sheet to AFCDA.

34. (013) What is the name of the period in world history that began at the end of World War II and lasted until the collapse of the Soviet Union?
    a. Cold War.
    b. Progressive Era.
    c. Information Age.
    d. Nuclear Arms Race.

35. (013) Which statement best explains the authority of launching intercontinental ballistic missiles?
    a. Air Force Global Strike Command (AFGSC) has the authority to launch a missile attack, but the president has the means of delivery.
    b. The president has the authority to launch a missile attack as well as controlling the means of delivery.
    c. The president has the authority to launch a missile attack, but AFGSC has the means of delivery.
    d. AFGSC has the authority to launch a missile attack as well as controlling the means of delivery.

36. (013) Which strategic characteristic is identified by a pre-targeted, onboard guidance-control system capable of quick transition?
    a. Rapid reaction.
    b. Low vulnerability.
    c. High in-commission rate.
    d. Thermonuclear striking power.

37. (013) Select the strategic characteristic identified by having penetration aids, which allows the warhead to arrive at its intended target.
    a. Rapid reaction.
    b. Low vulnerability.
    c. High in-commission rate.
    d. Thermonuclear striking power.

38. (014) Which launch facilities (LF) can a launch control center (LCC) assume control and monitoring responsibility of?
    a. All those in its squadron.
    b. Only those in its group.
    c. Only those in its flight.
    d. All those in its wing.

39. (015) What is the minimum number of authorized technicians that must be present during any operation involving a nuclear weapon system?
    a. One.
    b. Two.
    c. The number necessary to conduct the operation.
    d. The number necessary to be qualified on the Personnel Reliability Program.

40. (015) Personnel that have physical access to nuclear weapons must have what type of qualification?
    a. M9 pistol.
    b. Deployment.
    c. Two-Person Concept.
    d. Personnel Reliability Program.

41. (016) A restricted vehicle on the master nuclear certification list must *not* be used for
    a. non-nuclear tasks.
    b. nuclear operations.
    c. training special purpose vehicle operations.
    d. movements in a missile support base parking area.

42. (017) The primary method used for shipping missile downstages from the depot to the missile transfer building is by
    a. road or highway in a transporter-erector.
    b. rail in a ballistic missile trailer.
    c. air in a ballistic missile trailer.
    d. rail in a payload transporter.

43. (017) Which area or facility of the missile support area provides storage and parking for loaded transporter-erectors?
    a. Maintenance facility building.
    b. Missile transfer building.
    c. Weapons storage area.
    d. Transient storage area.

44. (018) The facilities included at a missile alert facility are: security control center, launch control center, and
    a. launch equipment room.
    b. weapons storage area.
    c. transient storage area.
    d. clean room.

45. (018) The launch control center (LCC) blast door lock pins are extended and retracted using
    a. a manually-operated hydraulic pump in the LCC.
    b. an electrical switch in the security control center.
    c. a manually-operated hand pump on the outside of the blast door.
    d. an electrically controlled hydraulic unit in the launch control equipment building.

46. (018) One of the squadron command posts at each missile wing is designated as the
    a. Alternate command post.
    b. Squadron command post.
    c. Primary launch control center.
    d. Missile maintenance operations center.

47. (018) What equipment is found in the Wings 3 and 5 launch control equipment building?
    a. Blast valve hydraulic control unit and oxygen regeneration unit.
    b. Standby diesel-engine generator and emergency storage batteries.
    c. Normal environmental control equipment and an emergency air handler.
    d. Electrical control and distribution panels and a standby diesel generator.

48. (019) Which design feature permits limited motion between the launch tube and equipment room without danger of major structural damage?
    a. Shock loops.
    b. Shock-isolated floor.
    c. Six-to eight-inch rattle space.
    d. Mechanical suspension system.

49. (019) The launch facility secondary door provides access to the
    a. launcher equipment building.
    b. launcher equipment room.
    c. security pit vault door.
    d. launch control center.

50. (019) Which two systems make up the launch facility security system?
    a. Doppler radar and launcher support building switch loop.
    b. Switch loop and transducers.
    c. Outer zone and switch loop.
    d. Inner and outer zone.

51. (019) What condition will cause an outer zone security alarm to report to the launch control center?
    a. Launch support building entry door opened.
    b. Security pit vault door removed.
    c. Launch facility gate opened.
    d. Primary door opened.

52. (020) What is the purpose of the Minuteman III's first-stage motor?
    a. Jettison the reentry system shroud.
    b. Maneuver the post-boost vehicle into position.
    c. Create the spinning action necessary to keep the reentry vehicle stable.
    d. Provide the required thrust to propel the missile out of the launch tube.

53. (020) Which Minuteman III missile component contains the missile guidance control cable?
    a. Propulsion system rocket engine.
    b. Missile guidance set.
    c. Downstage.
    d. Raceway.

Please read the unit menu for unit 4 and continue ➔

Unit 4. Hardness Assurance

THE MINUTEMAN III weapon system is primarily a deterrent against aggression. To meet this objective, it must first be able to survive a nuclear attack, and then have the capability to effectively strike back. Hardness is the major defining factor in survivability. Hardness is designed and built into the system and must be preserved through proper maintenance as well as through consideration in follow-on design changes, modifications, and substitution of parts. The hardness program covers the entire operational weapon system. Regardless of hardness considerations, all LFs must be maintained in normal technical order configuration. Although different configurations and hardness levels exist at the MWs, the designed-in hardness of each wing is kept by performing maintenance according to technical manuals for each configuration.

This unit gives you important information about nuclear weapon effects and how our facilities are hardened against them. It will also ensure that as a technician, you do not degrade the hardness of the weapon system through sloppy or poor maintenance practices. The first section will focus on the nuclear environment and how our systems are designed to withstand it. The second section will focus on how you will preserve the designed-in hardness features of the weapon system.

4–1. Weapons Effects and Protection

This section discusses what happens during a nuclear detonation and how our facilities are hardened to withstand each effect. Before we discuss these features, let's begin with the terminology we will use throughout this unit.

021. Hardness terminology and functions

Knowing the common terminology will provide a frame of reference and prepare for later discussions of the hardness assurance program. This will in turn help to ensure an understanding of the equipment on site and its purpose as it relates to hardness.

Nuclear environment

As mentioned earlier, the reason the facilities are hardened is to protect them from the nuclear environment, created by the detonation of a nuclear weapon. The specific exposure level of a facility in a nuclear environment depends upon the type of weapon and its yield. A weapon's "yield" is the amount of energy discharged when a nuclear device is detonated, expressed in kilotons or megatons. For further clarification, a "kiloton" of yield is equal to 1,000 pounds of dynamite.

Other factors that affect what the facility is exposed to are the height of the burst and the miss distance. When coupled with the atmospheric conditions, soil characteristics, and terrain, these factors play a large role in the nuclear environment created from a nuclear detonation.

Hardness
Hardness, as it pertains to our weapon system, is defined as the measure of the ability of a system to withstand exposure to one or more of the environmental effects of a nuclear or non-nuclear weapon. In other words, it determines how well the weapon system handles exposure to one of the nuclear weapon effects mentioned earlier.

Survivability
Survivability is closely related to hardness. It is the capability of a system to withstand a nuclear or non-nuclear environment without losing the ability to accomplish its mission. For example, an LF exhibits survivability if it can withstand the effects of a nearby nuclear detonation and still successfully launch its missile.

Extended survival period
The extended survival period is the period in which the facility is still capable of executing its mission without needing the power supplied by a commercial power company. This period begins when an attack occurs or commercial power is lost, whichever occurs first. During extended survival, all power is provided by the site's diesel-generator.

Emergency survival period
The emergency survival period is the period where the facility's critical functions are kept ready without dependence on any external power or normal ECS. During the emergency survival period, electrical power is provided by the emergency storage batteries in the LER at the LF, or LCC at the MAF. The storage batteries also supply power to the emergency ECS. Remember, in extended survival, the facility is powered by a diesel-generator, and the site runs just as it would on commercial power; in emergency survival, the facility is powered by emergency batteries, and only certain critical equipment items receive power.

Launch-essential
An item of equipment or a system function is considered launch-essential if it is required to launch the missile. First and foremost, it's only considered launch-essential if its malfunction would prevent a launch before, during, or after a nuclear attack.

Launch-essential functions are those functions that must occur between the time the initial launch command is initiated and the moment the missile exits the launch tube. All systems must function within specified tolerances and without sustaining any damage during an attack that would prevent the success of a missile launch.

Mission-critical
An item of equipment or a system function is considered mission-critical if it is required to launch the missile within a given time span, or is required to successfully complete the mission. As with launch-essential equipment or functions, an item or function is considered mission-critical if it supports or protects other mission-critical equipment or functions.

Hardness-critical items
An item is considered hardness-critical if it could be designed, repaired, manufactured, installed, or maintained for normal operation in a non-nuclear environment, yet degrade survivability when exposed to a nuclear environment if it was not maintained according to hardness requirements. A good example would be a radio frequency interference (RFI) gasket that is made of conductive metal fibers. The gasket's job is to electrically bond the cover or door of a piece of equipment with the rest of the cabinet. This gasket serves no function in a non-nuclear environment; however, in a nuclear environment, this gasket is vital to the survival of the electrical equipment in the panel. Failure to maintain RFI gaskets properly will have no impact during normal operations, but can degrade survivability when exposed to a nuclear environment.

There are three categories of hardness-critical equipment, as illustrated in the following table.

Categories of Hardness-Critical Equipment		
Category	**Purpose**	**Examples**
Perform	Directly performs a hardness critical function.	AFGSC command networks, cryptographic equipment, ordnance interlocks, safety devices, and squib drivers.
Support	Supports other equipment that performs hardness-critical functions.	The ECS, storage tanks for coolant liquids, pipes for carrying the coolant liquids, and the missile suspension system.
Protect	Protects other equipment that performs hardness-critical functions.	Includes equipment that protects MAF and LF components from nuclear environments. Examples of these are the launcher closure, LCC blast door, electrical surge arrester (ESA) assemblies, ventilation safety valves, shock isolators, and the launcher PAS primary door.

Facility hardness requirements

Originally, the Minuteman III facilities were designed to withstand the nuclear environment created by the "near-miss" of a nuclear detonation. Over the years, as the different weapon systems evolved, the Minuteman facilities received hardness upgrades, technical order procedures were changed, and the threat scenario has changed based on accuracy and yield. Not all structures are designed to survive all effects of a nuclear detonation. For example, the LSB at Wings 3 and 5 have some ground shock protection, whereas the Wing 1 LSB has no shock protection. Because of the obvious criticality of the equipment in the LER and LCC, these structures must withstand the effects of all nuclear environments.

022. Effects of a nuclear detonation

Earlier, we touched on what a nuclear environment is and the environmental effects created when a nuclear weapon detonates. Now let's explore in more detail each of those environmental effects. Understanding these effects is important in order to comprehend how the facility is protected from them, and what your role is as a technician is in preserving hardness. The effects we will study are as follows (fig. 4–1):

- Ground shock and vibration.
- Air blast and acoustics.
- EMP.
- Nuclear radiation.
- Thermal effects.
- Debris.

Study the figures in this section closely, as they contain a lot of information to clarify and further explain the material.

Ground shock and vibration

For our purposes, we define ground shock as the physical movement of the ground due to a nuclear detonation. This includes air-blast-induced and direct-induced ground motion. A series of ground surface waves move outward from the detonation crater just like waves in water. These waves produce "ground roll" which at any given location is felt as the back and forth movement of the surface as the waves pass by.

Rocks will be crushed close to the explosion. Stress builds up by the passage of the pressure wave and produces radial cracks. At greater distances from the crater, the direct-induced motions are not powerful enough to cause damage. The air blast induces motion as it passes over the surface, forcing the ground down and away from the explosion. If the air blast is powerful enough, it can even damage buried structures. Even if the structure is strong enough to withstand the effect of the ground shock, the sharp jolt resulting from the impact of the shock wave can cause injury to occupants and damage to equipment.

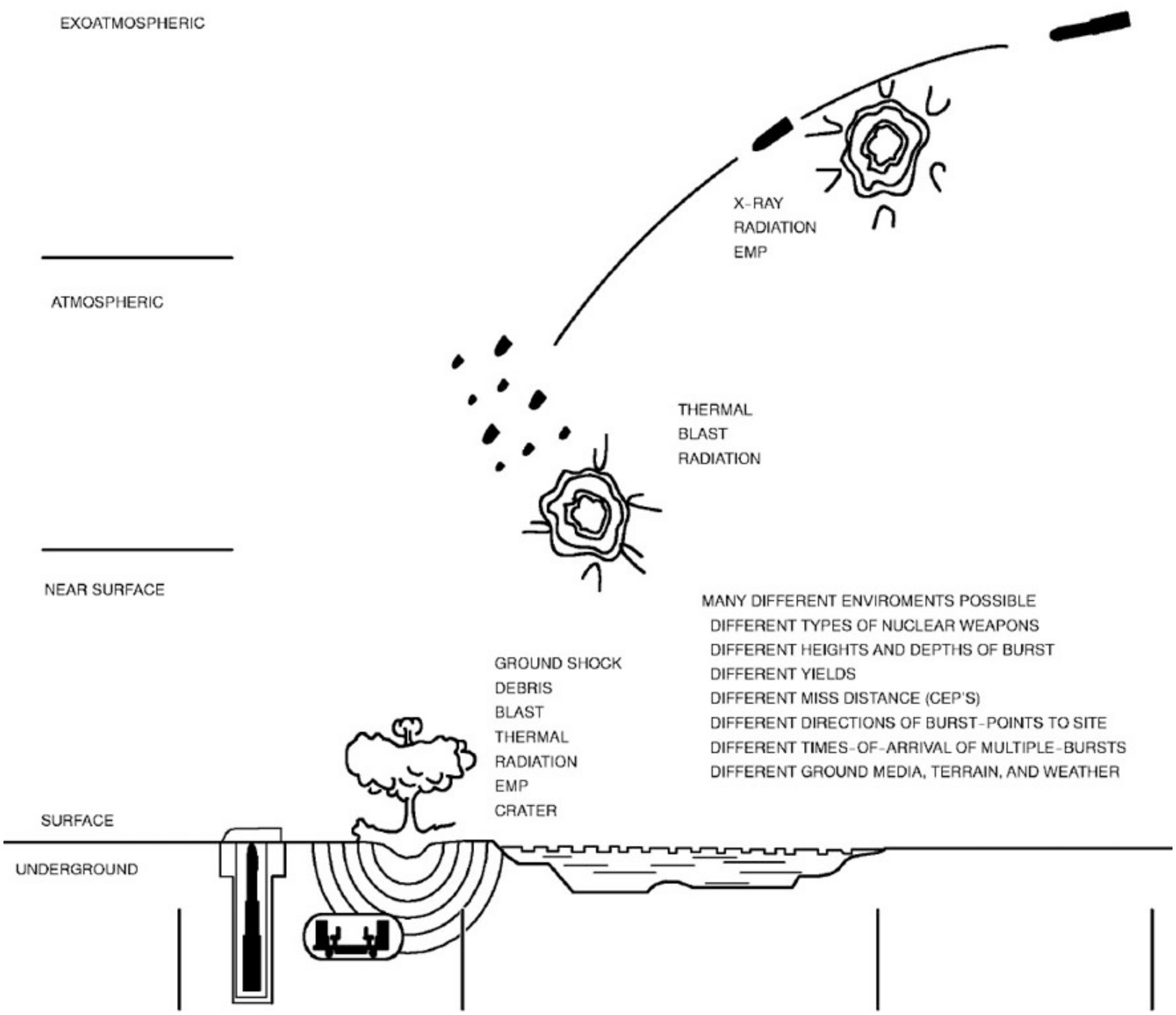
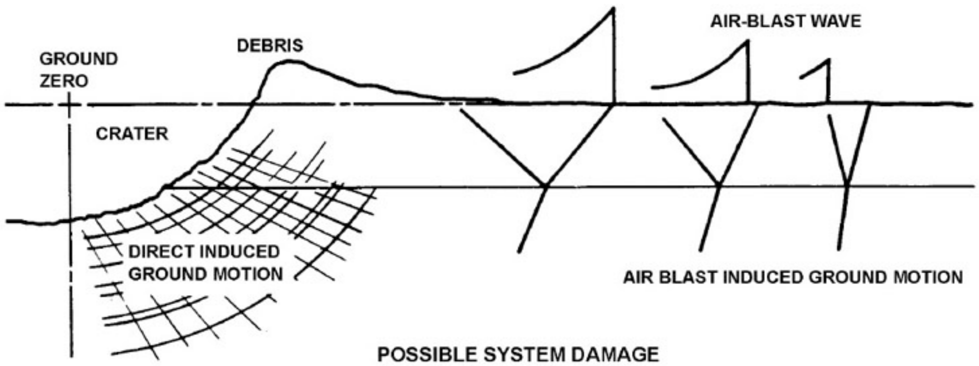


Figure 4–1. Nuclear weapons effects.

