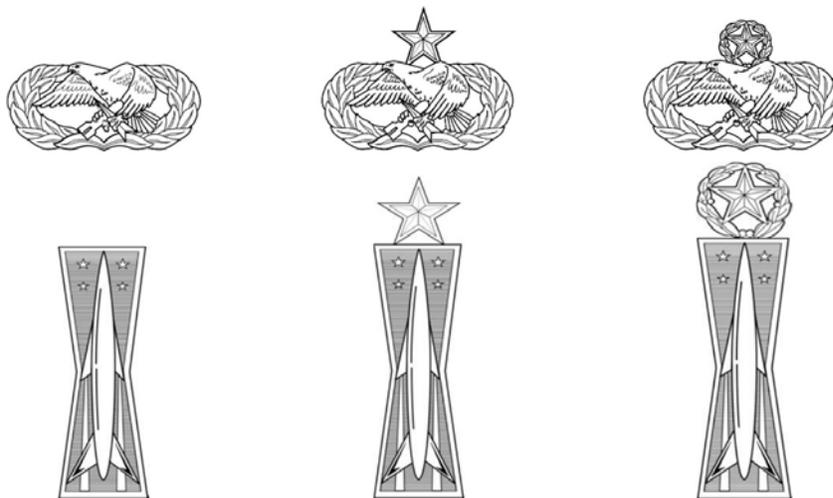


# **CDC 2M052**

## **Missile and Space Systems Maintenance Journeyman**

### **Volume 2. Maintenance Management, Practices, and Principles**



**Air Force Career Development Academy**

**Air University**

**Air Education and Training Command**

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THIS SECOND volume of the Career Development Course (CDC) 2M052, *Missile and Space Systems Maintenance Journeyman*, is designed to provide an orientation to maintenance management, practices, and principles. This information will help you perform your job as a missile maintenance technician.

Unit 1, hardness assurance, covers four sections: weapons effects and protection, hardness preservation principles, maintenance programs, and weapons safety. Finally, unit 1 introduces you to the functions and responsibilities within maintenance organizations using a top down approach from Air Force Global Strike Command (AFGSC) to wings.

Unit 2, publications, covers standard publications and technical orders, and civil engineering manuals.

Unit 3, maintenance fundamentals, covers troubleshooting techniques, hardware, electrostatic discharge control, hydraulic systems, and pneumatic systems.

Unit 4, materiel management and supply discipline, covers the basics of materiel management, supply discipline, illustrated parts breakdown, supply systems priorities, and supply forms.

A glossary is included for your use.

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**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 complete the unit review exercises.

	<i>Page</i>
<b>Unit 1. Hardness Assurance .....</b>	<b>1-1</b>
1-1. Weapons Effects and Protection .....	1-1
1-2. Hardness Preservation Principles .....	1-26
1-3. Maintenance Programs .....	1-34
1-4. Weapon Safety .....	1-45
<b>Unit 2. Publications .....</b>	<b>2-1</b>
2-1. Standard Publications and Technical Orders .....	2-1
2-2. Civil Engineering Manuals .....	2-20
<b>Unit 3. Maintenance Fundamentals .....</b>	<b>3-1</b>
<b>Unit 4. Materiel Management .....</b>	<b>4-1</b>
<i>Glossary.....</i>	<i>G-1</i>

**Please read the unit menu for unit 1 and continue →**

# Unit 1. Hardness Assurance

<b>1-1. Weapons Effects and Protection .....</b>	<b>1-1</b>
201. Hardness terminology and functions .....	1-1
202. Effects of a nuclear detonation .....	1-3
203. Facility hardness protection features .....	1-12
204. Shock attenuation system features .....	1-15
205. Features of electromagnetic pulse hardness design .....	1-20
<b>1-2. Hardness Preservation Principles .....</b>	<b>1-26</b>
206. Preventing hardness degradation .....	1-26
207. Equipment installations .....	1-29
208. Radio frequency interference gasket inspections .....	1-30
<b>1-3. Maintenance Programs .....</b>	<b>1-34</b>
209. Deficiency reporting .....	1-34
210. Integrated Maintenance Data System .....	1-38
211. Maintenance data collection .....	1-40
<b>1-4. Weapon Safety .....</b>	<b>1-45</b>
212. Nuclear-certified equipment .....	1-45
213. Nuclear weapon system safety rules .....	1-48

**T**HE 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 launch facilities (LF) must be maintained in normal technical order configuration. Although different configurations and hardness levels exist at the missile wings, 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 maintenance practices. The first section focuses on the nuclear environment and how our systems are designed to withstand that environment. The second section focuses on how you will preserve the designed-in hardness features of the weapon system.

## 1-1. Weapons Effects and Protection

This section provides a look at what happens during a nuclear detonation and how our facilities are hardened to withstand each effect. Before we discuss these features, let us begin with the terminology that we use throughout this unit.

### 201. 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, which is the 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 (kt). For further clarification, a "kiloton" of yield is equal to 1,000 pounds of trinitrotoluene (TNT).

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 nonnuclear 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 nonnuclear environment without losing the ability to complete 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 environmental control system (ECS). During the emergency survival period, electrical power is provided by the emergency storage batteries in the launcher equipment room (LER) at the launch facility (LF), or launch control center (LCC) at the missile alert facility (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 is *only* considered launch-essential if its malfunction would prevent a launch before, during, or after a nuclear attack.

Launch-essential functions are those functions which 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 (MC) if it is required to launch the missile within a given time span, or 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 (HC) if it could be designed, repaired, manufactured, installed, or maintained for normal operation in a nonnuclear environment, yet degrades 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, which is a gasket 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 nonnuclear 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.

Category	Purpose	Examples
<b>Perform</b>	Directly performs hardness critical function.	AFGSC command networks, cryptographic equipment, ordnance interlocks, safety devices, and squib drivers.
<b>Support</b>	Supports other equipment performing hardness critical functions.	The environmental control system, storage tanks for coolant liquids, pipes for carrying the coolant liquids, and the missile suspension system.
<b>Protect</b>	Protects other equipment performing 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 assemblies, ventilation safety valves, shock isolators, and the launcher personnel access shaft primary door.

### Facility hardness requirements

The Minuteman III facilities were originally 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 launch support buildings (LSB) at Wing 3 and Wing 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.

### 202. 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 to comprehend how the facility is protected from them, and what your role as a technician is in preserving hardness (fig. 1-1). The effects that we study are as follows:

- Ground shock and vibration.
- Air blast and acoustics.
- Electromagnetic pulse (EMP).
- Nuclear radiation.
- Thermal effects.
- Debris.

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

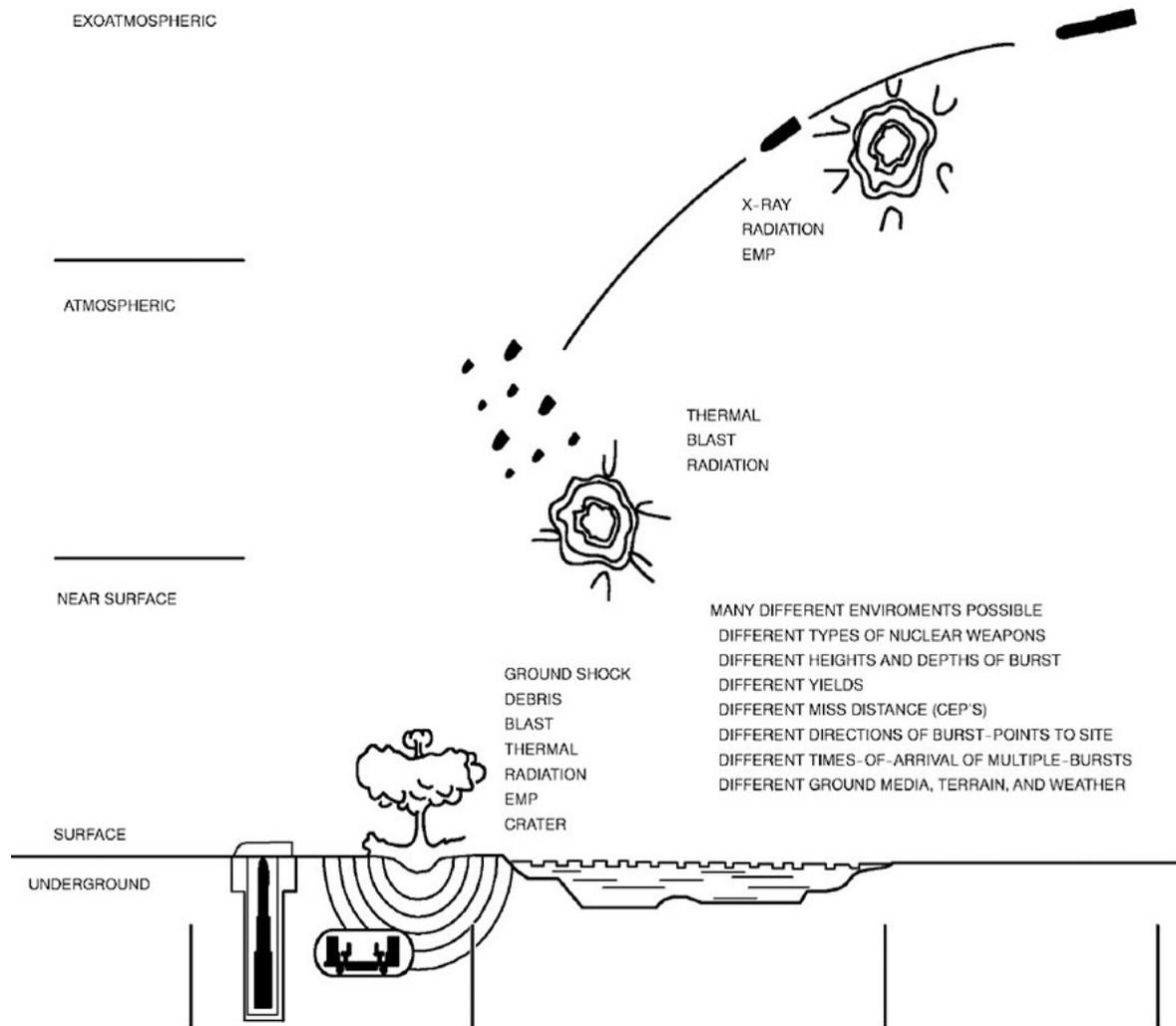


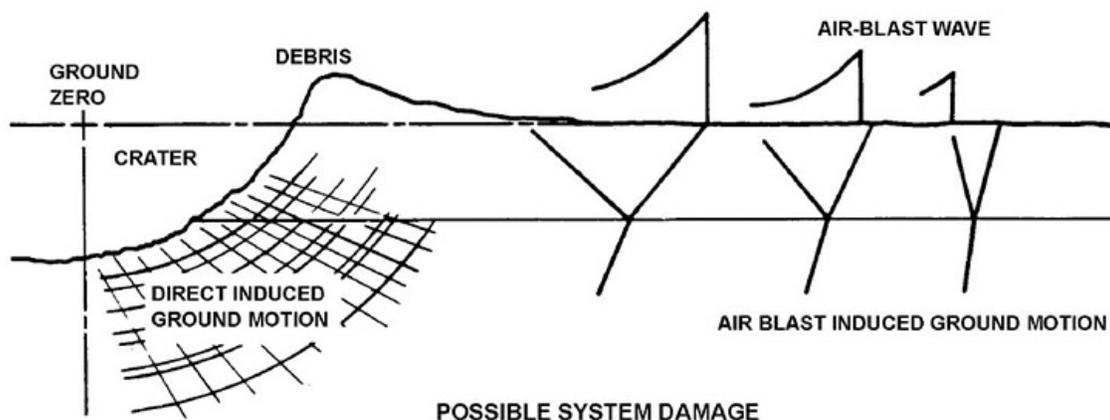
Figure 1-1. Nuclear weapons effects.

### 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* ground motion 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.

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 1-2 for a description of the way the system responds to ground shock.

**LAUNCHER**

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

**CABLES**

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

**OGE**

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

**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 1-2. Ground shock effects.

### *Effects on walls, ceilings, and fixed floors*

The LER, LSB, LCC, and launch control equipment building (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 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 reducing characteristics of the shock isolation systems. A good example of this are 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.

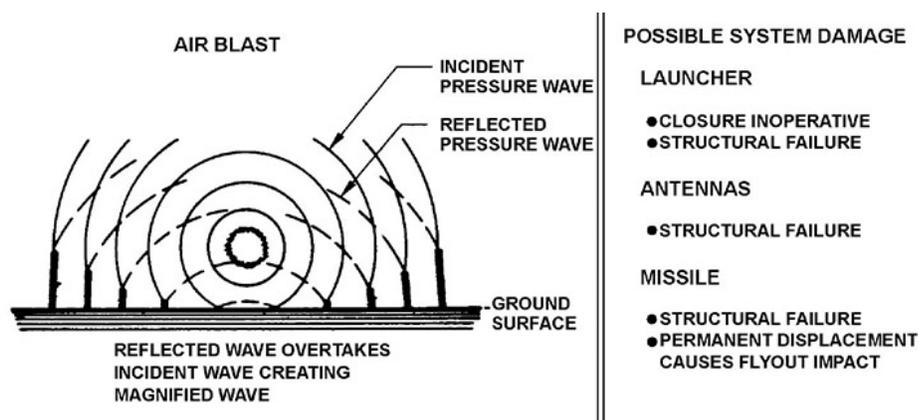
### **Air blast and acoustics**

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 (mph), at very low pressures.

The destructive effect of the blast is proportional to the amount of its overpressure. The maximum value of the air blast at the blast wave front is called the "peak overpressure." 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.

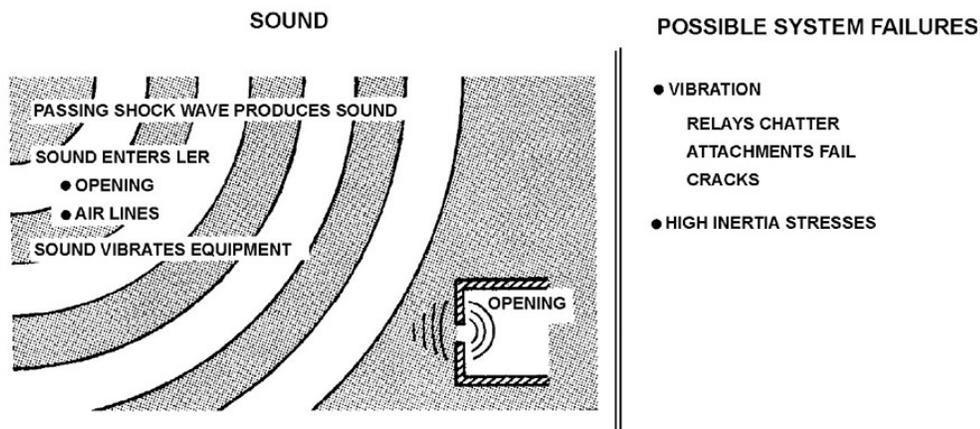
See figures 1-3 and 1-4 for a description of air blast and acoustics and their effects. These effects occur at the ground surface and within the hardened underground facilities. Exposed portions of facilities and all equipment located on the ground surface are subjected to maximum effects. Certain equipment (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 1-3. Air blast effects.



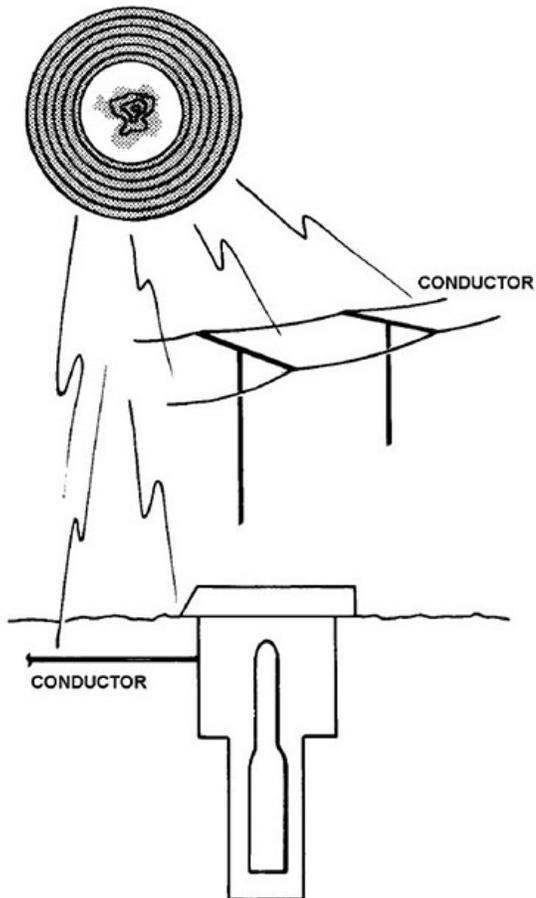
SOUND WITHIN THE SILO CAUSES RAPID PRESSURE FLUCTUATIONS. THIS RAPID PRESSURE FLUCTUATION CAUSES HIGH STRESSES IN MOVABLE OR FLEXIBLE EQUIPMENT. DURING TESTING OF A WING V RACK ONE FLAT PANEL DRAWER FRONT REACHED ACCELERATIONS UP TO 130 G'S AT ONE FREQUENCY.

Figure 1-4. Acoustic effects.

### Electromagnetic pulse

A nuclear detonation generates an electromagnetic field, which can induce electric currents in any exposed metallic object. These currents, when induced in antennas, conductors, metal conduits, etc., 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, which may penetrate a facility and be transmitted into sensitive equipment. See figure 1-5 for a description of EMP effects on system equipment.

## ELECTROMAGNETIC FIELD



## 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 1-5. Electromagnetic pulse effects.

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 (HAB) (fig. 1-6), 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, which greatly increases 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.