Ground shock levels are greatly reduced before they reach the internally mounted equipment. This reduction depends upon the depth of the facility, type of soil, and the facility structure. These factors are considered in the design criteria. See figure 4–2 for a description of the way the system responds to ground shock.



POSSIBLE SYSTEM DAMAGE

LAUNCHER

- CLOSURE INOPERATIVE
- STRUCTURAL FAILURE
- MSS BOTTOMS OUT
- MSS IMPACTS LAUNCH TUBE

OGE

- COMPONENT STRUCTURAL FAILURE
- COMPONENT ON SHOCK ISOLATED FLOOR IMPACTS LER WALL OR LAUNCH TUBE

CABLES

- DISPLACEMENT-INDUCED BREAKAGE
- DAMAGED AT PENETRATION DUE TO STRUCTURAL FAILURE

MISSILE

- STRUCTURE FAILURE
- FLYOUT IMPACT WITH LAUNCHER DUE TO DISPLACEMENT OR TILT

CRATER OR DIRECT-INDUCED MOTIONS ARE CHARACTERIZED BY LOW ACCELERATIONS AND LARGE DISPLACEMENTS. AIR-INDUCED MOTIONS ARE CHARACTERIZED BY HIGH ACCELERATIONS AND SMALL DISPLACEMENTS.

THE SEQUENCE OF ARRIVAL AT A GIVEN TARGET AND THE RELATIVE IMPORTANCE OF DIRECT-INDUCED MOTIONS AND AIR-BLAST-INDUCED MOTIONS CHANGES WITH DISTANCE FROM GROUND ZERO.

Figure 4–2. Ground shock effects.

Effects on walls, ceilings, and fixed floors

The LER, LSB, LCC, and LCEB walls are in direct contact with the ground and relatively close to the surface. They must be able to survive ground shocks because they are not buried very deep below the surface. The shock that the launch tube and LER fixed floor are exposed to is less severe because they are buried deeper underground. The depth of the soil reduces the shock due to the elastic and damping properties of the ground. The upper portion of the launch tube is also protected from the surface effects by the launcher closure and the LER. The LER walls, ceiling, and launcher closure are structurally tied together in order to provide a path for shock. Surface pressure will directly hit the launcher closure which in turn will be transferred to the LER ceiling and walls.

Effects on the launch tube liner

The lower part of the launch tube liner is subjected to shock environments in the same manner as described previously; however, being buried deeper reduces the severity of the effects.

Effects on shock-isolation devices

Equipment mounted on shock-isolated devices, such as the LER and LCC shock-isolated floors, are subjected to a lesser effect than the hard-mounted equipment due to the shock reducing characteristics of the shock-isolation systems. A good example of this is the springs in your car’s suspension. They create a sort of protection between you and the road. Without the springs, the ride would be extremely uncomfortable because you would be exposed to every bump in the road.

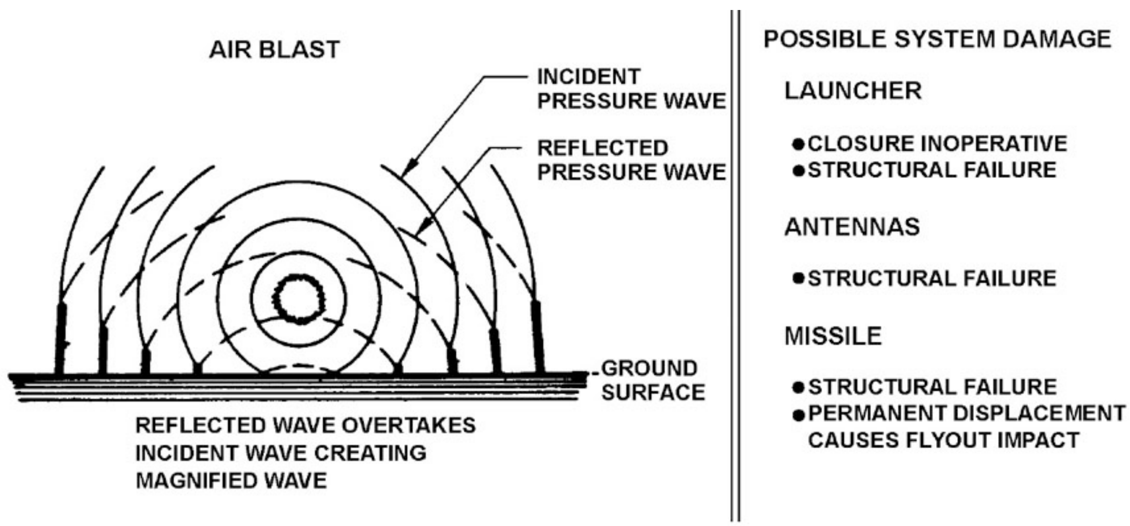
Air blast and acoustics

A large percentage of the energy from a nuclear detonation results in air blast effects. Air blast is a shock wave or moving wall of compressed air created by the explosion. Initially, the wave travels at very high velocities, eventually slowing to sonic velocity, approximately 770 miles per hour, at very low pressures.

The destructive effect of the blast is proportional to the amount of its over-pressure. The maximum value of the air blast at the blast wave front is called the "peak over pressure." The strength of the blast wave diminishes as the blast wave travels outward from the center of the detonation.

The passing shock wave produces sound waves, defined as acoustic effects. Acoustic hardness refers to the ability of sensitive equipment to survive high noise levels. Components may be damaged or even fail if they are subjected to acoustic levels that are higher than they were designed to withstand. The basic cause of the damage is due to the fluctuating air pressure; the louder the noise, the more pronounced the compression of the air. The rapid pressure fluctuations cause high stresses in delicate equipment. High noise levels, creating extremely high-pressure fluctuations, can accelerate flat panels. This extreme acceleration effect causes the damage.

See figures 4–3 and 4–4 for a description of air blast and acoustics and their effects. These effects occur at the ground surface and within the hardened underground facilities. Exposed portions of facilities and all equipment located on the ground surface are subjected to maximum effects. Certain equipment (i.e., launcher closure) that is hardness critical must survive. However, other non-hardness critical surface facilities and soft communications antennas are not required to survive. Equipment located in the LER, launch tube, and LCC is exposed to lower acoustics and overpressures due to how deep they are buried, structure configuration, and by the blast valves or seals on openings to the structure.



FIFTY PERCENT OF THE TOTAL BOMB ENERGY ENDS UP AS AIR BLAST. AIR BLAST IS A SHOCK WAVE OR MOVING WALL OF COMPRESSED AIR. THE PEAK OVERPRESSURE EXPERIENCED WHEN THE AIR BLAST SHOCK WAVE PASSES IS FOLLOWED BY RAPID PRESSURE FLUCTUATIONS AND HIGH WINDS.

THE PEAK OVERPRESSURE DIMINISHES AS IT TRAVELS OUTWARD FROM GROUND ZERO.

Figure 4–3. Air blast effects.

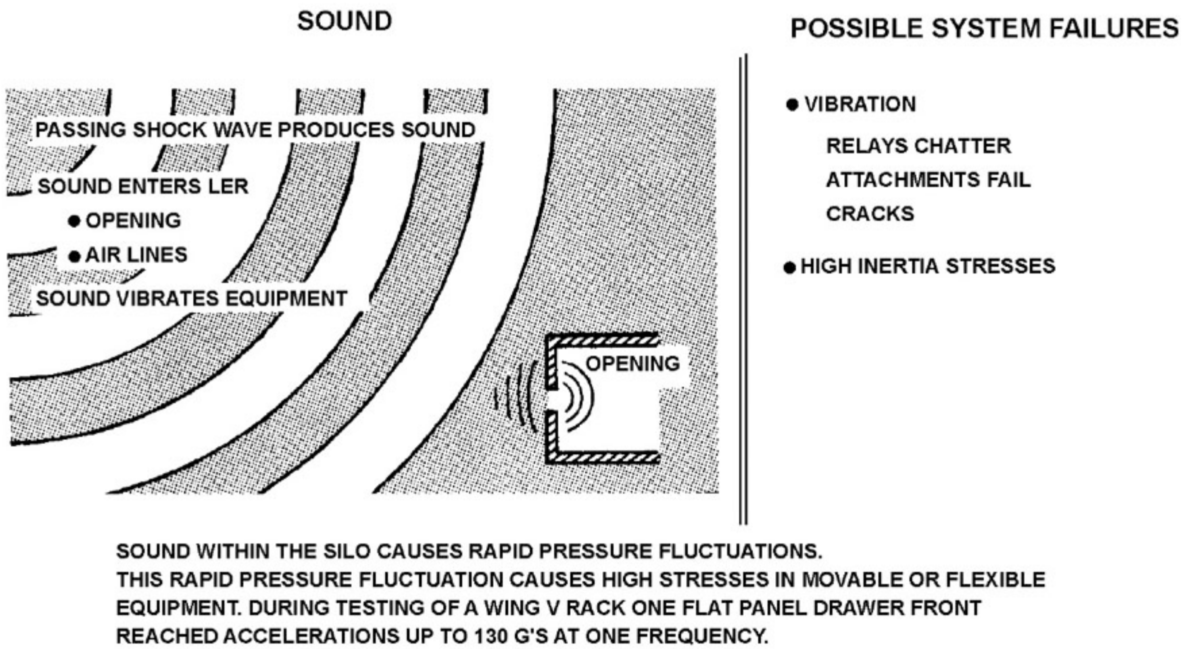


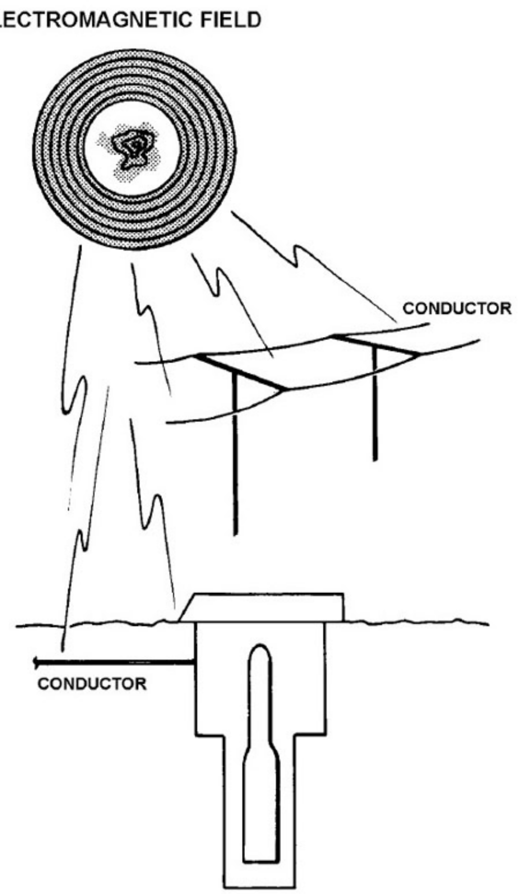
Figure 4–4. Acoustic effects.

Electromagnetic pulse

A nuclear detonation generates an electromagnetic field that can induce electric currents in any exposed metallic object. These currents, when induced in antennas, conductors, metal conduits, and so forth, can have undesirable effects on electronic equipment and components. Exposure of electronic equipment to these induced currents can cause temporary malfunctions or permanent damage. The major concern is the generation of electrical currents that may penetrate a facility and then be transmitted into sensitive equipment. See figure 4–5 for a description of electromagnetic pulse (EMP) effects on system equipment.

The EMP hardness depends on the geometry of the facility, the arrangement of the equipment inside, and the precautions taken to eliminate or diminish the undesired currents. The LF liner greatly reduces the effects of electrical and magnetic fields that actually penetrate the launcher. The major consideration is the EMP energy carried to the system from the external field through liner penetrations. Characteristics such as geometry, conduit shielding, and earth conductivity greatly influence how strong the EMP is by the time it reaches the launcher and LER liner.

When a nuclear weapon is detonated above the atmosphere, it is called a high-altitude burst (fig. 4–6), and the electromagnetic fields that are created radiate onto the earth's surface. The area of effect of the EMP increases to roughly 1,000 miles in diameter, due to the high altitude. High up in the atmosphere, the air is very thin. This enables the gamma rays produced by the detonation to travel many miles before being dissipated by air molecules, greatly increasing the effective range of the EMP. Such electromagnetic fields are capable of disabling electrical and electronic systems as far away as 3,000 miles from the site of the detonation.