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

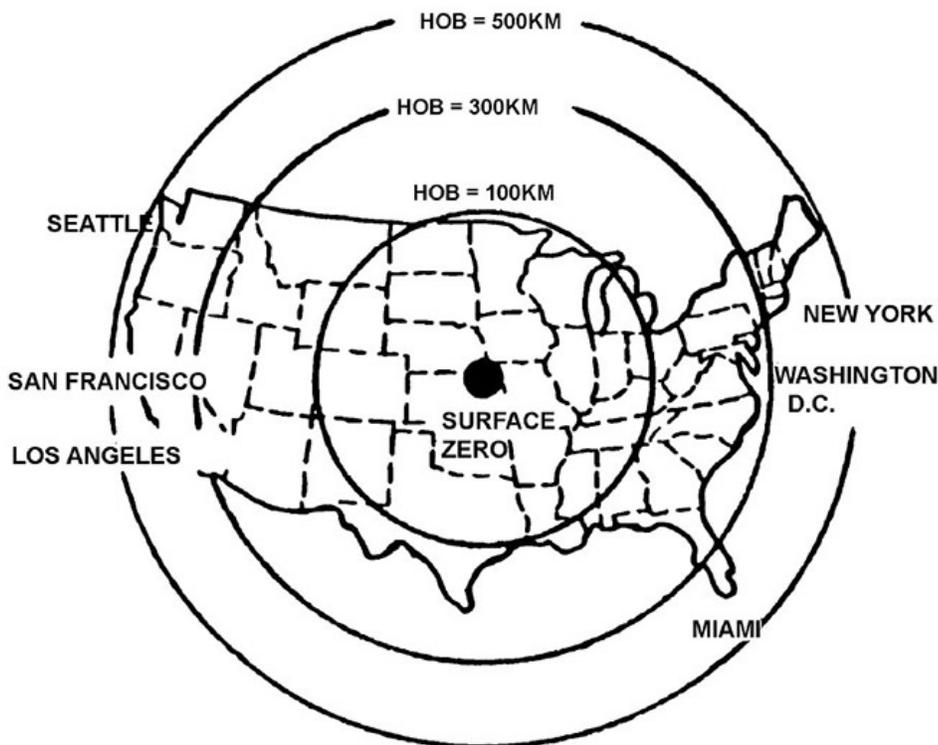
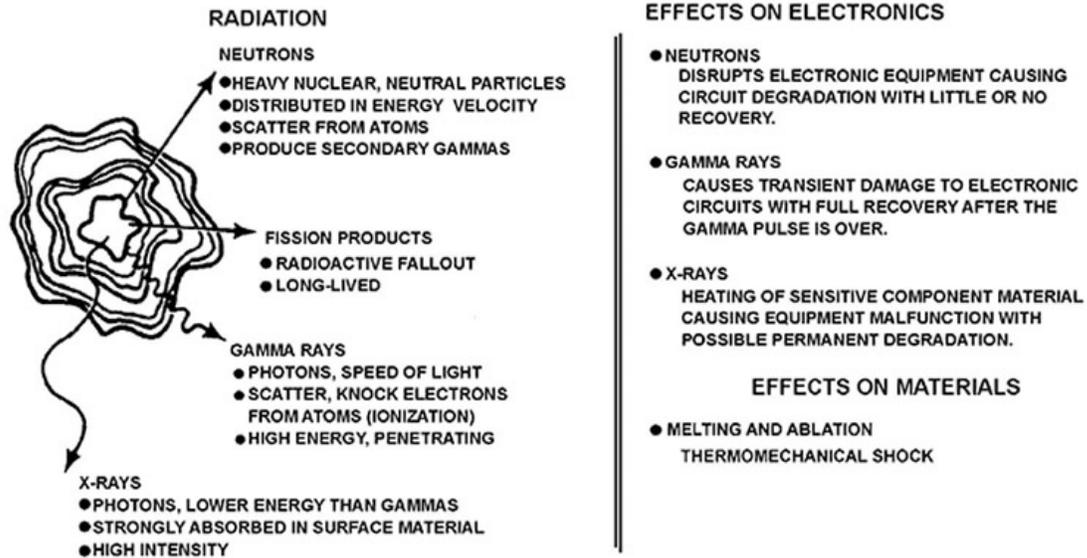


Figure 1-6. High-altitude burst.

### **Nuclear radiation**

There are some 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 at MAFs; therefore, the radiation environment inside these facilities is much lower than the external environment. Refer to figure 1-7 for a description of nuclear radiation effects.



**NEUTRONS** 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.

**FISSION PRODUCTS** 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.

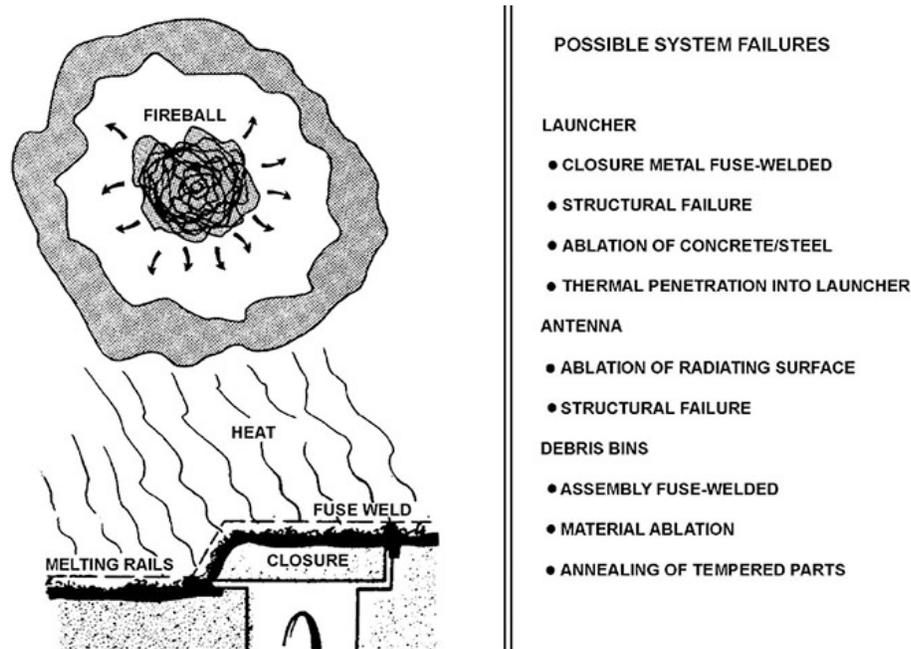
**GAMMA RAYS** ARE PHOTONS LIKE VISIBLE LIGHT, THAT IS, "BUNDLES" OF PURE ELECTROMAGNETIC ENERGY, TRAVELING AT THE SPEED OF LIGHT. THE ENERGY OF THE PHOTON CAN DISPLACE ELECTRONS LEAVING IONIZED ATOMS AND CREATING UNWANTED CURRENTS. GAMMA DAMAGE RESULTS FROM IONIZATION.

**X-RAYS** 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 1-7. 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 1-8 for a detailed description of the thermal effects due to a nuclear detonation.



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 1-8. 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 inter-site 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 1-9 for a summary of debris and crater effects and their potential impact upon the weapon system.

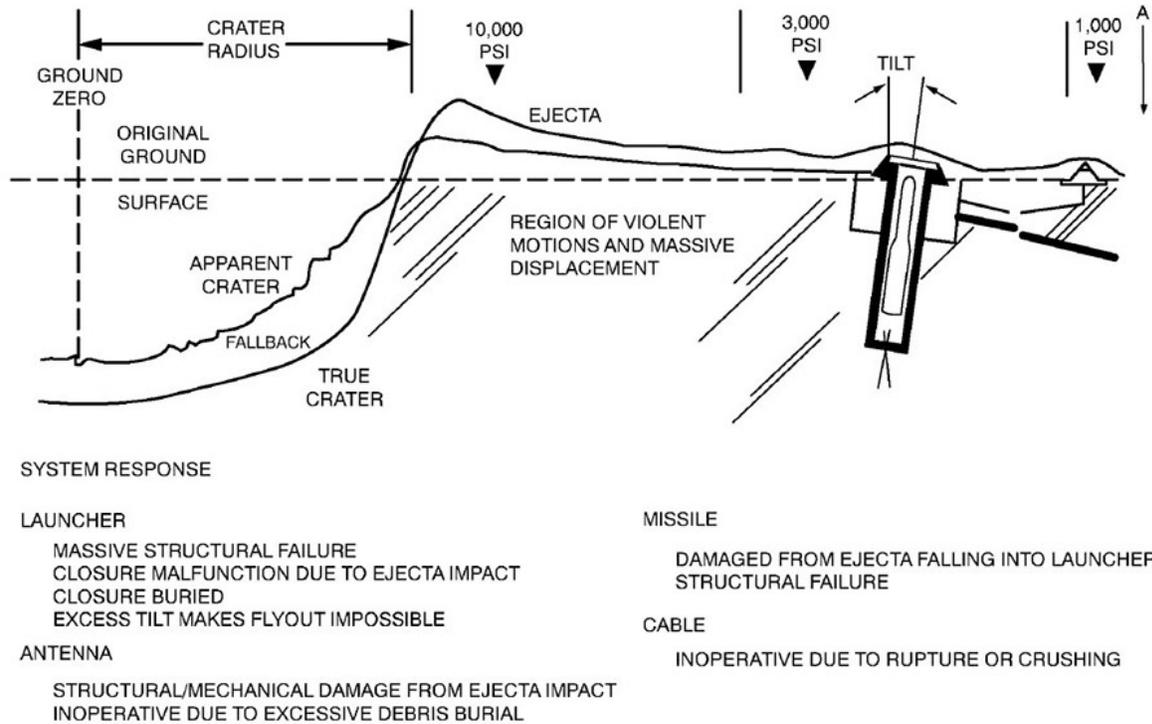


Figure 1-9. Debris and crater effects.

### 203. 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 us explore how the missile facilities are protected against each part of the nuclear environment.

#### Hardness critical items and 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, there are three methods of protecting equipment from ground shock and vibration.

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/hoses to prevent stretching or breaking.
Accelerations, which 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 in 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 the following 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 (fig. 1-10) that the launcher closure door rolls on are exposed on the surface of the LF, and will undoubtedly take damage from a nuclear detonation. To counter this, the steel portion of both tracks is cut through about 4 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 and prevent it from rolling away from the launch tube.

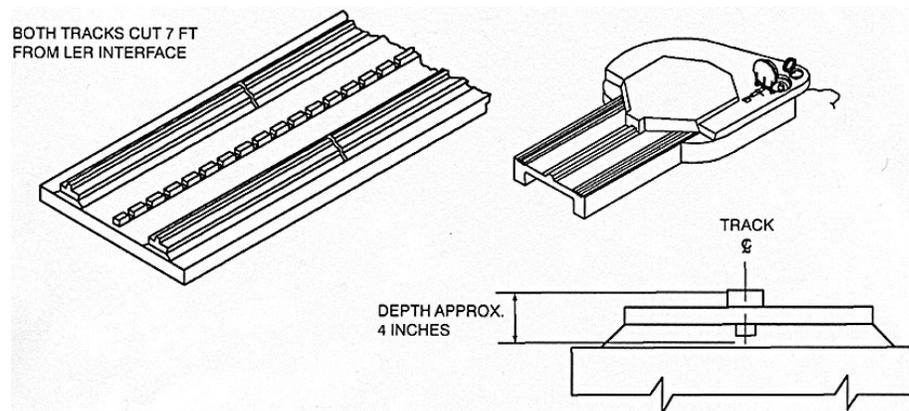


Figure 1-10. Launcher closure track modification.

### 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 and mission-critical functions both during and after exposure to nuclear radiation. Due to this, 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 done 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**

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 snow plow, 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 has some protection. The missile's nozzles are protected by a debris deflector ring.

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 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 borax or boric acid) to minimize heating due to X-ray radiation. The EMP antenna re-bar is non-borated glass which minimizes how much radiation it absorbs, which in turn reduces how hot it gets.

### **204. Shock attenuation system features**

As shown in previous lessons, the massive jolt from a ground shock can have a devastating effect on the facilities. You learned that equipment is protected from ground shock by providing adequate clearance, hard-mounting equipment, or having sensitive equipment shock-isolated. This lesson focuses 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.

##### ***Launch support building (Wing 3 and Wing 5 only)***

The LSB floor at Wing 3 and Wing 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-type shock mounts to minimize the damage caused by the suspended floor striking the walls of the LSB. Each rubber pad is 5 inches thick and bonded to a steel mounting plate. Figure 1-11 illustrates the shock absorbers and shock mounts.

##### ***Launch 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.

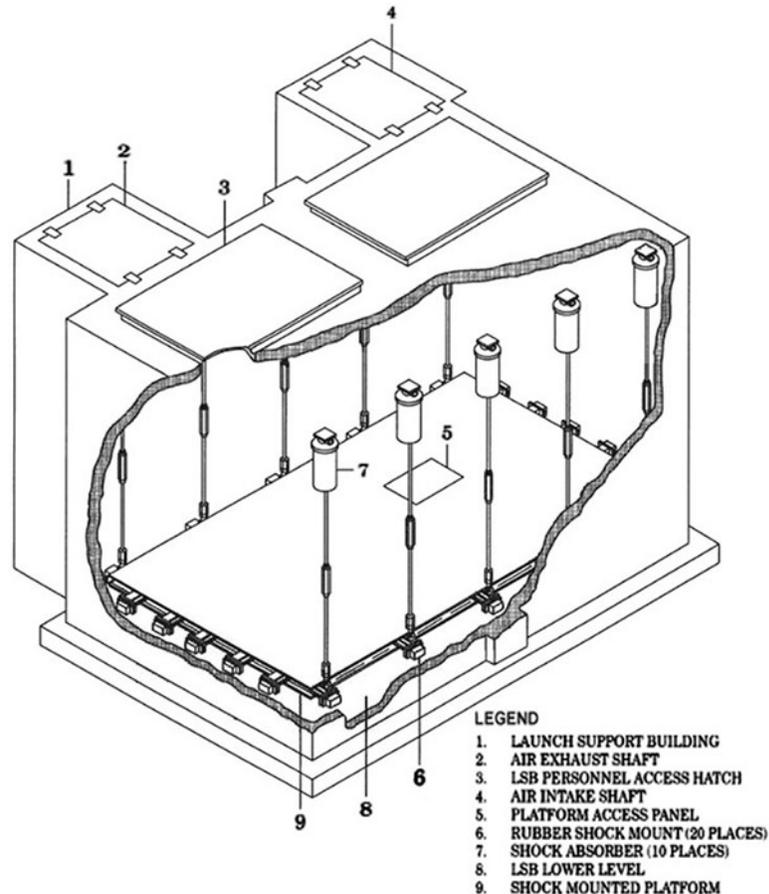


Figure 1-11. Wing 3 and Wing 5 launch support building shock attenuation system.

In addition to shock protection for the LSB floor, the LSB also contains flexible hoses and flexible electrical conduits. The light fixtures are mounted on springs.

Remember that the 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.

Foam-type blocks called *horizontal restraints*, which are designed to dampen horizontal motion, are mounted on the inside and outside of the suspended floor. These blocks also provide a walking surface for personnel, and are protected by a rubber tread surface. Figure 1-12 shows the shock isolators and horizontal restraints.

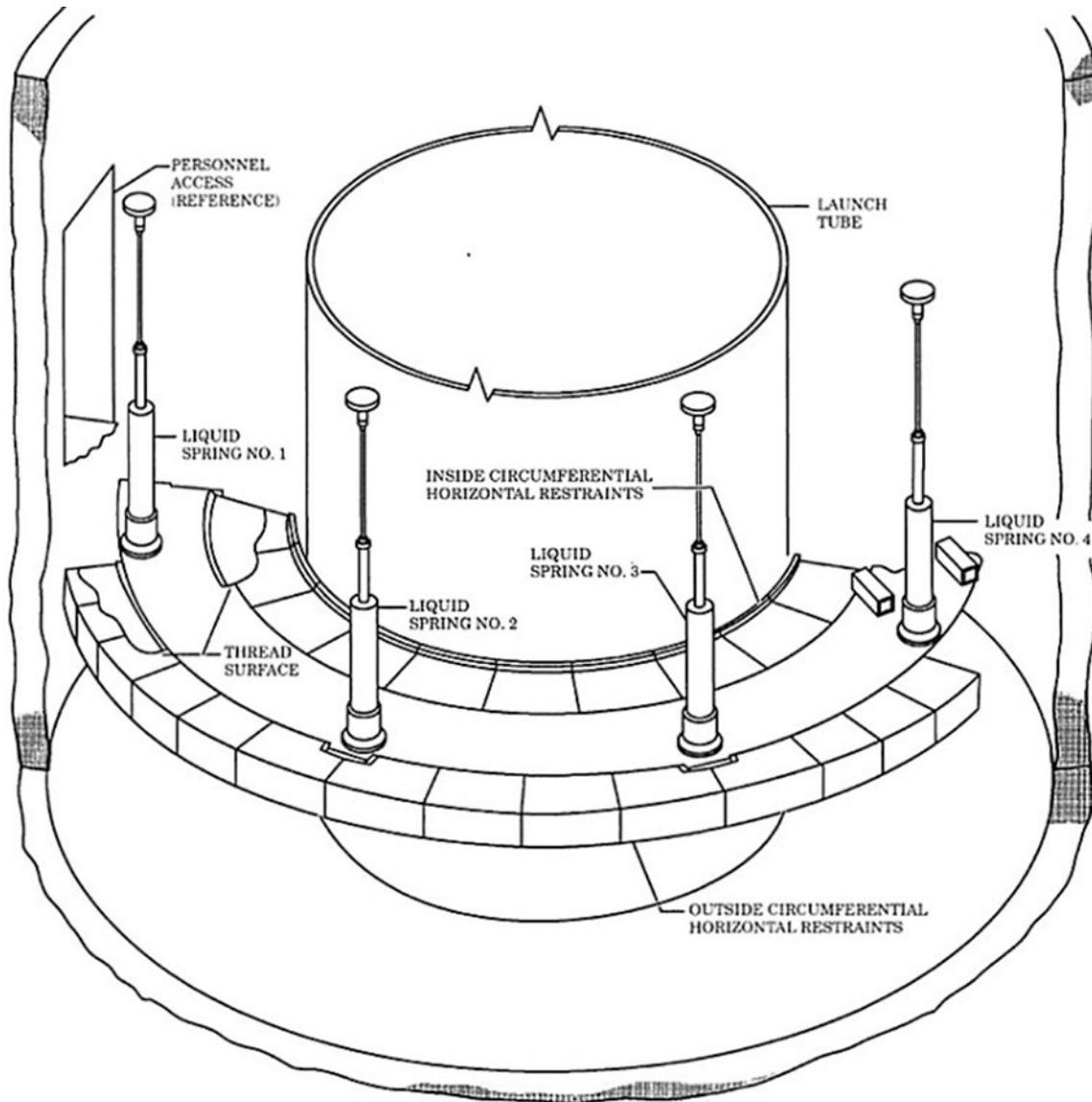


Figure 1-12. Launcher equipment room shock isolation system.