POSSIBLE EFFECTS

- CURRENTS INDUCED IN POWER LINES, INTERSITE CABLES ETC.
- FIELDS PENETRATE MAF AND LF
- ARCING MAY RESULT INSIDE SYSTEM

POSSIBLE SYSTEM FAILURES

- OGE

  COMPONENT BURNOUT

  SPURIOUS SIGNALS

- MISSILE

  LOSS OF COMPUTER MEMORY
  COMPONENT BURNOUT
  SPURIOUS SIGNALS

- CABLES

  SHORTS
  BURNOUT
  INDUCED SIGNALS

THE NET RESULT OF MOST RADIATION PRODUCED BY A NUCLEAR DETONATION IS A TREMENDOUS FLOW OF ELECTRONS. THIS FLOW OR CURRENT PULSE IN THE AIR RADIATES ELECTROMAGNETIC ENERGY AS IF FLOWING IN A LARGE WIRE. THIS ELECTROMAGNETIC ENERGY WILL INDUCE ELECTRICAL CURRENTS INTO METALLIC CONDUCTORS.

Figure 4–5. Electromagnetic pulse effects.

EFFECTIVE EMP COVERAGE FOR HIGH-ALTITUDE BURSTS
AT HEIGHT-OF-BURSTS (HOB) OF 100, 300, AND 500 KM

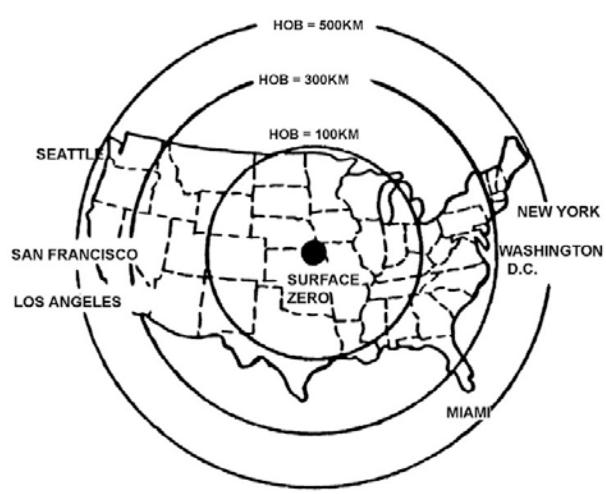
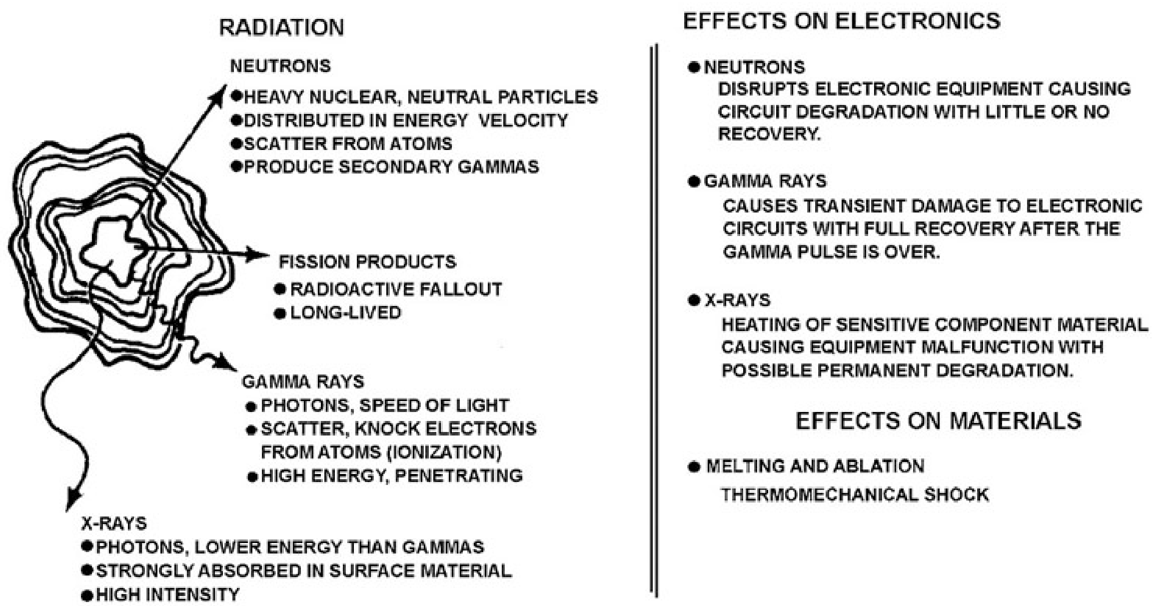


Figure 4–6. High altitude burst.

Nuclear radiation

There are significant differences between conventional and nuclear explosions. Highly penetrating and harmful invisible waves called radiation accompany nuclear detonations. Nuclear radiation affects the weapon system equipment in various ways. The depth of the earth covering the facilities and the concrete and steel that form their enclosure reduce the radiation effects in the launcher and MAFs. Therefore, the radiation environment inside these facilities is much lower than the external environment. Refer to figure 4–7 for a description of nuclear radiation effects.



<u>NEUTRONS</u> ARE HEAVY UNCHARGED PARTICLES WHICH TRAVEL AT VARIOUS VELOCITIES DEPENDING ON THE INITIAL ENERGY IMPARTED BY THE NUCLEAR REACTION. ENERGETIC NEUTRONS PENETRATE THICK CONCRETE AND CREATE GAMMA RAYS AS THEY COLLIDE WITH THE NUCLEUS OF ATOMS.

<u>FISSION PRODUCTS</u> CAN BE RADIOACTIVE FROM MILLIONTHS OF A SECOND TO BILLIONS OF YEARS. FISSION PRODUCTS CARRIED AS PARTICLES INTO THE ATMOSPHERE FALL BACK TO THE GROUND SURFACE, FORMING A CONTAMINATION PATTERN WHICH DEPENDS ON ATMOSPHERIC WINDS AT AND AFTER DETONATION.

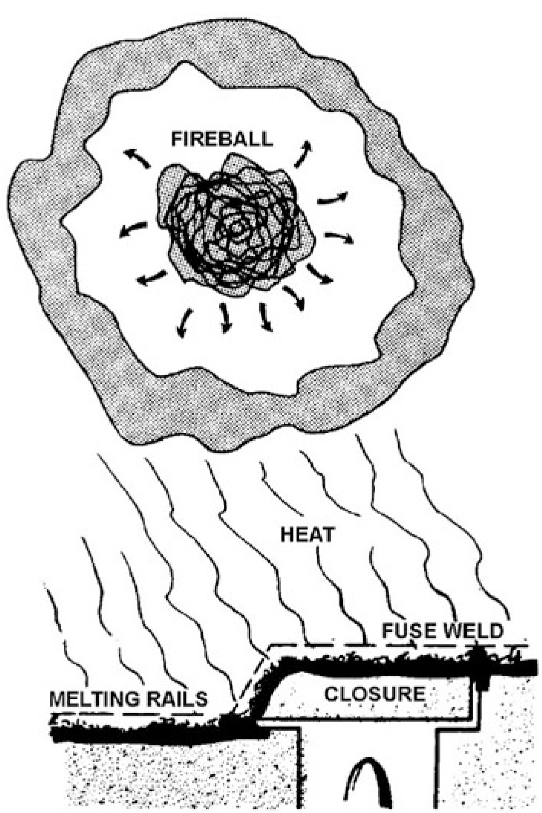
<u>GAMMA RAYS</u> ARE PHOTONS LIKE VISIBLE LIGHT, THAT IS, "BUNDLES" OF PURE ELECTROMAGNETIC ENERGY, TRAVELING AT THE SPEED OF LIGHT. THE ENERGY OF THE PHOTON CAN DISPLACE ELECTRONS LEAVING IONIZED ATOMS AND CREATING UNWANTED CURRENTS. GAMMA DAMAGE RESULTS FROM IONIZATION.

<u>X-RAYS</u> ARE ALSO PHOTONS HAVING LOWER ENERGY THAN GAMMA RAYS. X-RAYS ARE USUALLY ABSORBED IN A THIN LAYER IN THE SURFACE OF THE TARGET MATERIAL, RELEASING THEIR ENERGY AS HEAT.

Figure 4–7. Nuclear radiation effects.

Thermal effects

Over one-third of the energy from a nuclear detonation is emitted in the form of heat and light. Nuclear detonations produce extreme temperatures that can vaporize and melt exposed steel and concrete. Exposed metal, such as the launcher closure door seal area, melts and re-solidifies, creating welds across areas of separation. Temperature spikes within the underground facilities are negligible due to the protection of the facility, soil, and the seals and blast valves that prevent the entry of hot gases. See figure 4–8 for a detailed description of the thermal effects due to a nuclear detonation.



POSSIBLE SYSTEM FAILURES

LAUNCHER

- CLOSURE METAL FUSE-WELDED
- STRUCTURAL FAILURE
- ABLATION OF CONCRETE/STEEL
- THERMAL PENETRATION INTO LAUNCHER

ANTENNA

- ABLATION OF RADIATING SURFACE
- STRUCTURAL FAILURE

DEBRIS BINS

- ASSEMBLY FUSE-WELDED
- MATERIAL ABLATION
- ANNEALING OF TEMPERED PARTS

RANGE OF THERMAL ENERGY DEPENDS ON CONDITION OF THE ATMOSPHERE. ON A VERY CLEAR DAY THERMAL RADIATION CAN REACH 30 OR 40 MILES; ON A HAZY OR FOGGY DAY, IT MAY BE ATTENUATED IN LESS THAN A MILE.

WHETHER THE THERMAL RADIATION IS REFLECTED OR ABSORBED INFLUENCES EXTENT OF DAMAGE. BLACK ABSORBS, WHITE REFLECTS, CHARRING BEHAVES AS BLACK.

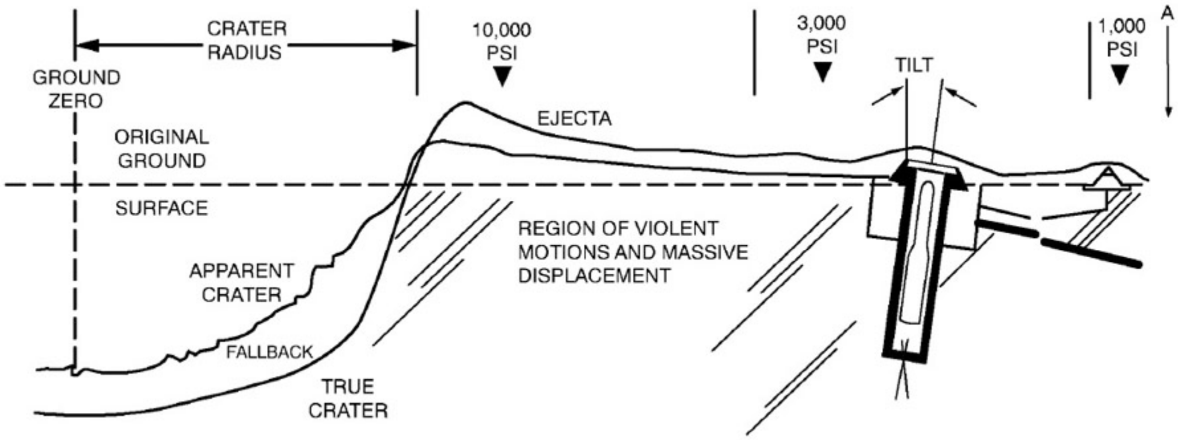
A HIGH-AIR BURST EXPOSES A MUCH LARGER AREA TO A GIVEN THERMAL INTENSITY THAN DOES A LOW AIR OR A SURFACE BURST.

Figure 4–8. Thermal radiation effects.

Debris and crater effects

Pressure and shock effects produced by a nuclear detonation displace soil and other material. Material is moved by vaporization, and by being thrown out of the detonation area as debris. The formation and size of the crater depends on the size of the weapon (kiloton/megaton rating), the altitude of the detonation, and the type and condition of soil. For a one-megaton weapon, the formation of a crater is unlikely unless detonation occurs at an altitude of 450 feet or less.

The primary impact of the crater is destruction or displacement of facilities and intersite cables. The primary impact of debris is blockage of the launcher closure and debris spilling into the launch tube when the closure is opened. See figure 4–9 for a summary of debris and crater effects and their potential impact upon the weapon system.



SYSTEM RESPONSE

LAUNCHER

MASSIVE STRUCTURAL FAILURE
CLOSURE MALFUNCTION DUE TO EJECTA IMPACT
CLOSURE BURIED
EXCESS TILT MAKES FLYOUT IMPOSSIBLE

ANTENNA

STRUCTURAL/MECHANICAL DAMAGE FROM EJECTA IMPACT
INOPERATIVE DUE TO EXCESSIVE DEBRIS BURIAL

MISSILE

DAMAGED FROM EJECTA FALLING INTO LAUNCHER
STRUCTURAL FAILURE

CABLE

INOPERATIVE DUE TO RUPTURE OR CRUSHING

Figure 4–9. Debris and crater effects.

023. Facility hardness protection features

Now that we know some of the terminology of hardness and the specific environments our facilities are designed to withstand, let’s explore how the missile facilities are protected against each part of the nuclear environment.

Ground shock and vibration

Some hardness-critical items are required to be mounted in a manner that reduces shock and vibration to a tolerable level. Electronic equipment in the LER and LCC is especially vulnerable to these effects. Electronic racks contain many connective devices such as wires, cables, solder joints, printed circuit wiring, and terminal connections that can be damaged from excessive vibration.

Structural elements of the facilities have been designed to withstand greater levels of ground shock and vibration. There are three methods of protecting equipment from ground shock and vibration as illustrated in the following table, based on the cause of the damage.

Methods of Protecting Equipment from Ground Shock	
Cause of Damage	**Control Method**
Relative movement between equipment items.	Adequate clearance between items prevents them from contacting each other; shock loops are built in (extra length) for cables and hoses to prevent stretching or breaking.
Accelerations that produce large loads on structural members and surges in fluids.	Design hard-mounted equipment and mounts to withstand specified acceleration loads. Provide shock attenuation for fluids.
Vibration that produces stress on vulnerable equipment items.	Equipment that cannot withstand a hard-mounted environment is shock isolated.

The following are examples of design features that provide hardness to shock and vibration. Not all of these examples exist at all wings.

- The missile suspension and alignment system protects the missile from ground shock. It cushions the missile from vertical and horizontal movement so that during a ground shock environment, the missile does not contact the sides of the launch tube.
- The shock-isolated LER floor provides mounting for critical electronic equipment, reducing shock and vibration to acceptable levels. The shock isolators cushion the vertical movement and foam blocks soften the impact of horizontal movement between the launch tube side and LER walls.
- The guidance and control (G&C) chiller plumbing reduces surge pressures resulting from ground shock. Shock loops are provided to reduce the possibility of damage due to unwanted motion. The hoses are secured to the G&C umbilical to provide greater stability.
- There are a number of hardness provisions in the electronic equipment racks on the shock-isolated floor. Circuit breaker panels, power supply drawers, and power supply groups are designed to reduce vibration. Drawer fronts are stiffened if vibration-sensitive components are installed. Cabinets are bolted directly to the LER shock-isolated floor, so they move with the floor.
- The steel rails that the launcher closure door rolls on are exposed on the surface of the LF, and will undoubtedly take damage from a nuclear detonation (fig. 4–10). To counter this, the steel portion of both tracks is cut through about four inches, approximately seven feet out from the LER. This allows the launcher closure track to break at this point instead of bending which could block the door, preventing it from rolling away from the launch tube.