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 environmental control system 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***

See figure 1-13. The acoustical enclosure of the Wing 1 LCC is suspended above the capsule by four pneumatic shock isolators. One is located in each corner of the floor, and its job is to protect the acoustical enclosure from excessive vertical movement. An air compressor assembly, located in the launch control support building (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.

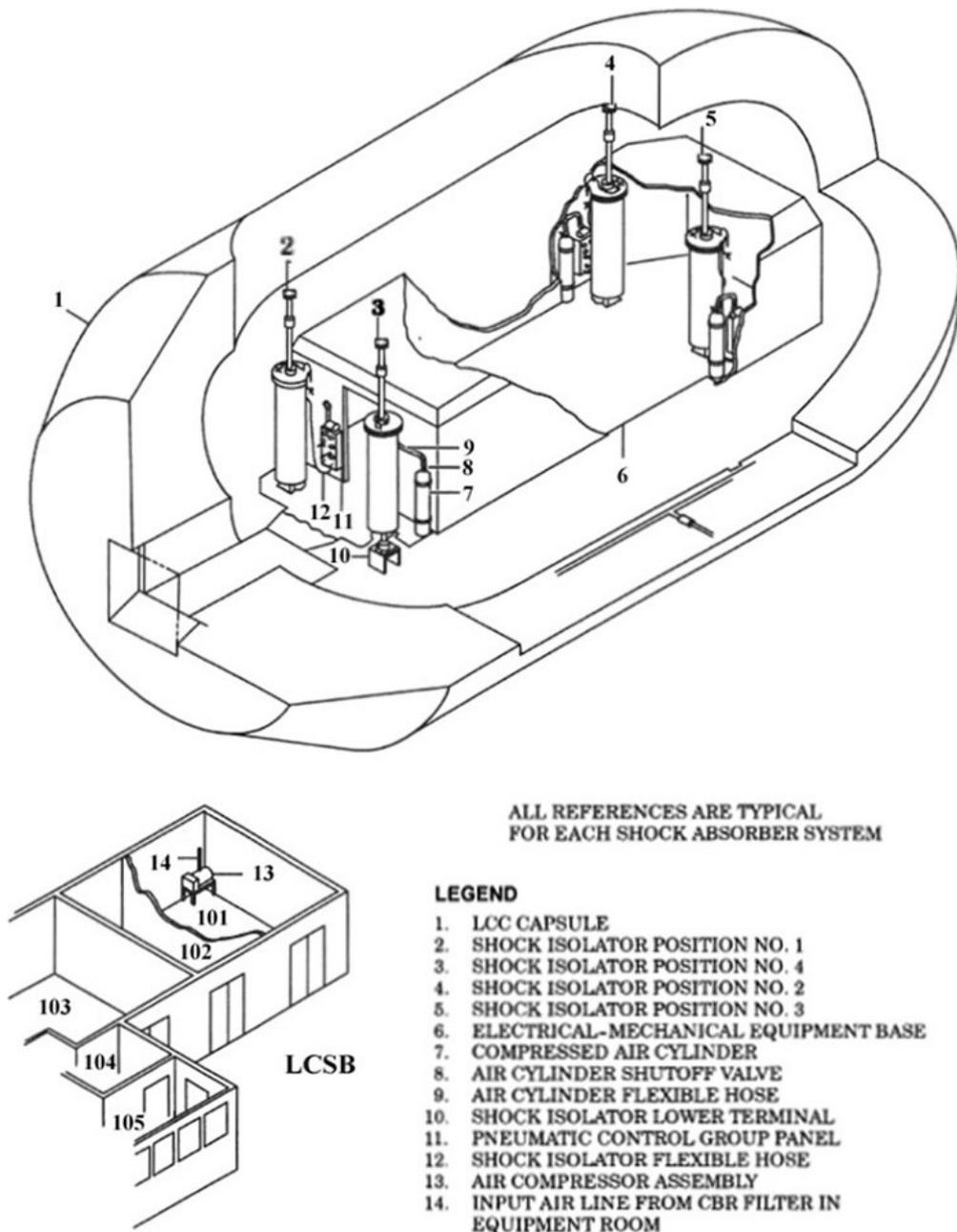


Figure 1-13. Wing 1, launch control center shock isolation system.

### *Wing 3 and Wing 5 launch control center shock isolation system*

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

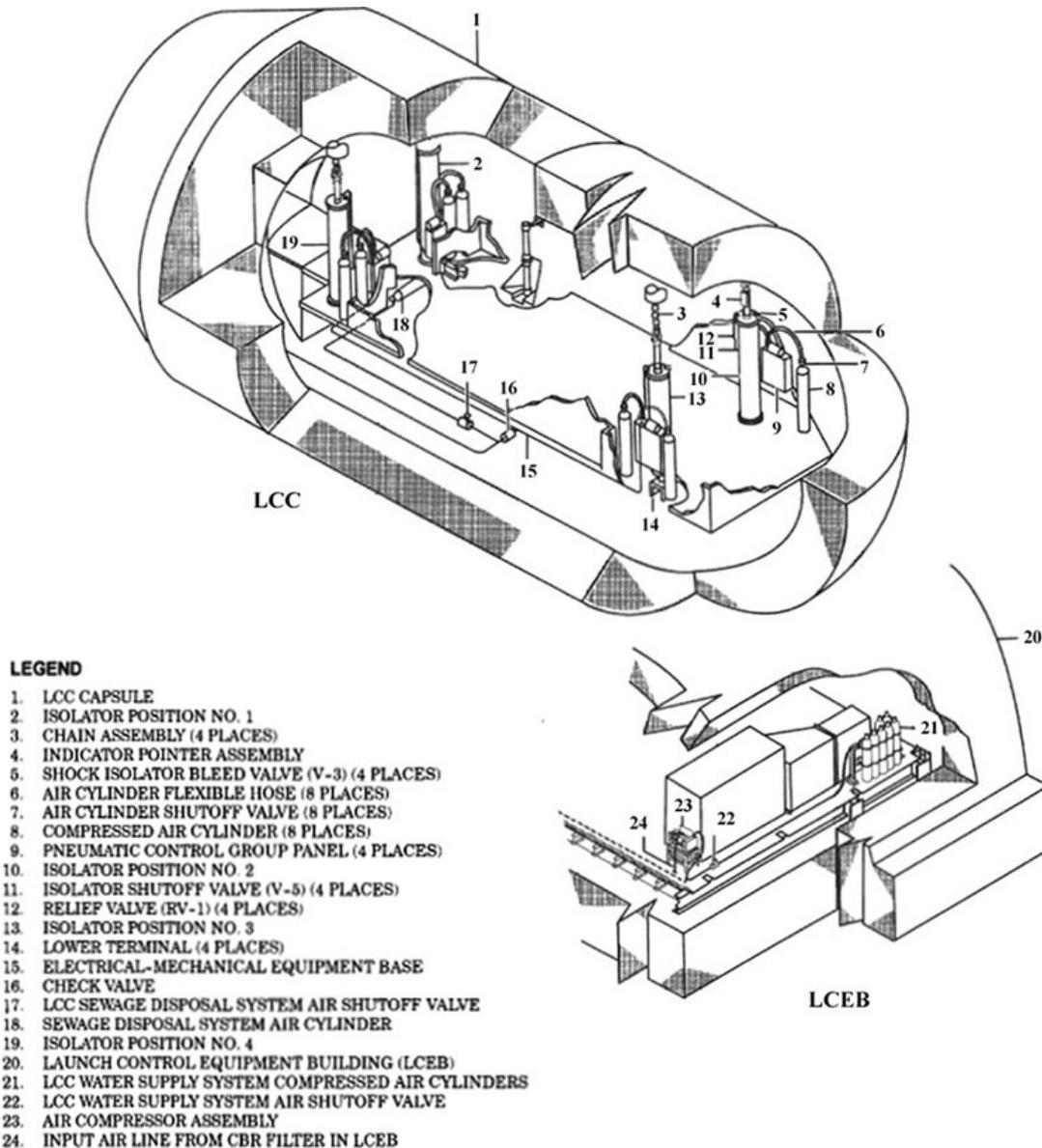


Figure 1-14. Wing 3 and Wing 5 launch control center shock isolation system.

### *Wing 3 and Wing 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. The shock absorbers in the LCEB 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.

The Wing 3 and Wing 5 MAFs also have an attenuation system for their liquid lines (fig. 1-15). 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.