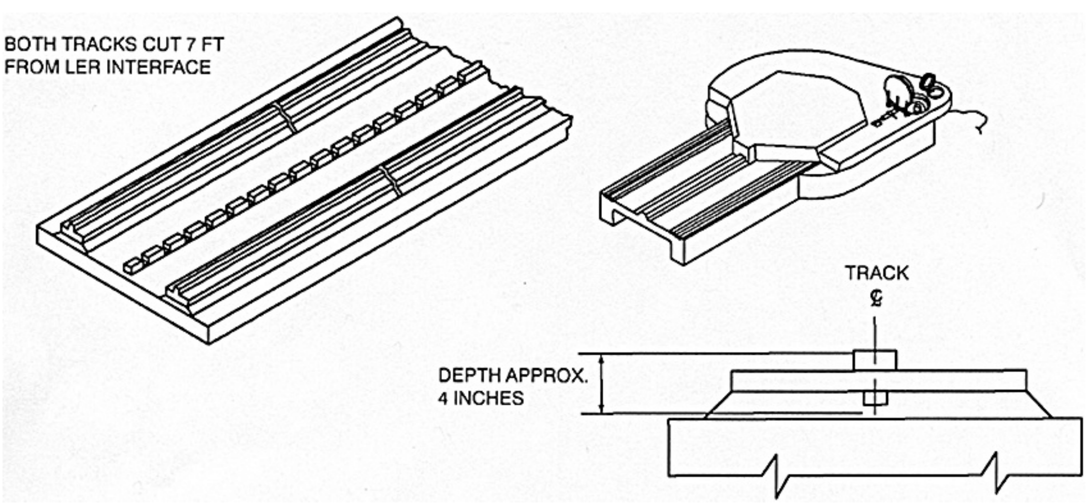


Figure 4–10. Launcher closure track modification.

Air blast and acoustics

Launch-essential and mission-critical equipment on the ground surface is exposed to maximum air blast effects. The launcher closure, launcher personnel access hatch primary door, and the topside antenna structures are all designed to withstand the air blast and acoustic effects of a nuclear blast. Blast valves installed in the MAFs immediately seal off ventilation ducts the instant that an overpressure is sensed to prevent harmful overpressures from entering the facility. The blast valves open again when the overpressure drops to a safe level. The LCC's blast door provides protection to personnel and launch-essential, mission-critical equipment in the LCC.

Nuclear radiation

The electronic racks inside the LER and the LCC are the only equipment considered potentially vulnerable to radiation because they contain semiconductors in their electronic circuits. This equipment still needs to be able to perform launch-essential, mission-critical functions both during and after exposure to nuclear radiation. Therefore, equipment must not sustain permanent damage to its internal parts. Furthermore, the equipment containing critical circuits cannot produce an electrical response which could cause an accidental activation of any device or damage to any essential, mission-critical equipment. If the equipment is exposed to radiation, it has to be able to remain stable and/or be capable of recovery.

Launch-essential, mission-critical equipment incorporates the following hardness features to protect it from the effects of nuclear radiation:

- Internal circuit protection.
- Transient response improvements.
- Reset of circuit elements and memory devices.
- Nuclear radiation reduction.

Internal circuit protection

Critical circuits use semiconductors that have a predictable response to radiation exposure. Some of the methods used to protect circuits in the weapon system include photocurrent bypass, protective diodes, and current-limiting resistors.

Transient response improvements

If a circuit has been damaged by radiation, a time delay device can provide a “hold-off” (or delay). Critical circuits that control equipment shutdown sequences are designed with either dielectric-isolated integrated circuits, time delay hold-offs, or circumvention/reset protection. In many cases, a combination of these design features is used.

Reset of circuit elements and memory devices

Circumvention/reset operation was incorporated as a backup tactic to protect against upsets in the circuit caused by an EMP. Circumvention/reset counteracts circuit upsets by suspending the operation of a circuit in a known operating mode until after the EMP or radiation has subsided. This is accomplished by a circuit-level signal which forces circuit elements to a known state during and after the nuclear event. The holding pattern in critical circuit chains is long enough to allow circuit corrections after the event has subsided. Thus, the reset pulse may be disturbed for a time by EMP or radiation, and still return the circuit to the desired state. This reset capability is used to protect circuits and memory devices from gamma radiation, as well as EMP.

Nuclear radiation reduction

Another method of protecting this equipment is to eliminate or reduce the radiation entering the facility in the first place. The radiation in the launcher and LCC is reduced by the depth of the earth covering these facilities as well as the concrete and steel that form their enclosure. The LCC is buried deeper than the launcher and has additional shielding, so it is better protected from radiation. The launcher closure door provides protection to the launcher by its mass and the boron content of the concrete that it is made of. The boron is especially good at absorbing thermal neutrons without producing gamma rays; therefore, the intensity of the gamma ray is reduced.

Thermal

To harden sites against thermal effects, enough extra material is provided to allow for a certain amount of material loss during multiple nuclear attacks. After the first strike, the structure must have enough strength remaining to withstand ground shock, overpressures, and air blast effects. When designing against thermal effects, consideration must be given to what will happen when a material melts and then solidifies. Equipment below ground is generally protected by how deep it is buried, but the launch-essential, mission-critical equipment topside must be designed to survive.

Debris collection system

The debris and thermal shields of the debris collection system are protected from the thermal environment by a layer of fiberglass insulation. The fiberglass is thick enough to withstand some loss due to melting or vaporization, and still be capable of performing its job. The shields themselves protect the debris bins and tension straps by blocking the intense heat. However, hot gases may penetrate into the gap between the launcher closure and abutment. Melted materials in this area may re-solidify, but this is avoided by additional fiberglass insulation. Wherever possible, metal-to-metal contact is avoided in areas where those two surfaces could melt and weld together.

Antennas

Antennas are buried and completely encapsulated in concrete to provide protection from the extreme heat. The concrete is thick enough to allow for material loss and cracking while still letting the antenna perform its mission. For the EMP antenna, the concrete is borated (mixed with boron) to minimize heating due to X-ray radiation. The EMP antenna rebar is non-borated glass which minimizes how much radiation it absorbs, which in turn reduces how hot it gets.

Debris

All hardness-critical equipment above ground must survive and still be able to function, even when subjected to a specific level of debris. The front of the launcher closure resembles a snowplow, allowing it to push debris out of the way. This ensures the missile will be able to exit the launch tube.

The equipment in the LER is affected when the launcher closure opens and debris spills in. Therefore, a debris collection system is installed on the face of the launcher closure to reduce the amount of debris that falls into the launch tube. The primary elements of the debris collection system are the six collection bins and their supporting cables. A bin is mounted on each of the three northerly vertical faces of both the launch tube closure and abutment. Each bin is designed to provide a curved sheet with spring action. The bin is stored in the gap between the abutment and the launcher closure door when it is closed. When the launcher closure door opens, the springs open to form a container for debris. The debris bin opening distances are controlled by the length of the restraining cables attached near the top of each bin. Besides the debris collection system, the missile also has some protection. The missile’s nozzles are protected by a debris deflector ring.

024. Shock attenuation system features

As discussed in previous lessons, the massive jolt from a ground shock can have a devastating effect on missile facilities. We learned that the equipment is protected from ground shock by providing adequate clearance, hard-mounting equipment, or having sensitive equipment shock isolated. This lesson will focus on how the LFs and MAFs are shock isolated to protect equipment from the ground shock environment created by a nuclear blast.

Launch facility shock attenuation systems

The LF shock attenuation system is divided into two parts: the LSB shock attenuation system and the LER shock-isolation system.

Launcher support building (Wings 3 and 5 only)

The LSB floor at Wings 3 and 5 is suspended from the ceiling by 10 spring-type shock absorbers. The shock absorbers limit vertical movement of the floor in a ground shock environment. To prevent horizontal movement, the LSB suspended floor has 20 rubber pad shock mounts to minimize the damage caused by the suspended floor striking the LSB walls. Each rubber pad is five inches thick and bonded to a steel mounting plate. Figure 4–11 illustrates the shock absorbers and shock mounts. In addition to floor shock protection, the LSB also contains flexible hoses, flexible electrical conduits, and light fixtures that are spring mounted.

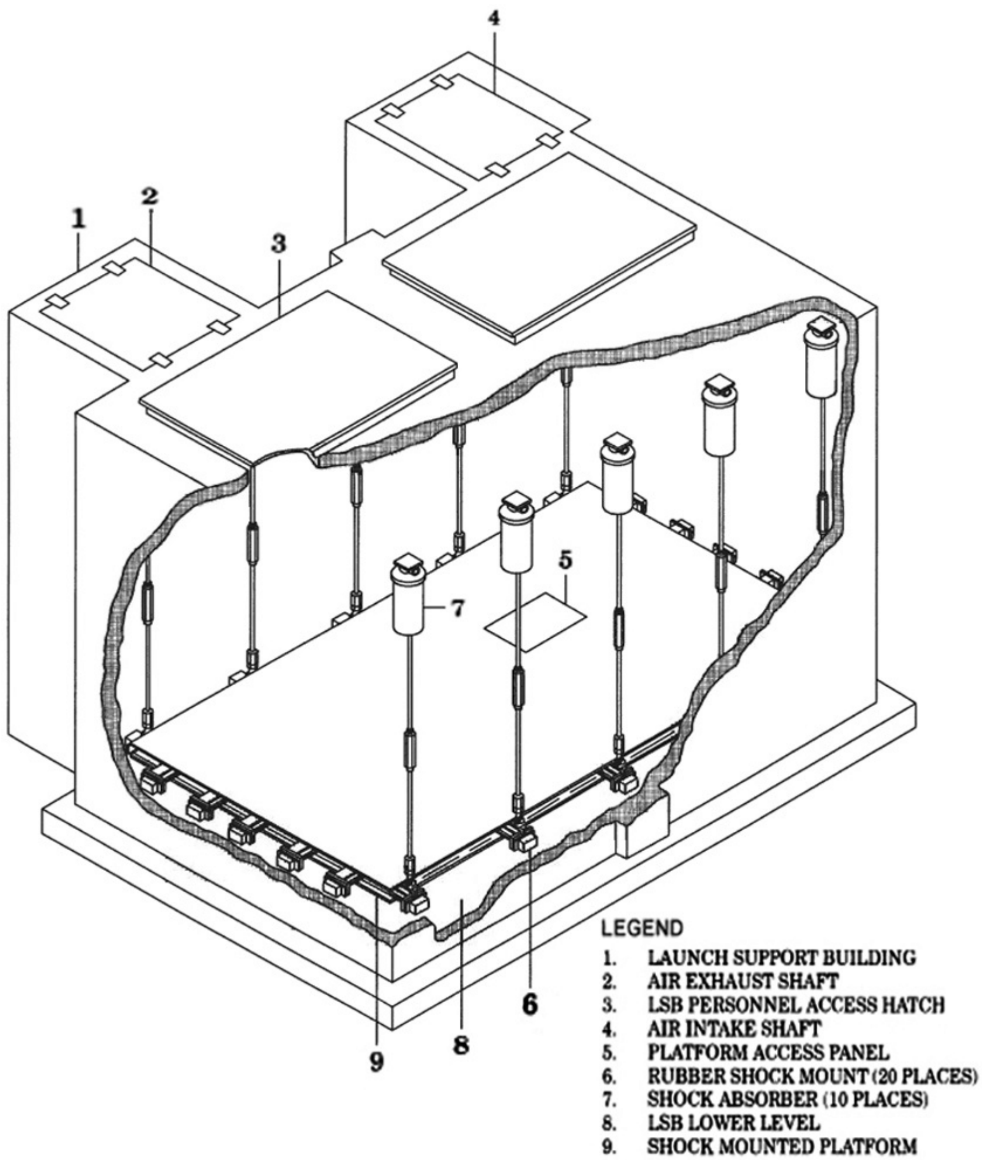


Figure 4–11. Wing 3 and 5 launcher support building shock attenuation system.

Launcher support building (Wing 1 only)

The LSB at a Wing 1 LF is simply a concrete room whose ceiling is at ground level, and therefore is not hardened against a ground shock environment.

Remember, Wing 1 LSB does not have any protection from ground shock. It is essentially a concrete cube, with ground level being the roof of the cube.

Launcher equipment room

At all three wings, launch-critical equipment in the LERs is located on the shock mounted portion of the floor. This special floor encompasses nearly half of the circumference of the upper LER. This floor is not hard mounted, and is suspended by four liquid spring shock isolators. The shock isolators dampen vertical movement, or bouncing.

Mounted on the inside and outside of the suspended floor are foam type blocks called horizontal restraints that are designed to dampen horizontal motion. These blocks also provide a walking surface for personnel, and are protected by a rubber tread surface. Figure 4–12 shows the shock isolators and horizontal restraints.

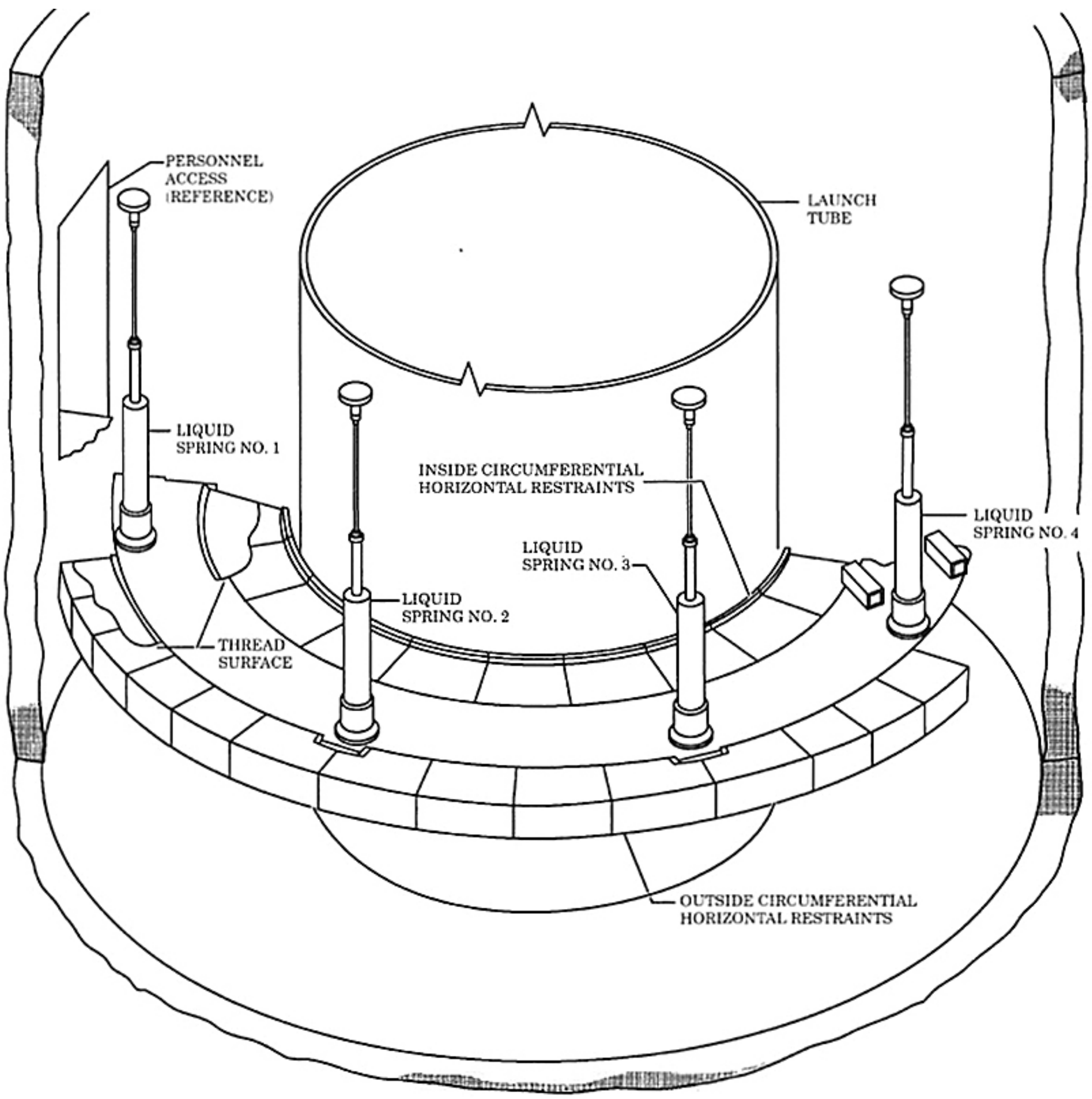


Figure 4–12. Launcher equipment room shock isolation system.

There are many cables in the LER that are protected by shock loops. A shock loop means that there is enough “slack” in the cables to allow them to move with the suspended floor without breaking or causing stress on the cables. The air ducts for the ECS also have extra slack to allow freedom of movement. This is why it is important to ensure the air duct above the air handler is extended through the supports; otherwise, it could be torn in half during a ground shock.

Missile alert facility shock attenuation systems

The MAF shock attenuation system is much more extensive than the LF system and has several differences between the wing configurations.

Wing 1 launch control center shock-isolation system

The acoustical enclosure of the Wing 1 LCC is suspended from above the capsule by four pneumatic shock isolators (fig. 4–13). One is located in each corner of the floor to protect the acoustical enclosure from excessive vertical movement. An air compressor assembly, located in the LCSB topside, provides air pressure to maintain the shock absorbers at an adjusted length and compensates for movement or load changes on the floor. Each shock absorber is regulated by its own pneumatic control panel.

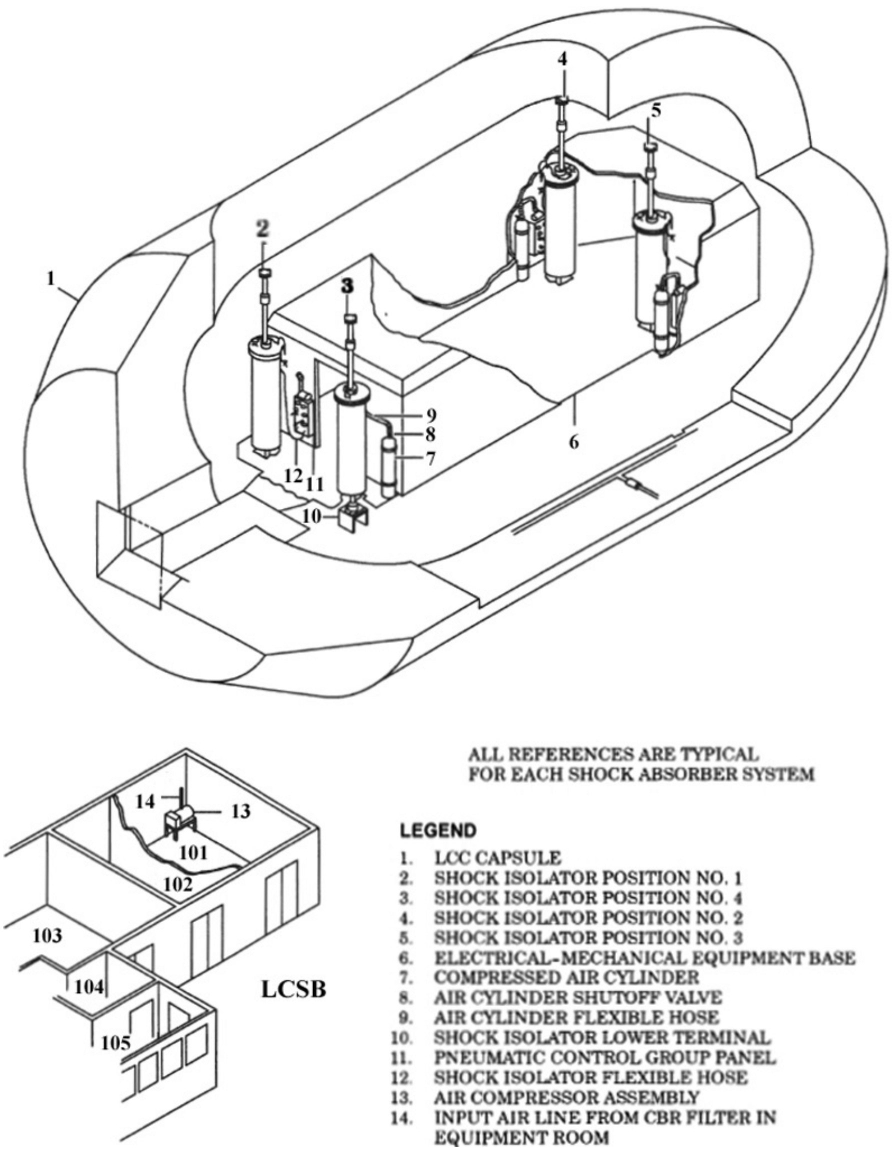


Figure 4–13. Wing 1 launch control center shock-isolation system.

Wing 3 and 5 launch control center shock-isolation system

The Wing 3 and 5 LCC shock-isolation systems are similar to the Wing 1 system. This system utilizes four air-filled pendulum-type shock isolators. There is a high-pressure air compressor assembly for Wing 3 and 5 as well, but it is located in the LCEB instead of the LCSB topside. A major difference that Wing 3 and 5 MAFs have is that there are two compressed air cylinders that provide 2,200 pounds per square inch (psi) of pressurized air in case of an emergency affecting the shock isolator air compressor (fig. 4–14).

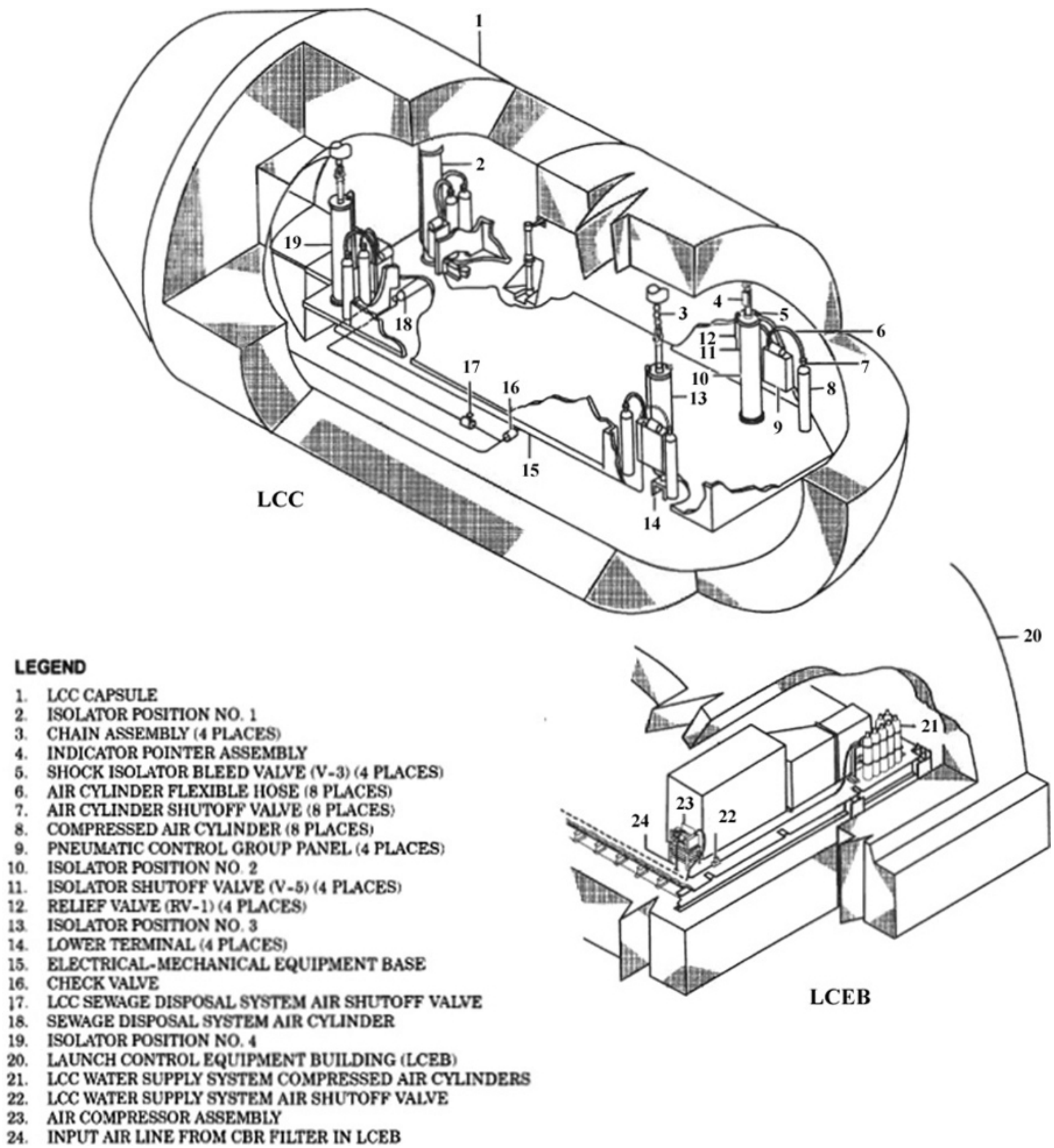


Figure 4–14. Wings 3 and 5 launch control center shock-isolation system.

Wings 3 and 5 launch control equipment building shock attenuation system

Perhaps the most elaborate shock attenuation system is the LCEB system, consisting of 12 shock absorbers, 16 sway dampers, three shock attenuators, and flexible hoses.

The LCEB floor is suspended above ground level by the 12 shock absorbers; six on each side that limit vertical movement. There is no air pressure associated with these shock absorbers and they are adjusted independently. An indicator pointer and marker index is located on top of each one to ensure the floor is level and each absorber is adjusted properly.

The sway damper system consists of 16 leaf-type springs around the edge of the floor. Just as the name implies, they prevent damage from horizontal “swaying” of the floor. The LCEB has several flexible lines installed on the diesel exhaust, fuel, air, and brine lines to allow the LCEB’s platform to sway without damaging any equipment.

Wing 3 and 5 MAFs also have an attenuation system for their liquid lines (fig. 4–15). The three shock attenuators exist to keep pressurized lines from bursting due to overpressure. Each one consists of a dual chamber pressure vessel. In between the two chambers is a rubber diaphragm. The lower chamber is connected to the liquid system, and the upper chamber is empty. An overpressure in the brine or water system will rupture the rubber diaphragm, allowing the liquid to expand into the upper chamber. This will prevent the lines from bursting by giving the liquid room to expand.

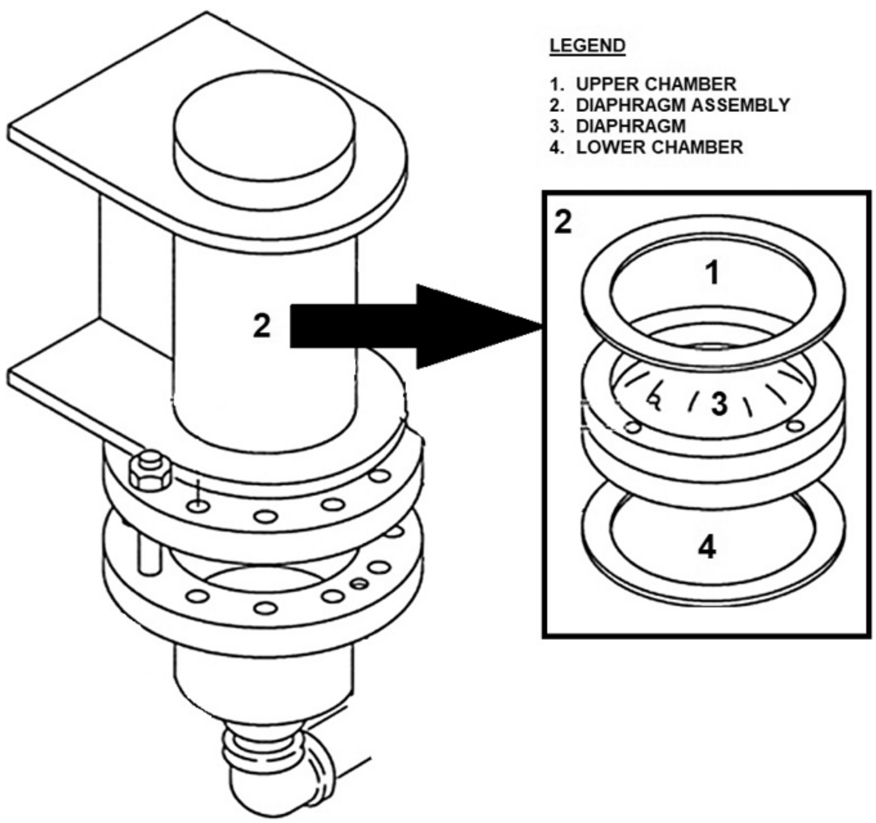


Figure 4–15. Liquid line shock attenuator.

025. Electromagnetic pulse hardness design

Various EMP hardness designs are incorporated into components that perform launch-essential, mission-critical functions that could possibly be damaged by an EMP. The launcher provides enough shielding against the EMP to protect internal equipment from all but the electrical transients at the point of entry. Those transients are either directed straight to ground or limited by ESAs. Equipment downstream is further protected by filtering or creating a break in all paths leading to critical circuits.

The LCC steel liner provides the same type of EMP reduction as the launcher at the LF, and has ESAs on cables and antennas at their points of entry into the capsule.