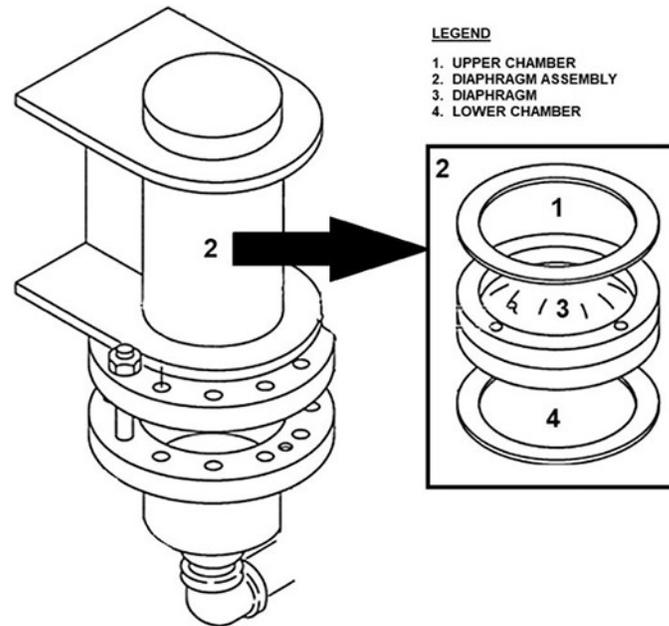


Figure 1-15. Liquid line shock attenuator.

### 205. Features of electromagnetic pulse hardness design

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 field 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 electrical surge arresters (ESA). 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 field 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 your technical order.

#### Missile alert facility

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

- Shielding of the facility from the EMP field.
- 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.
- Protection provided by ESA.
- Protecting circuits that could be exposed to EMP.
- Designing circuits to be immune to EMP.

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Some of the protection from EMP comes from the fact that the LCC is buried far beneath the 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, Hardened Intersite Cable System (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 enters 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:

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

Let us now look at these four approaches and 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. In addition, EMP seals are incorporated in the nose of the closure at the multiplying linkage assembly.

### *Reduction and decoupling of electromagnetic pulse energy*

First off, let us define decoupling. To put it simply, 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), and still send a normal amount of power to the circuitry after it. 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 after the piece of wire. In an essence, we want the same amount of power to come out, no matter how much power is put in.

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 EMP's energy as possible directly into the ground, where it can't do as much 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. EMP energy is reduced by the ground clamps contacting the cable shield, which provide a continuity path between the conduit and the launcher liner. These clamps are installed at both ends of one conduit for the LSB support information network (SIN) and power monitor lines, and at the ends of the two security antenna line conduits in the ESA vault.

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 outer zone 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 ESA 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 command and control system uses selected components in the drawer interface circuits to provide circuit protection for the transistor-to-transistor logic. In addition, the ultrahigh 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.

### 201. 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.

<i>Column A</i>	<i>Column B</i>
____ (1) The measure of ability of a system to withstand exposure to one or more of the environment effects of a nuclear or nonnuclear weapon.	a. Hardness critical item.
____ (2) The capability of a system to withstand a nuclear or nonnuclear environment without losing its ability to complete its designated mission.	b. Extended survival period.
____ (3) That period in which critical functions are maintained in a state of readiness without dependence on commercial power.	c. Hardness.
____ (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.	d. Launch-essential.
____ (5) An item of equipment or a system function required to launch the missile and its malfunction would prevent a launch before, during, or after a nuclear attack.	e. Mission-critical.
____ (6) An item of equipment or a system function required to launch the missile within a given time span, or to successfully complete the mission.	f. Survivability.
____ (7) An item that could be maintained for normal operation in a nonnuclear environment, yet degrade survivability when exposed to a nuclear environment if not maintained properly.	g. Emergency survival period.
	h. Nuclear environment.

### 202. Effects of a nuclear detonation

1. In what directions, away from the detonation, do air blast-induced ground motion force the ground?
  
2. Why is the shock that the launch tube and the launcher equipment room fixed floor exposed to less severe?
  
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 electromagnetic pulse 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?

**203. 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?

**204. Shock attenuation system features**

1. In a Wing 3 or 5 launch support building, what limits vertical movement of the floor?
2. What are the two purposes for the horizontal restraints in the launcher equipment room?
3. In the Wing 3 and Wing 5 launch control center shock isolation system, when are the two compressed air cylinders used?
4. What type of movement do the Wing 3 and Wing 5 launch control equipment building shock absorbers limit?
5. In the Wing 3 and Wing 5 launch control equipment building, what would cause the rubber diaphragm in the liquid line attenuation system to rupture?

**205. Features of 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 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 in penetrating conduits?
6. What provides additional EMP limiting and filtering where ESAs do not provide enough decoupling?

## 1-2. Hardness Preservation Principles

This section provides information that you need to preserve the weapon system hardness features we discussed earlier, and will cover a special category of equipment known as installation hardware. This section ends with radio frequency interference gasket inspections.

### 206. 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, and leaves 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 us begin by taking a look 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 was part of a ground path, which reduced or destroyed the effectiveness of the ground path.
- A hole that 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 that 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 degrades hardness should be reported to the missile maintenance operations center (MMOC), who will then determine whether or not corrective action is required. The three basic rules for preserving hardness during maintenance activities are as follows:

- 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.
- Report to MMOC any maintenance requirement not specifically covered by technical order procedures.

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 (TO) will be identified by the symbol **\*\*HCP\*\***. A 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, then the whole paragraph is hardness critical. If the symbol appears immediately prior to a step or sentence, then 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 1-16 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 1–16. 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, the 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, you should 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 a 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 washers are used as additional washers will permit 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 using 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 and possibly cause 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. See the snapshot in figure 1–17.

- 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 1–17. 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 nonconductive finishes, such as paints, etc. 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, you should not remove cadmium or zinc plating unless the technical order procedure tells you to do so.

#### ***Torque***

Proper torquing 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 you will use 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 are at the end of your procedure, and it is time to put everything back together, it is important that you pay attention to connector mating requirements. You must be sure of the condition of the connector, its alignment, and also ensure that the two connectors are sufficiently tightened. Prior to mating, you will 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***

You should always be alert to potential hardness degradations that may be unrelated to the maintenance you are doing. Some examples of conditions discovered during site surveys are as follows:

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

- Missing fasteners.
- Unauthorized loose equipment on site.

A mislaid tool or other piece of hardware such as a nut, bolt, or washer can become wedged into 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. While performing maintenance on or around cable assemblies, you should be alert for the following conditions:

- 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 has 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 your technical orders, these methods will soon become second nature to you.

## **207. Equipment installations**

Every piece of equipment on site is secured in some way. You should not find any 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 that 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 types of equipment installations are as follows:

- 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 to 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. 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, and you also do not 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 your technical orders or civil engineering manuals (CEM).

## 208. Radio frequency interference gasket inspections

Radio frequency interference (RFI) gaskets play a pivotal role in EMP hardness. Sometimes referred to as electromagnetic interference (EMI) gaskets, these gaskets are installed where they are needed 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.

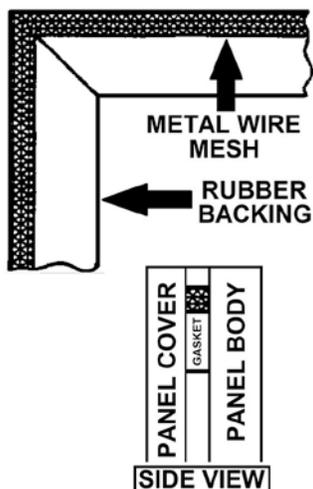


Figure 1-18. Parts of a radio frequency interference gasket.

### Parts of a radio frequency interference gasket

Before we get into the inspection of an RFI gasket, let us 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 is what 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. 1-18).

### Radio frequency interference gasket inspection

Whenever you complete any maintenance where an RFI gasket or mating surface is 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 typical equipment, such as the emergency storage battery charger when performing a checkout, ECS equipment when opening panels, or electrical surge arrester vaults when performing a filter inspection. Though quite similar, each different gasket has its own procedure and its own criteria to determine pass or fail; as a result, ensure you are on the correct procedure before you start. RFI gasket inspections can be found in Air Force Technical Order (AFTO) 21M-LGM30F-112, *Organizational Maintenance Instructions; General Inspection and Repair Procedures ICBM Systems*. As a technician, you will usually just refer to this book as the “F-112”. For illustration, figure 1-19 shows a typical RFI gasket installed on a panel.

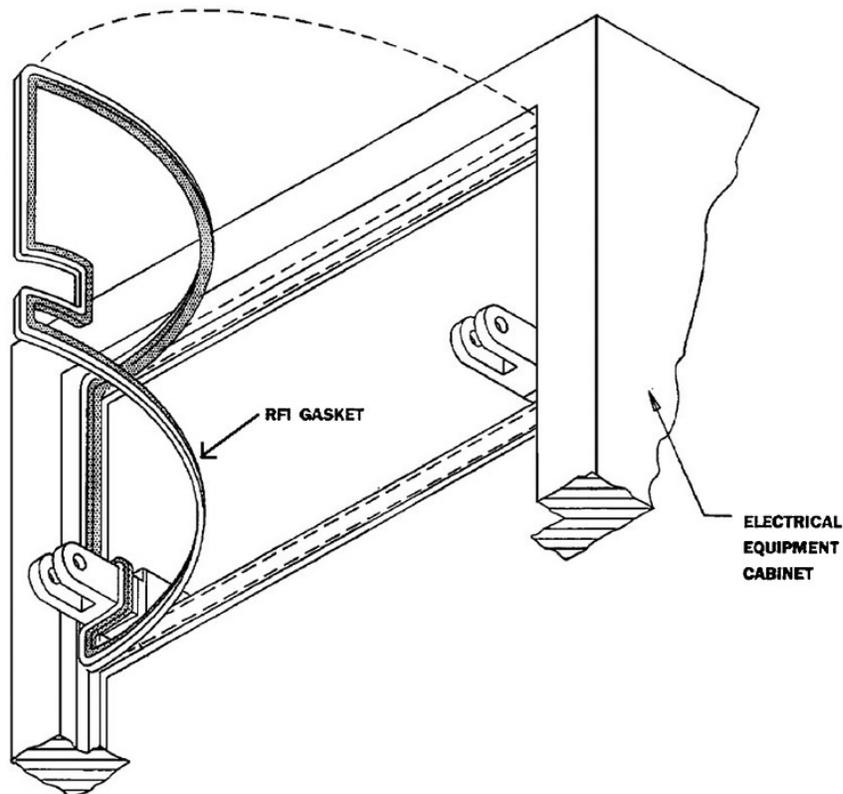


Figure 1-19. Radio frequency interference gasket (typical).