Although the EMP paths within the launcher and the LCC are primarily determined by the electrical arrangement of equipment, the mechanical arrangement also influences these paths. Any one change in mechanical arrangement may not significantly affect the EMP paths; however, making several changes all at once could significantly change these paths. Therefore, mechanical changes should not be performed unless directed by the technical order.

Missile alert facility

The MAF design features that contribute directly to the EMP hardness of that facility and its equipment include the following:

- Protection provided by ESAs.
- Designing circuits to be immune to EMP.
- Shielding of the facility from the EMP field.
- Protecting circuits that could be exposed to EMP.
- Shielding provided to the equipment by the facility.
- Shielding of antenna-like devices entering the facility.
- Grounding of dangerous currents at their point of entry to the facility.

Some of the protection from EMP comes from the fact that the LCC is buried far beneath the earth's surface. The LCC's steel liner also protects against direct EMP, sending it straight to ground. However, the main concern is EMP entering through openings in the steel liner; most EMP energy enters the LCC through conductors that are penetrating the liner. These openings serve as points of entry for communication antennas, HICS cables, electrical power, environmental air, water lines, and similar support equipment. These penetrating lines can act like antennas, using their exposed metal surfaces to direct EMP into the LCC. These exposed surfaces, primarily the HICS and communication lines, have shields that protect their internal conductors from most EMP currents. At every point where a conductor comes through the LCC's liner, ESAs are used to direct EMP to ground.

Conductors associated with power distribution systems and equipment power supplies provide a major path for EMP currents. The transmission lines and the equipment in the LCEB are protected by lightning arresters. The LCC's motor-generator is used for power conversion which isolates the input power source from the output power. Other equipment uses filters or RFI gaskets to protect its own circuitry and to protect the LCC personnel against hazardous voltages.

Circuit protection and noise suppression is provided by individual filters, diodes, shielding, power monitoring, and regulation. Interface circuits most susceptible to EMP are designed for high damage or upset levels and are usually protected by a diode. The capability of some equipment to perform self-check and reset operations is useful in protecting against circuit upsets.

Launcher

The launcher is not totally buried since the launcher closure door is exposed. Some shielding is provided by the dirt and rocks surrounding the launcher; however, the steel enclosure formed by the launch tube and LER provides the shielding necessary to reduce EMP to an acceptable level. Shielding is also provided through the use of EMP seals at the launcher closure and personnel access shaft openings, as well as the EMP rattle space screen and steel bellows. The rattle space screen electrically joins the lower LER to the launch tube and the steel bellows electrically join the upper launch tube to the LER, providing EMP isolation between the launch tube and LER.

The launcher has fewer openings in the liner than the LCC since it does not connect to as many external systems that may act like EMP antennas. The antenna leads, cables, pipes, and similar supporting equipment that enter the launcher are bonded at the liner in the same manner as the LCC penetration lines. Any high-level EMP voltages entering the facility on conductors are limited by installing an ESA at their point of entry. Just like the MAF, the motor-generator provides EMP suppression by isolating the input power source from the output power.

The electronic racks in the LER have special protection. The ways that this equipment is hardened against EMP is grouped into the following four categories:

1. External-to-internal EMP field reduction.
2. Reduction and decoupling of EMP energy.
3. Circuit upset and damage.
4. Electromagnetic circumvention/reset systems.

Let's look at these four approaches and see how they have been incorporated.

External-to-internal electromagnetic pulse field reduction

The main principle here is to reduce EMP outside of the facility before it reaches any of the internal components. The launcher closure incorporates EMP seals. For example, the seals have a stiff seal ring and high seal mating pressure to ensure electrical contact between the launcher closure and the launch tube liner. Additionally, EMP seals are incorporated in the nose of the closure at the multiplying linkage assembly.

Reduction and decoupling of electromagnetic pulse energy

First, let's define decoupling. Decoupling is putting a component into a circuit that will limit or stop the free flow of power spikes. This is usually done with a capacitor, because a capacitor will absorb a large spike of power (an EMP), but will still send the normal power to the circuitry after the spike. For example, a straight piece of wire will have no decoupling effect whatsoever, because the amount of power that goes in is the amount of power that will go to the components at the end of the piece of wire. However, we want the same amount of power to come out, no matter how much power is induced into the wire.

The primary methods for reducing EMP energy induced into the cables that penetrate the LER are through the installation of cable ground clamps, ESAs, and filters at the penetration points. This reduces the EMP energy reaching all equipment downstream of the liner, thereby reducing decoupling requirements on complex equipment downstream. Remember that the key is to send as much of the EMPs energy as possible directly to ground, where it cannot do harm.

The shields of the cables penetrating the LER are major contributors to EMP. Ground clamps are used on these shields to ground these cables to their conduits. The EMP energy is reduced by the ground clamps contacting the cable shield that provide a continuity path between the conduit and the launcher liner. These clamps are installed at both ends of one conduit for the LSB SIN and power monitor lines, and at the ends of the two security antenna line conduits in the ESA vault.

The ESAs are installed where conductors penetrate the launcher to limit high-voltage EMP. Examples include the carbon block ESAs in the HICS, as well as LSB penetrations and the ESAs on the OZ security system. Additional EMP filtering and decoupling is provided in areas where ESAs do not provide enough decoupling. EMP limiting and filtering is added to penetrating conductors that do not have existing surge protection which helps the existing ESAs to further reduce the EMP level. This additional EMP limiting and filtering is provided by electrical surge filter assemblies. These EMP limiter filters are made up of shunt gaseous discharge devices followed by low-pass filters.

Circuit upset and damage

The hardened C2 system uses selected components in the drawer interface circuits to provide circuit protection for the transistor-to-transistor logic. Additionally, the ultra-high frequency (UHF) command radio receiver group incorporates a diode surge limiter between the UHF antenna and the receiver circuits of the UHF command radio receiver group.

Electromagnetic circumvention/reset system

As discussed in nuclear radiation protection, the circumvention/reset system also counters the effects of EMP. Once EMP antennas sense an EMP event, it signals the equipment to either go into a holding pattern or sets it to a known state. After the EMP has passed, the system resets to that known state or continues from its holding pattern. This ensures critical circuits and signals are not disrupted by harmful EMP currents.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

021. Hardness terminology and functions

1. Match the term in Column B with the definition in Column A. Items in column B may only be used once.

Column A

____ (1) The measurement of a systems ability to withstand exposure to one or more of the environment effects of a nuclear or non-nuclear weapon.

____ (2) The capability of a system to withstand a nuclear or non-nuclear environment without losing its ability to accomplish its designated mission.

____ (3) That period in which critical functions are maintained in a state of readiness without dependence on commercial power.

____ (4) That period in which the critical functions are maintained in a state of readiness without dependence on external electrical power or normal environment control support.

____ (5) An item of equipment or a system function required to launch the missile; its malfunction would prevent a launch before, during, or after a nuclear attack.

____ (6) An item of equipment or a system function that is required to launch the missile within a given time span, or is required to successfully complete the mission.

____ (7) An item that could be maintained for normal operation in a non-nuclear environment, yet degrade survivability when exposed to a nuclear environment if not maintained properly.

Column B

a. Hardness-critical item.
b. Extended survival period.
c. Hardness.
d. Launch-essential.
e. Mission-critical.
f. Survivability.
g. Emergency survival period.
h. Nuclear environment.

022. Effects of a nuclear detonation

1. Air blast induced ground motion forces the ground in what directions away from the detonation?

2. Why is the shock that the launch tube and the launcher equipment room fixed floor are exposed to less severe than other facilities?

3. What happens to the strength of the blast wave, from an air blast, as it travels outward from the center of the detonation?

4. What is the basic cause of damage in an acoustic environment?

5. What is EMP hardness strongly dependent upon?

6. What atmospheric condition allows gamma rays to travel many miles before being dissipated?

7. What prevents the entry of hot gases into the underground facilities?

8. What factors determine the formation and size of a crater and the resulting debris?

023. Facility hardness protection features

1. What prevents items from coming into contact with each other during a ground shock?

2. How does the missile suspension and alignment system protect the missile from ground shock?

3. What modification was made that allows the launcher closure rails to break instead of bending?

4. What is installed in the missile alert facility to keep harmful overpressures from entering the facility?

5. Why are the electronic racks the only equipment considered potentially vulnerable to radiation?

6. What hardness features protect the electronic racks from the effects of nuclear radiation?

7. What is the design requirement for hardening against thermal effects?

8. How is the launcher closure and abutment designed to prevent metal from melting and re-solidifying (welding)?

9. How is the amount of debris falling into the launch tube reduced to an acceptable limit?

024. Shock attenuation system features

1. In a Wing 3 or 5 LSB, what limits vertical movement of the floor?

2. What are the two purposes for the horizontal restraints in the LER?

3. In the Wing 3 and 5 LCC shock-isolation system, when are the two compressed air cylinders used?

4. What type of movement do the Wing 3 and 5 launch control equipment building shock absorbers limit?

5. In the Wing 3 and 5 LCEB, what would cause the rubber diaphragm in the liquid line attenuation system to rupture?

025. Electromagnetic pulse hardness design

1. How does most EMP energy enter the LCC?

2. How does the LCC motor-generator provide EMP reduction?

3. What limits high-level EMP from entering the facility on conductors?

4. Why do the launcher closure seals have a stiff steel ring and high seal mating pressure?

5. How do ground clamps reduce EMP energy on penetrating conduits?

6. What provides additional EMP limiting and filtering where ESAs do not provide enough decoupling?

4–2. Hardness Preservation Principles

This section provides information to preserve the weapon system hardness features we discussed earlier, and will cover a special category of equipment known as installation hardware. This section will conclude with RFI gasket inspections.

026. Preventing hardness degradation

All of the hardness provisions in the world will not do any good if a maintainer fails to follow technical data or identify an abnormal condition on site, leaving a site vulnerable to weapon system effects. The following lesson will cover cable shielding, hardness-critical procedures, maintenance practices, and how to recognize abnormal conditions on site. Let's begin by looking at the role proper maintenance precautions and practices play in preventing hardness degradation.

Maintenance precautions and practices

The hardness-critical features previously described can be degraded or rendered ineffective by improper maintenance practices. Even maintenance actions completed with "good intentions" that do not adhere to authorized technical data can impair important hardness provisions. For example:

- A corrosion preventative coating was applied to a metal surface that is a part of a ground path which reduced or destroyed the effectiveness of the ground path.
- A hole was drilled in a wall in an attempt to drain a pool of water, could result in degradation of EMP and acoustic protection.
- A shock loop was moved or tied out of the way to provide more room to work, and was never put back into normal configuration at the end of the day, could remove the necessary slack to survive a shock.

Electronic equipment is especially vulnerable to any shock resulting from bumping or dropping during handling. The equipment may pass checkout and continue to function in a normal environment but fail in a nuclear shock environment. Any condition you suspect that degrades hardness should be reported to the MMOC, who will then determine whether corrective action is required. The three basic rules for preserving hardness during maintenance activities are as follows:

1. Perform all maintenance in accordance with applicable technical manuals.
2. Report to MMOC any maintenance requirement not specifically covered by technical order procedures.
3. Continually consider weapon system hardness requirements and provisions and be alert to any conditions or occurrences that may affect them.

Some of the more common maintenance actions that may impact hardness are discussed in the following paragraphs.

Hardness critical procedures

Hardness critical procedures (HCP) in your technical order will be identified by the symbol **HCP**. An HCP is defined as any maintenance action that, if not followed strictly, could directly degrade the hardness design feature of parts, components, systems, or subsystems, as described in the following paragraphs.

If the **HCP** symbol appears immediately after a paragraph, the whole paragraph is hardness critical. If the symbol appears immediately after a step or sentence, only that step or sentence is hardness critical. Whenever the HCP symbol appears, no deviation from the procedure may be made without notifying MMOC and receiving authorization from the proper authority. Figure 4–16 shows an example of a technical order procedure with a hardness critical step.

5.60 EMERGENCY FAN CONTROL PANEL RELAY (K-7 AND K-8).

5.60.2 Installation. Install normal operation damper positioning relay (FO-12, 7) or emergency mode disabling relay as follows:

a. Plug relay into socket.

b. **HCP** Using wire tie gun (Table 2-1, 31) set at 2, install tie down strap (Table 2-4, 20) around relay socket and relay.

c. Inspect emergency fan control panel RFI gaskets in accordance with T.O. 21M-LGM30F-112.

d. Close emergency fan control panel.

d1. Perform Air Handler Operation (Following Emergency Fan Control Panel Maintenance) Paragraph 5.3.5.

Figure 4–16. Example of a hardness-critical procedure.

Fastener installation

The ability of a joint to perform its designed function depends on the strength of the fastener, joint material, type of joint, and the loads applied to the joint. The primary function of fasteners is to transmit full design load to the joined members. Weapon system equipment uses specific fasteners with the size, material, configuration, location, position, and installation designed to perform this function under various environments. During a nuclear blast, equipment will be subjected to static and dynamic loads that will require maximum performance from each fastened joint.

During installation, carefully examine fasteners for damage and corrosion. Damaged or corroded fasteners must be replaced with an exact duplicate or authorized equivalent as identified in the weapon system illustrated parts breakdown (IPB). You must call MMOC if the fasteners are not listed in the IPB. Whether you are on a PMT or FMT team, you will typically have a collection of commonly used hardware and fasteners called “bench stock” with you in the field.

When installing fasteners, verify that all fasteners in a group are installed and that all required attaching parts, such as washers, spacers, and locking devices, are properly installed with each fastener. For example, one or two spacer washers may be found under a nut. These are used for grip length adjustment. Another washer may be found under the nut or bolt head (whichever is being turned). The purpose of this washer is to protect the surface from damage while the fastener is tightened. No more than three additional washers can be used which will prevent bending of the bolt. Washer material must be compatible with the material the washer bears against to avoid surface corrosion. Mechanical locking safety devices are used where a vibration environment is expected. Ensure that you replace all fasteners with authorized substitutes to maintain the designed hardness of the facility.

Proper thread engagement, using the correct torque values and the correct tightening sequence (pattern) are important considerations during fastener installation. All threads of the nut should be engaged, and at least one complete thread should be visible on the end of the bolt. For proper thread engagement, flat-end bolts and screws should extend at least 1/32 inch through the nut.

Torque

Weapon system components can fail if fasteners are torqued to the wrong values. Not enough torque could enable the fastener to vibrate loose, while too much torque can weaken it, possibly causing it to fail. Therefore, properly installing threaded fasteners is an important consideration for hardness preservation. If the fastener you are tightening requires a specific torque value, your technical order will specify it (fig. 4–17).

x. Close loose item container and secure with latches.

y. Close access door and install four bolts. Torque bolts at 750 (±50) inch-pounds.

z. Remove and temporarily stow stepladder.

Figure 4–17. Torque value stated in a procedure.

Electrical bonding and grounding

Proper bonding and grounding, between equipment contact surfaces and structures, are essential to the retention of EMP hardness. Weapon system components have paths that are intentionally built with minimal resistance to ground to protect against the effects of EMP. Some important considerations in replacing or repairing bonding and grounding connections are discussed in the following paragraphs.

Type of hardware

When repairing or replacing electrical bonding and grounding hardware, the same type and quantity of hardware in the original configuration must be used. The material and finish of the hardware must be conductive and compatible with the bonding or grounding surfaces. The length, size, and material of the ground strap must be identical to the original, if a replacement is necessary. The shape and size of the connecting parts are also important for a good connection.

Cleaning

Remove all foreign matter from the fasteners and areas being bonded prior to assembling the fastener and applying torque. Remove all non-conductive finishes, such as paints, from areas that are being bonded. You do not need to remove the actual finish of the fastener, only any foreign debris that would impair bonding. For example, do not remove cadmium or zinc plating unless the technical order procedure tells you to do so.

Torque

As previously stated, proper torqueing of fasteners is just as essential for a good bond or ground connection as it is for proper fastener installation. Good metal-to-metal contact (bonding) of joined surfaces is a requirement for a good ground path. Adhere to the torque values pointed out in your technical order procedures. However, most of the fasteners used on a day-to-day basis will not have a specific torque value. These nuts and bolts should also be clean, free of paint, and sufficiently tightened. This is simply a good maintenance practice. Remember, proper torque and cleanliness ensures that the fastener will perform its intended function.

Connector mating

When you finish your procedure, and it is time to put everything back together, it is important that you pay attention to connector mating requirements. Make sure the connectors are in good condition, aligned, and sufficiently tightened. Prior to mating, inspect the connector for contamination and damage. Look for bent, broken or missing pins, and damaged surfaces. Hardware such as seals, gaskets, O-rings, and metallic braids must be carefully handled. Check to make sure the two halves of the connector are properly aligned and secure during every installation.

Recognizing abnormal conditions

Always be alert to potential hardness degradations that may be unrelated to the maintenance you are performing. The following are examples of conditions discovered during site surveys:

- Missing fasteners.
- Restricted shock loops.
- Corrosion on RFI gaskets.
- Cables not connected in a panel.
- Loose wires or cable connections.
- Unauthorized loose equipment on site.
- Corroded or painted grounding tie points.
- Flexible lines installed without necessary shock loop.
- Unused silo or equipment openings not sealed or capped.

A mislaid tool or other piece of hardware such as a nut, bolt, or washer can become wedged in a critical area and cause a system malfunction under the shock of a nuclear environment.

Even though a loose nut or bolt might seem harmless on a day-to-day basis, during the shock from a nuclear blast, these items can become projectiles that could damage equipment or pierce the skin of the missile.

Cable shielding

The integrity of the shielding on wires and cables in an EMP environment is an important hardness consideration. Be alert for the following conditions while performing maintenance on or around cable assemblies:

- Shield damage such as broken or frayed strands, punctures, or corrosion.
- Cables or wires that are bent too sharply. This can result in a broken conductor or shielding.

This lesson concentrated on ways that every technician can prevent degradation to the hardness of the weapon system. Some seem obvious, while others seem like they would be more difficult to remember. If you always adhere to the technical orders, these methods will soon become second nature to you.

027. Equipment installations

Every piece of equipment on site is secured in some way. You should not find any piece of equipment at a MAF or LF that, when it is in its proper configuration, is not secured in some way. In this lesson, you will see the importance of not just how a piece of equipment is secured, but also how the location and type of hardware used contribute to hardness as well.

Installation hardware

Installation hardware is a term applied to equipment, and the provisions necessary for installation of equipment. Installation hardware is anything that fastens, anchors, or protects weapon system components. It is required to complete the connection between the equipment and the mounting surface, and to provide and maintain system hardness. Installation hardware consists of items such as nuts, bolts, washers, screws, brackets, clamps, hangers, studs, tethers, ties, plating, welds, and protective coatings. How critical each piece of installation hardware is will depend on its use and function in the weapon system. Remember, installation hardware may be performing a hardness-critical function even when it is not directly associated with hardness-critical equipment.

Types of equipment installations

The following are types of equipment installations:

- Hard-mounted.
- Shock-mounted.
- Surface installation.

Hard-mounted

Hard-mounted equipment is mounted directly to a facility structure which means that shock and vibration loads will not be reduced to any great degree. Examples of hard-mounted electrical equipment are ESA frames, filters, and junction boxes mounted directly to the launch tube walls or the ESA enclosure walls. Equipment such as junction boxes do not have to survive any particular weapons effects, but need to stay mounted so that they do not become a projectile and cause damage to critical equipment. Hard-mounted mechanical equipment is generally very large. Installation restrictions and rules, such as interface alignment, adequate weld, fastener torque, and corrosion protection are important to hardness integrity.

Shock-mounted

Shock-mounted equipment is mounted on individual shock mounts or on a shock-isolated structure. This equipment is generally considered to be fragile or be of high value to the weapon system. All of the equipment on the shock-isolated floor in the LER is in this category. Special shock mounts may be required for some equipment, such as the launch tube heater control panel. In such cases, the installation hardware is normally supplied as part of the installed item.

Another example of a shock-mounted installation is when cables or hoses pass from a shock-isolated mounting to hard-mounted surface. Shock loops are required for these installations. As we discussed earlier, a shock loop provides enough slack between two attachments to permit the full range of shock-isolated movement without overstressing the line or clamps. The area of free movement that is required for shock-mounted equipment is called the rattle space.

Surface installations

Examples of hardness-critical surface installations are the launcher closure at the LF and the UHF antenna at the MAF. The hardness-critical features of installation hardware used on surface installations are primarily resistance to shock, vibration, and air blast. The possibility of EMP transmissions into the facility must be considered in all surface installations.

Maintenance requirements

Remember, installation hardware must be replaced with identical items or authorized equivalents, and the hardness-critical provisions of the original installation must be maintained. Not all installation hardware maintenance is hardness-critical. As a technician in the field, determining hardness criticality is out of your scope, nor do you carry the necessary technical orders. Depot engineers have the necessary guidance at their disposal, and can therefore make these determinations. Technical assistance from Ogden Air Logistics Complex must be requested for all installation hardware or maintenance requirements not specifically covered in the technical orders or CEMs.

028. Radio frequency interference gasket inspections

The RFI gasket plays a pivotal role in EMP hardness. Sometimes referred to as electromagnetic interference (EMI) gaskets, these gaskets are installed to keep unwanted electrical transients out of sensitive electrical equipment. As a technician, you will encounter RFI gaskets nearly every dispatch, so it is critical that you understand how to inspect them.

Parts of a radio frequency interference gasket

Before we get into the inspection of an RFI gasket, let’s take a moment to familiarize ourselves with the parts of the gasket. An RFI gasket has two parts; a woven mesh of metal wire and a sponge rubber backing. The metal mesh portion provides the electrical conductivity between the panel and the cabinet mating surfaces. The rubber backing gives structure and support to the metal mesh, and is where the adhesive is applied to stick the gasket to the panel surface. The gasket is “sandwiched” between a panel and the panel’s door or cover (fig. 4–18).

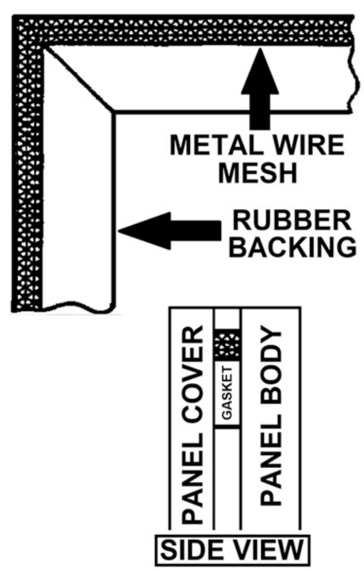


Figure 4–18. Parts of a radio frequency interference gasket.

Radio frequency interference gasket inspection

Whenever you complete any maintenance where an RFI gasket or mating surface exposed, you are required to perform a full inspection before replacing the panel cover. After determining the need to perform an inspection, it is also important to note what type of equipment you are working on. As an FMS technician, you will inspect gaskets on such items as the emergency storage battery charger when performing a checkout, ECS equipment when opening panels, or ESA vaults when performing a filter inspection. Though quite similar, each type gasket has its own procedure and its own criteria to determine pass or fail; as a result, ensure you are using the correct procedure before you start. RFI gasket inspections can be found in Technical Order (TO) 21M-LGM30F-112, *Organizational Maintenance Instructions and General Inspection and Repair Procedures*. As a technician, you will usually refer to this book as the “F–112”. Figure 4–19 shows a typical RFI gasket installed on a panel.

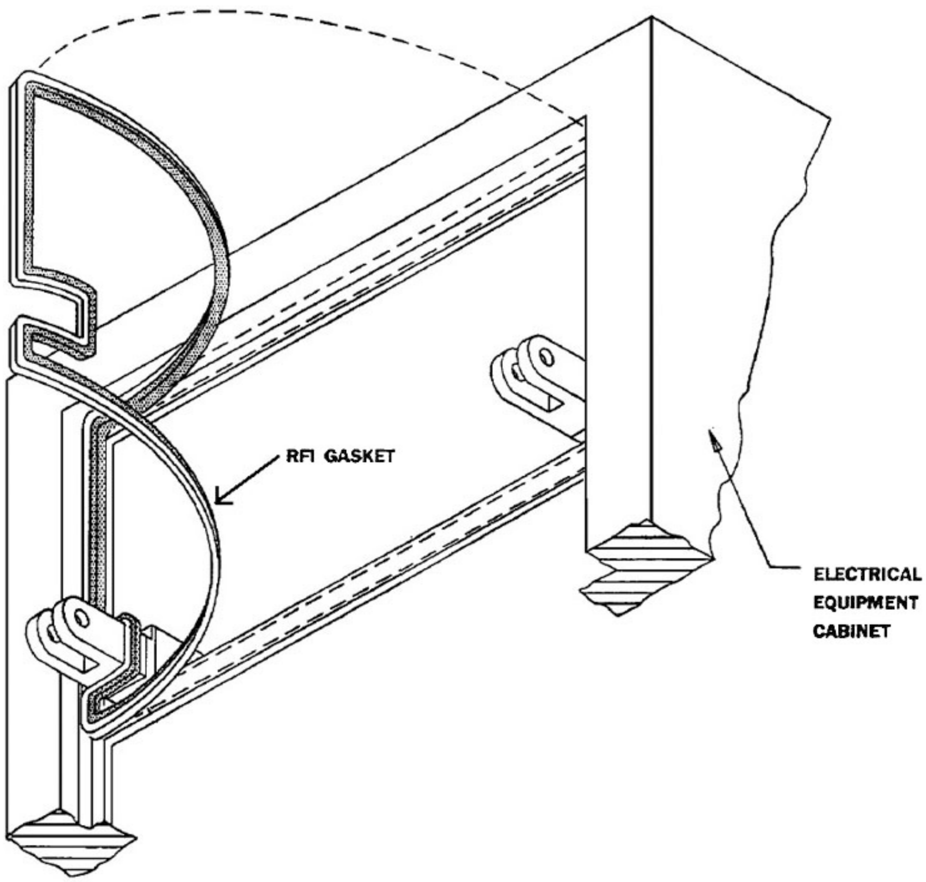


Figure 4–19. Radio frequency interference gasket (typical).

General gasket inspection criteria

When inspecting an RFI gasket and mating surface, such as the front cover of the emergency storage battery charger, the below inspection criteria apply. Be sure to use a magnifying glass when performing inspections, sometimes it can be hard to detect damage without it.

- Sponge rubber not hard, brittle, cracked, or separated from wire mesh, cabinet, or console.
- Mating surface free of warps or dents that prevent uniform contact between the gasket and the mating surface.
- Gaskets not be excessively deformed. If you find indentations, measure the gasket for a minimum of ⅛ inch uniform thickness.
- Fraying or unraveling cannot exceed 10 percent per foot of gasket and be no deeper than one layer of the triple knitted wire mesh.
- Broken strands cannot exceed 20 broken wires per inch and not more than 10 percent of strands can be cut or broken at worn spots.

- Gasket end joints have visible contact with wire mesh on both sides. And, sponge rubber cannot overlap wire mesh by more than ⅛ inch.
- Exposed wire mesh and mating surface free of paint, corrosion or nonconductive deposits that can prevent metal-to-metal contact.

If any out of tolerance conditions exist, report it to the MMOC immediately.

Environmental control system gasket inspection criteria

The RFI gaskets on typical enclosures and ECS panels have slight differences, but are generally similar and serve the same purpose. The one notable difference is that ECS panels do not have sponge rubber; rather, they are secured to the panel using conductive tape. All of the typical inspection criteria apply, with the exception of the sponge rubber inspections. In addition to the typical gasket inspection criteria, the conductive tape-mating surface should be free of bubbles or gaps greater than ¼ inch in diameter. The conductive tape ensures conductivity between the ends of the gaskets without the hassle of weaving the wire mesh together.

Electrical surge arrester vault inspection criteria

The ESA vaults have much larger doors and mating surfaces, therefore much larger RFI gaskets. These applications have significantly different criteria for inspection and are as follows:

- Gasket ends have visible contact of wire mesh and must be intermeshed at least 90 percent.
- Gasket and mating surface have no paint, lubricants, non-conductive deposits or corrosion.
- Fraying or unraveling does not exceed 10 percent per foot of gasket and no deeper than one layer of the triple-knitted wire mesh.
- Wire mesh gasket is not folded or crimped and gasket ends are abutted and sewn together with minimal overlap. Replace gasket if it is prominently bumped, cupped, or otherwise deformed.
- The wire mesh and mating surface has 50 percent bonding contact.

  NOTE: The surface is so large and the gasket so spread out that as long as 50 percent of the gasket is making contact with the mating surface, it provides sufficient EMP protection.
- Broken wires in the mesh do not exceed 20 per inch and not more than 10 percent of the wires are cut or broken at worn spots. This does not apply to the bolt holes, as it is expected that tightening the nuts around the gasket material will cause some broken wires.

To consider the inspection complete once you have finished the initial inspection, install the hatch cover and install all bolts. When installing the bolts, ensure you tighten them with a progressive tightening technique to ensure even compression on the gasket surface. Once installed, ensure that 75 percent of the gasket width is in contact with the hatch cover.

As you have noticed, RFI gaskets play a large part in maintaining the hardness of our MAFs and LFs. Therefore, it is important to inspect them each time they are exposed to view. Remember that different types of gaskets use different inspection criteria. After performing a few inspections, you will know right where to turn in the technical order.

Self-Test Questions

After you complete these questions, you may check your answers at the end of the unit.