### *General gasket inspection criteria*

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

- Broken strands shall not exceed 20 broken wires per inch and not more than 10 percent of strands shall be cut or broken at worn spots.
- Fraying or unraveling shall not exceed 10 percent per foot of gasket and be no deeper than one layer of the triple knitted wire mesh.
- Gasket end joints shall have visible contact of wire mesh on both sides. There should be no overlap of sponge rubber exceeding 1/8-inch.
- Exposed wire mesh and mating surface should be free of paint, corrosion, or nonconductive deposits. This contamination can prevent metal-to-metal contact.
- Sponge rubber must not be hard, brittle, cracked or separated from wire mesh, cabinet, or console.

- Gaskets should not be excessively deformed. If you find indentations, measure the gasket for a minimum 1/8-inch uniform thickness.
- Mating surface should be free of warps or dents that prevent uniform contact between the gasket and the mating surface.

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

#### *Environmental control system gasket inspection criteria*

RFI gaskets on typical installations 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 1/4-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, as follows:

- The wire mesh and mating surface must have 50 percent bonding contact. 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 should not exceed 20 per inch and not more than 10 percent of the wires shall be 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.
- Fraying or unraveling shall not exceed 10 percent per foot of gasket and be no deeper than one layer of the triple-knitted wire mesh.
- Gasket ends must have visible contact of wire mesh and must be intermeshed at least 90 percent.
- Gasket and mating surface must not have paint, lubricants, nonconductive deposits or corrosion.
- Wire mesh gasket must not be folded or crimped and gasket ends must be abutted and sewn together with minimal overlap. If the gasket is prominently bumped, cupped, or otherwise deformed, it will need to be replaced.

To consider the inspection complete once you have finished the initial inspection, you must 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, you must ensure that 75 percent of the gasket's width is in contact with the hatch cover.

As you have seen, 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 your technical order.

## Self-Test Questions

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

### 206. 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?

### 207. 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?

### **208. Radio frequency interference gasket maintenance**

1. When must 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 nonconductive deposits?
3. What is the purpose of the conductive tape used in environmental control system RFI gaskets?

## **1-3. Maintenance Programs**

There are several maintenance programs that enable us to complete our maintenance mission. How often have you dispatched to a site to replace a component and discovered that your replacement component was defective before you installed it? The deficiency reporting process will help resolve that particular issue. How many times have you dispatched to a site to replace a component and found that the wrong part was ordered? This could have been prevented by proper use of the Integrated Maintenance Data System (IMDS). On a different note, national, and world news covered some incidents that brought special attention to how we control nuclear weapons related material (NWRM). This section identifies and teaches you about these special programs and systems: deficiency reporting, IMDS, and maintenance data collection.

### **209. Deficiency reporting**

Let us say you are busy at work repairing the hoist on a payload transporter (PT). As you work, you find some of the materials you received from supply do not work properly. In fact, this is becoming a recurring problem. Under these circumstances, what should you do? The answer—this is a prime example of a situation where you should initiate a deficiency report (DR). This lesson serves as an introduction to the deficiency reporting process and outline some key responsibilities in the process.

#### **Deficiency report purpose**

The purpose of the DR system is to provide and collect deficiency data on hardware, software, mission-critical computer systems, vehicles, clothing, and other government acquired equipment. You might be wondering what a deficiency is. A deficiency is a defect or design flaw. Deficiencies can be in the design process *or* manufacturing. A deficiency prevents materials from performing the way they are intended. The DR system ensures the deficiency information is routed to the agency responsible for development, procurement, and other management functions so action can be taken to correct and prevent maintenance, materiel, design, and quality deficiencies. As a technician, you must know how to report materiel deficiencies and maintenance actions promptly. Your supervisor will help you report suspected deficiencies to quality assurance (QA) and show you how to correctly document maintenance actions.

#### **Definitions**

Before we discuss the deficiency reporting process, you need to be familiar with some important terms that are used. The following paragraphs will introduce you to some terms that you need to know to understand the deficiency reporting process.

### **Acceptance inspection**

An acceptance inspection is performed by the receiving organization to determine the condition of newly received equipment. These inspections will be of sufficient depth to determine the ability of the item to perform its designed function. This is required for all items received from the air logistics complex (ALC). If there are any problems noted during the inspection a deficiency report must be drafted.

### **Defect**

A defect is any problem or issue with a product where it does not perform as required. This does not mean any defective component is classified as a “defect” under the deficiency reporting process. When you replace a launch tube heater motor and your new one fails to operate properly, you have a defect—the part you received was defective. A defect can also be hardware that is missing from an equipment item that does not affect its operation when you first receive it.

### **Deficiency report**

A deficiency report is a generic term used to record, submit, and transmit deficiency data. When a component or item is found to have a defect, a DR needs to be submitted to alert managers of the product. This will ensure your unit is reimbursed the cost of the component or item, ensures we have the right product in service, and provides a means of notifying leadership, ALCs, and other units with a similar mission of potential defect trends.

### **End item**

An end item is a system, equipment, or component, which by itself performs a military function contributing to the mission. End items are usually made up of several smaller parts that are procured separately; however, these smaller parts are removed and replaced to return the end item to service. For instance, the PT auxiliary power unit (APU) is an end item made up of smaller parts. In its entirety it performs its own function. In maintenance you may even replace the whole end item. When you replace parts of the PT APU, you are getting it back to service as an end item.

### **Exhibit**

The exhibit is the component or equipment with a defect. This represents the deficient condition and the item must be tagged and segregated to ensure it can be properly investigated by the product managers.

### **Defects**

When a deficiency report is submitted, it is classified according to the possible outcomes of the defect. There are three types: critical, major, and minor.

<b>Types of Defects</b>	
<b>Type</b>	<b>Description</b>
Critical defect	This is a defect that judgment and experience indicate is likely to result in hazardous or unsafe conditions for people using, maintaining, operating, or depending on the product. It may also be a defect that judgment and experience indicate is likely to prevent performance of the strategic function of a major end item, such as a missile or space vehicle.
Major defect	This is a condition, other than critical, that is likely to result in failure, or reduces the usability of the item for its intended purpose.
Minor defect	A minor defect is a defect that is <i>not</i> likely to reduce the usability of the unit or product for the intended purpose, or is a departure from established standards having little bearing on the effective operation of the unit.

## Types of deficiencies

Not only does the method and response to a deficiency depend on the criticality of the defect, but action is also determined by what type of deficiency it is. The following are some common deficiencies.

Types of Deficiencies	
Type	Description
Design deficiency	<p>This is any condition that limits or prevents the use of a component or equipment for the purpose intended or required, where it meets all other specifications or contractual requirements.</p> <p>These deficiencies cannot be corrected except through a design or specification change. This is the case when a component is used in the system and works the way it is supposed to, but it just does not do what we need it to do.</p>
Material deficiency	<p>A material deficiency is an unacceptable condition or recommendation for enhancement that impacts operational safety, suitability, or effectiveness of a system, subsystem, or component.</p>
Procurement deficiency	<p>A procurement deficiency is any unsatisfactory product condition that is attributable to improper, incorrect, ambiguous, omitted, or conflicted contract requirements.</p> <p>This is when the government contracts an agency to develop a component or equipment item for us and we accept it when it <i>actually does not</i> meet the requirements we need it for.</p>
Product quality deficiency	<p>This is the most common type of deficiency. This applies when a component or equipment item does not fulfill its expected purpose or service due to deficiencies in design, specifications, material, manufacturing process, or workmanship.</p> <p>This is when you install or use a brand new component or equipment item and it fails right away or fails within its warranty service period. Back to our initial example; launch tube heater motors were installed and failed upon startup or after a few days. A quality deficiency report (QDR) was submitted to let the air logistics complex know the products were defective and the unit was reimbursed the cost of the failed motors.</p>

## Deficiency report categories

Deficiency reports are prescribed as either Category I or Category II. The following table will help you determine which category deficiency to report. If any doubt exists about where to categorize a deficiency, your unit QA or wing safety office can help.