026. Preventing hardness degradation

1. What work activity can degrade or render hardness-critical features ineffective?

2. What are the three basic rules for preserving hardness?

3. What important considerations should you remember when installing fasteners?

4. When replacing or repairing electrical bonding and grounding hardware, what criteria must the new hardware meet?

5. Before mating a connector, what kind of contamination and damage are you looking for?

6. What two conditions should you be alert to while performing maintenance on or around cable assemblies?

027. Equipment installations

1. What is installation hardware?

2. List examples of installation hardware.

3. What are the types of equipment installations?

4. What are some examples of hard-mounted equipment?

5. What is the purpose of shock loops?

6. What weapons effects are surface installations primarily designed to resist?

7. What is the basic requirement for replacing installation hardware?

028. Radio frequency interference gasket inspections

1. When do you complete an RFI gasket inspection?

2. When performing an inspection, why should the exposed wire mesh and mating surface be free of paint, corrosion, or non-conductive deposits?

3. What is the purpose of the conductive tape used in ECS RFI gaskets?

Answers to Self-Test Questions

021

1. (1) c.
   (2) f.
   (3) b.
   (4) g.
   (5) d.
   (6) e.
   (7) a.

022

1. Down and away.
2. Because they are buried deeper underground.
3. It diminishes.
4. Fluctuating air pressure.
5. The geometry of the facility, the arrangement of the equipment, and the precautions taken to eliminate or diminish undesired currents.
6. Very thin air that is high up in the atmosphere.
7. The protection of the facility, soil, seals, and blast valves.
8. The size of the weapon, the altitude of the detonation, and the type and condition of the soil.

023

1. Adequate clearance between the items.
2. It cushions the missile from vertical and horizontal movement so the missile does not contact the launch tube sides.
3. A four-inch cut was made approximately seven feet out from the LER.
4. Blast valves.
5. Because of the semiconductors within the electronic circuits.
6. Internal circuit protection, transient response improvements, reset of circuit elements and memory devices, and nuclear radiation reduction.
7. Enough excess material is built into structures to allow for a certain amount of material loss to occur during multiple nuclear attacks.
8. Metal to metal contact is avoided in areas where those two surfaces could melt and weld together.
9. A debris collection system is installed on the closure face.

024

1. 10 spring-type shock absorbers.
2. Dampen horizontal movement of the shock-isolated floor and provide a walking surface for personnel.
3. In case of an emergency when something affects the shock isolator air compressor operation.

4. Vertical movement.
5. An over pressure.

025

1. Through conductors penetrating the LCC liner.
2. By isolating the input power source from the output power.
3. ESAs at the point of entry.
4. To ensure electrical contact between the launcher closure and launch tube liner.
5. They contact the cable shield providing a continuity path between the conduit and the launcher liner.
6. Electrical surge filter assemblies.

026

1. Improper maintenance practices.
2. Perform all maintenance in accordance with applicable technical manuals, continually consider weapon system hardness requirements and provisions; and be alert to any conditions or occurrences that may affect them, and report to MMOC any maintenance requirement not specifically covered by technical order procedures.
3. Proper thread engagement, correct torque values, and correct tightening sequence (pattern).
4. The same type and quantity of hardware in the original configuration must be used.
5. Bent, broken, or missing pins, or damaged surfaces,
6. Shield damage such as broken or frayed strands, punctures, and corrosion; and sharp cable bends that can result in a ruptured cable shield.

027

1. Equipment and the provisions necessary for installation of equipment.
2. Nuts, bolts, washers, screws, brackets, clamps, hangers, studs, tethers, ties, plating, welds, and protective coatings.
3. Hard-mounted, shock-mounted, and surface installations.
4. ESA frames, filters, and junction boxes mounted directly to the launch tube walls or the ESA enclosure walls.
5. To provide enough slack between two attach points to permit movement without overstressing the line or clamps.
6. Shock, vibration, and air blast.
7. It must be replaced with identical items or authorized equivalents.

028

1. Anytime the gasket or the mating surface is exposed.
2. This contamination can prevent metal-to-metal contact.
3. Ensures conductivity between the ends of the gaskets without the hassle of weaving the wire mesh together.

Complete the unit review exercises.

Unit Review Exercises

Note to Student: Consider all choices carefully, select the *best* answer to each question, and *circle* the corresponding letter. When you have completed all unit review exercises, transfer your answers to the Field Scoring Answer Sheet.

Do not return your answer sheet to AFCDA.

54. (021) Identify the period in which the facility's critical functions are kept in a state of readiness without dependence on any external power or normal environmental control system.
    a. Emergency survival.
    b. Extended survival.
    c. Hardness-critical.
    d. Mission-critical.

55. (021) What supplies power to a missile facility during an extended survival period?
    a. Diesel batteries.
    b. Diesel-generator.
    c. Commercial power.
    d. Emergency batteries.

56. (021) Functions that must occur between the time the initial launch command is initiated and the missile exits the launch tube are called
    a. mission-essential.
    b. hardness-critical.
    c. launch-essential.
    d. survival-critical.

57. (022) Ground shock levels are greatly reduced before they reach the missile facility's internally mounted equipment by the depth of the facility,
    a. facility structure, and the angle of the shockwave.
    b. vibration safety valves, and facility structure.
    c. type of soil, and the angle of the shockwave.
    d. type of soil, and facility structure.

58. (022) Acoustic hardness pertains to the ability of sensitive equipment to survive
    a. ground shock.
    b. under pressures.
    c. high noise levels.
    d. resonant frequencies.

59. (022) What term is used to describe when a nuclear weapon is detonated above the atmosphere?
    a. Air burst.
    b. Space burst.
    c. High-altitude burst.
    d. Atmospheric burst.

60. (022) Over one-third of the energy from a nuclear explosion is emitted in the form of
    a. gamma rays.
    b. shock waves.
    c. heat and light.
    d. an electromagnetic field.

61. (023) The missile suspension and alignment system protects the missile from
    a. air blast.
    b. heat and light.
    c. over pressures.
    d. ground shock.

62. (023) What provides air blast and acoustics protection for the missile combat crew and the launch control center's launch-essential, mission-critical equipment in the event of a nuclear blast?
    a. Blast door.
    b. Liquid springs.
    c. Shock-isolators.
    d. Tunnel junction.

63. (023) What is installed in the debris collection system between the launcher closure and abutment to keep materials from melting in a nuclear environment?
    a. Asbestos insulation.
    b. Fiberglass insulation.
    c. High-heat resistant rubber.
    d. High-heat resistant plastic.

64. (023) What are the primary elements of the launcher closure debris collection system?
    a. Drop cloths and support nets.
    b. Collection bins and support cables.
    c. Forced-air curtains with collection bins.
    d. Debris deflectors with collection barrels.

65. (024) Which missile facility is *not* hardened against a ground shock environment?
    a. Wing 3 launch control center.
    b. Wing 1 launcher support building.
    c. Wings 3 and 5 launcher support buildings.
    d. Wing 5 launcher control equipment building.

66. (024) What type of shock isolators are used at Wing 3 and 5 launch control centers?
    a. Air-filled pendulum.
    b. Air-filled with springs.
    c. Liquid-filled pendulum.
    d. Hydraulic with leaf springs

67. (024) What prevents damage to the suspended launch control equipment building floor during horizontal movement?
    a. Spring-loaded hanger supports.
    b. Pendulum shock isolators.
    c. Leaf-type springs.
    d. Shock absorbers.

68. (025) An electromagnetic pulse could be directed into the launch control center by penetrating lines because they act as
    a. an insulator.
    b. an antenna.
    c. a ground.
    d. a neutral.

69. (025) What term is defined as “putting a component into a circuit that will limit or stop the free flow of power spikes”?
    a. Circumvention/reset.
    b. Circuit interface.
    c. Shunt discharge.
    d. Decoupling.

70. (025) What type of electrical surge arrestor is used to protect the hardened intersite cabling system?
    a. Decoupling filter.
    b. Gaseous shunt.
    c. Carbon block.
    d. Direct arc.

71. (026) Which is *not* a basic rule for preserving hardness during maintenance activities?
    a. Continually consider weapon system hardness requirements and provisions and be alert to any conditions or occurrences that may affect them.
    b. Report to missile maintenance operations center any maintenance requirement not specifically covered by technical order procedures.
    c. Perform maintenance in accordance with applicable technical manuals on critical components only.
    d. Perform all maintenance in accordance with applicable technical manuals.

72. (026) Where would you find the exact duplicate or authorized equivalent part when replacing damaged or corroded fasteners?
    a. Illustrated parts breakdown.
    b. Contractor maintenance data.
    c. Integrated Maintenance Data System.
    d. Missile maintenance operations center.

73. (026) It is important to ensure that the material a washer is made of is compatible with the material it bears against in order to
    a. ensure uniform torque distribution.
    b. ensure washer engagement.
    c. maintain fastener torque.
    d. avoid surface corrosion.

74. (026) For proper thread engagement, what is the *minimum* number of complete threads that should be visible on the end of a bolt when a nut is engaged?
    a. 1.
    b. 2.
    c. 3.
    d. 4.

75. (026) What should be performed prior to replacing or repairing a bonding or grounding connection?
    a. Strip off all conductive finishes.
    b. Remove cadmium or zinc plating.
    c. Remove foreign matter from the areas to be bonded.
    d. Notify the missile maintenance operations center the system will be down for repairs.

76. (027) The hardness-critical features of installation hardware used on surface installations must be primarily resistant to
    a. water.
    b. air blast.
    c. nuclear radiation.
    d. electromagnetic pulse.

77. (027) Who can provide technical assistance for all installation hardware or maintenance requirements not specifically covered in technical orders or civil engineering manuals?
    a. Nuclear Weapons Center.
    b. Maintenance team chief.
    c. Ogden Air Logistics Complex.
    d. Missile combat crew commander.

78. (028) What tool is used when performing radio frequency interference gasket inspections?
    a. Caliper.
    b. Multi-meter.
    c. Straight edge.
    d. Magnifying glass.

79. (028) If you find indentations in a radio frequency interference gasket during an inspection, measure the gasket for a *minimum* uniform thickness of
    a. ⅛ inch.
    b. ¼ inch.
    c. ⅜ inch.
    d. ⅝ inch.

80. (028) A radio frequency interference gasket is secured to a typical environmental control system panel by
    a. electrical tape.
    b. sponge rubber.
    c. liquid adhesive.
    d. conductive tape.

Glossary

°	degrees
ACP	alternate command post
AETC	Air Education and Training Command
AFB	Air Force base
AFCFM	Air Force career field manager
AFGSC	Air Force Global Strike Command
AFI	Air Force instruction
AFMAN	Air Force manual
AFMC	Air Force Materiel Command
AFS	Air Force specialty
AFSC	Air Force specialty code
AFTO	Air Force technical order
AGE	aerospace ground equipment
AFI	Air Force instruction
ALCC	airborne launch control center
ALCM	air-launched cruise missile
ALMM	air-launched missile maintenance
ALS	Airman Leadership School
ASU	automatic switching unit
BGG	ballistic gas generator
C2	command and control
CBR	chemical, biological, radiological
CC	commander
CDC	career development course
CEM	civil engineering manual
CFETP	career field education and training plan
CLC	Chief Master Sergeant Leadership Course
CMSgt	chief master sergeant
DMS	decentralized materiel support
DOD	Department of Defense

ECS	environmental control system
ELAB	electronics laboratory
EMI	electromagnetic interference
EMP	electromagnetic pulse
EMT	electro-mechanical team
ERMS	Environmental Control System Remote Monitoring System
ESA	electrical surge arrester
F	Fahrenheit
FLTS	flight test squadron
FMS	facilities maintenance section
FMT	facilities maintenance team
FTD	field training detachment
G&C	guidance and control
GMMP	guided missile maintenance platform
HAF	Headquarters, United States Air Force
HCP	hardness critical procedure
HICS	hardened intersite cable system
ICBM	intercontinental ballistic missile
ICBMSG	intercontinental ballistic missile system group
ICE	intercontinental ballistic missile center of excellence
IMDS	Integrated Maintenance Data System
IMPSS	Improved Minuteman Physical Security System
IPB	illustrated parts breakdown
IZ	inner zone
LCC	launch control center
LCEB	launch control equipment building
LCSB	launch control support building
LER	launcher equipment room
LF	launch facility
LSB	launcher support building
MA	mission assurance

MAF	missile alert facility
MAJCOM	major command
MAPS	mechanical and pneudraulics section
MCC	missile combat crew
MCL	master change log
MCM	missile communications maintenance
MDG	medical group
MES	missile engineer squadron
MGS	missile guidance set
MHT	missile handling team
MICAP	mission capability
MMOC	missile maintenance operations center
MMT	missile maintenance team
MMXS	missile maintenance squadron
MNCL	master nuclear certification list
MOO	maintenance operations officer
MPH	missile potential hazard
MPP	Minuteman power processor
MSB	missile support base
MSE	mission support equipment
MSG	mission support group
MW	missile wing
MXG	maintenance group
MXG SUPT	maintenance group superintendent
MXG/CC	maintenance group commander
MXS	maintenance squadron
NAF	numbered Air Force
NCE	nuclear certified equipment
NCOIC	noncommissioned officer in charge
OG	operations group
OGE	operational ground equipment

OIC	officer in charge
OJT	on-the-job training
OTL	operational test launch
OZ	outer zone
P&S	plans and scheduling
PAC	portable air conditioner
PAH	personnel access hatch
PAS	personnel access system
PMEL	precision measurement equipment laboratory
PMT	periodic maintenance team
PREL	power, refrigeration, and electrical
PRP	personnel reliability program
psi	pounds per square inch
PSRE	propulsion system rocket engine
PT	payload transporter
QA	quality assurance
QAE	quality assurance evaluator
REACT	Rapid Execution and Combat Targeting Console
RFI	radio frequency interference
RPIE	real-property installed equipment
RS	re-entry system
RTT	recurring technical training
RV	re-entry vehicle
RVA	remote visual assessment
SCC	security control center
SCP	squadron command post
SELM	simulated electronic launch of Minuteman
SIN	support information network
SKT	specialty knowledge test
SLBM	submarine-launched ballistic missiles
SMSgt	senior master sergeant

SPVO	special purpose vehicle operations
SQ/CC	squadron commander
SrA	senior Airman
SSgt	staff sergeant
SST	survivable systems team
START	Strategic Arms Reduction Treaty
SUPT	superintendent
TBA	Training Business Area
TCTO	time compliance technical order
TE	technical engineering; transporter erector
TO	technical order
TODO	technical order distribution office
TPC	two-person concept
TRG	training group
TRS	training squadron
UHF	ultra-high frequency
US	United States
USSTRATCOM	United States Strategic Command
UTM	unit training manager
VAC	volts alternating current
VACE	verification and checkout equipment
VES	vehicle and equipment section
VHF	very-high frequency
WAPS	Weighted Airman Promotion
WCP	System wing command post
WMD	weapons of mass destruction weapon
WSA	storage area
WSSR	weapon system safety rules

Student Notes

Student Notes

AFSC 2M051
2M051A 01 1901
Edit Code 06