### Category I

PRIORITY	IMPACT
Emergency	<ul style="list-style-type: none"> <li>• If uncorrected, may cause death, severe injury, or severe occupational illness. If uncorrected, may cause major loss or damage to equipment or a system.</li> <li>• Directly restricts combat or operational readiness.</li> </ul>
Urgent	<ul style="list-style-type: none"> <li>• Adversely affects an essential capability or negatively impacts operational safety, suitability, or effectiveness with no acceptable work-around.</li> <li>• Adversely affects technical, cost or schedule risks to the project or to life cycle support of the system with no acceptable work-around.</li> <li>• Results in a production line stoppage.</li> </ul>

### Category II

Use this category when reporting a deficiency that does not meet the criteria for a Category I deficiency.

PRIORITY	IMPACT
Urgent	<ul style="list-style-type: none"> <li>Adversely affects an essential capability or negatively impacts operational safety, suitability, or effectiveness with performance achieved by significant compensation or acceptable work around.</li> <li>Adversely affects technical, cost, or schedule risks to the project or to life cycle support of the system with acceptable work around.</li> </ul>
Routine	<ul style="list-style-type: none"> <li>Does not affect an essential capability but may result in user/operator inconvenience.</li> <li>Hinders maintenance actions or creates an annoyance with maintenance personnel, but does not prevent job completion.</li> <li>Adequate performance may be achieved through minimal compensation.</li> </ul>

### Responsibilities

The following table describes all of the steps in the deficiency reporting process and who is responsible to initiate and resolve it.

Actor	Responsibilities
Originator (example—you)	<ul style="list-style-type: none"> <li>Discovers and identifies impact of the deficiency.</li> <li>Secures the exhibit.</li> <li>Provides all available information to the originating point.</li> <li>Helps the originating point as requested.</li> </ul>
Originating Point (example—supervisor)	<ul style="list-style-type: none"> <li>Certifies the validity, completeness, and accuracy of the deficiency report.</li> <li>Validates the deficiency category.</li> <li>Ensures exhibits are available, secured, and properly identified.</li> <li>Submits the validated report to the screening point in the appropriate database, within specified time limits.</li> <li>Acts as focal point for communications and interaction with the screening point.</li> </ul>
Screening Point (example—QA)	<ul style="list-style-type: none"> <li>Reviews deficiency reports for proper categorization, validity, correctness of entries, and accuracy.</li> <li>Determines and transmits the report to the appropriate database.</li> <li>Maintains the audit trail for each report.</li> <li>Provides exhibit disposition instructions to the originating point.</li> <li>Establishes routing and tracking mechanisms.</li> </ul>
Action Point (example—ALC Item Manager)	<ul style="list-style-type: none"> <li>Responsible for all technical and administrative actions necessary for deficiency report resolution.</li> <li>Coordinates with item managers/specialists/engineers as necessary to evaluate and initiate a course of action for deficiency report resolution.</li> <li>Provides status updates, closing actions, and exhibit disposition instructions to the screening point.</li> <li>Maintains active oversight of all deficiency reports assigned to them.</li> </ul>
Support Point (example—Air Force Office of Special Investigations (AFOSI) if sabotage is possible)	<ul style="list-style-type: none"> <li>Assists the action point when requested.</li> <li>Conducts investigations, trend analysis, and recommends corrective/preventative actions.</li> </ul>

**One last important point**

Any item, regardless of cost, is subject to DR procedures. Just because it is a 10-cent resistor or a two-dollar wrench does not mean deficiencies in the quality of these items are not important. Remember, the item could be used all over the world. When viewed this way, the total cost could be thousands or millions of dollars of your tax money. When you initiate DR action, you provide the Air Force Materiel Command (AFMC) item manager (IM) with the best source of information for determining the satisfactory and continued safe operation of components. Unless you report a possible problem, the IM may continue to order defective components or be lulled into believing the best components on the market are being procured.

**210. Integrated Maintenance Data System**

The Integrated Maintenance Data System (IMDS) is an automated data collection and information system that supports all maintenance efforts. It was designed and implemented to enhance readiness by improving the flow and availability of maintenance information such as scheduling data, historical records, and logistical data. The automated data system supports the commander and managers at all levels of the maintenance community. The system uses a series of databases to provide automated inventory control and information recording to help base-level managers more effectively use their resources. IMDS also provides much of the maintenance data needed by major commands (Air Force Global Strike Command (AFGSC), AFMC, etc.), Headquarters (HQ) United States Air Force (USAF), and other agencies to manage and track maintenance resources worldwide. As a technician, you need to understand how IMDS is used in the maintenance complex as you are a major contributor to the integrity of the data collected.

**Objectives**

When maintenance is performed, whether on-site or on base, extensive data must be collected to account for the time you spent, the parts used, the systems you worked on, and the steps you took to checkout or repair the system. When this data is entered into IMDS, it tells the story of what you did, what it took to do that job, and how long you spent doing it. IMDS data translates to commanders and managers how many personnel are needed to do the job, what high-failure parts are needed to keep on hand, and/or what systems are outdated and need upgrade. When you record this data on your paperwork, it is very important that you record everything as accurately as possible. This only helps you as the technician, and future technicians that will follow you, to have a starting point in troubleshooting a similar and/or recurring issue. Here are some objectives of the IMDS program:

- Eliminate and/or reduce nonproductive administrative tasks, thereby improving efficiency in the organization.
- Ensure that Air Force materiel is serviceable, operable, and properly configured.
- Provide better capability for maintenance information programs and organizations to support Air Force peacetime and wartime missions.
- Provide more accurate maintenance data needed to develop technical requirements, concepts, and plans supporting weapon system development.
- Identify changing needs for the maintenance community in the areas of personnel, equipment, and subsystem technology (upgrades and modifications).
- Provide more responsive maintenance systems and methods to support changing operational needs.
- Support senior maintenance managers in their need to better organize and train the force to support the operational mission in the most effective and productive manner.

As you can see, IMDS will provide a wealth of information to managers to make your maintenance organization more productive, with the right personnel, equipment, and resources to do the job.

## Functions

IMDS allows you to perform three basic functions—update the database, retrieve information from the database, and report the data required to those agencies that manage and track maintenance resources.

Function	Description
Database updates	This function allows you to enter new data, change existing data, and delete erroneous and obsolete data from the database.
Information retrieval	There are two types of retrievals provided: <ul style="list-style-type: none"> <li>• Real-time retrievals are processed at the time of input and returned to the requesting terminal. Allows you to view current data.</li> <li>• Background retrievals are processed and sent to your remote line printer or the high-speed printer located at the data processing center. Allows you to view historical data.</li> </ul>
Reporting	Reports required by higher headquarters are produced to the extent possible as a byproduct of the normal base-level operation of IMDS. It is then automatically extracted and transmitted to other maintenance information systems, such as the Reliability and Maintainability Information System (REMIS) or the Standard Base Supply System (SBSS) on a periodic basis by IMDS interface programs. This eliminates one administrative task that makes your organization more efficient.

## Subsystems

IMDS uses several subsystems, or screen numbers, that aid IMDS in meeting the objectives and requirements of the maintenance community. Here are some IMDS screens that will be used most often.

Subsystem	Description
Maintenance Events	Allows the user to track maintenance actions and has both maintenance and supply data. The user can create, schedule, defer, reschedule, and cancel events. The user can also inquire into supply data related to recorded discrepancies.
Location	Allows the user to automate the location of missiles and aerospace ground equipment, as well as any other equipment deemed critical to the organization's operation.
Job Data Documentation (JDD)	Allows users to document, inquire, and retrieve information on maintenance actions. Work activity and job completion can be reported for all maintenance on-site and on base.
Operational Events	This subsystem can be described in three phases as follows: <ul style="list-style-type: none"> <li>• Phase one (Mission Recording) is the scheduling phase where teams and work orders can be scheduled.</li> <li>• Phase two (Mission Accomplishment) is the period of time from start to stop of an operational event.</li> <li>• Phase three (Analysis Phase) provides the capabilities for periodic reports of mission accomplishment.</li> </ul>
Maintenance Personnel	Allows the user to monitor manpower resources.
Training Management	Allows the user to schedule and forecast personnel training requirements. This is commonly used to schedule your recurring training, such as shotgun qualification, or gas mask training.
Base Supply System Interface	This interface provides the capability to order parts for unscheduled discrepancies. Additionally, numerous types of supply system inquiries can be made.

Subsystem	Description
Automated Debriefing	Provides debriefing functions including deviation data, discrepancies discovered, and tracking and reporting of recurring discrepancies.

### Data accuracy

The accuracy of the data put in the system is absolutely paramount. As a technician, it is critical that you provide the most accurate data. For example, if you forget to record the diesel hours or fuel level from an LF, it is best that you be honest about it and not guess what the figures were. When you discover a discrepancy that requires parts, it will be your role as a team chief or technician to research the correct parts and ensure the part information is attached to the work order when you create it. Work unit codes (WUC) are used to track the maintenance history on a certain component or end item. It is critical you use the correct WUCs of what you worked on. All this data projects future maintenance actions and gets you the resources needed to do the job. How many times have you been scheduled to complete a work order, but could not because you had the wrong part? The accuracy of the data you provide will only help you as the technician.

To protect data accuracy, your workcenter supervisors are responsible to review the data entered on a daily basis. This further ensures the accuracy and completeness of data entered into IMDS. Be prepared to come to work on a day off if your maintenance data is incomplete or inaccurate. Remember, the job is not finished until the paperwork is done! If it is not done right, then the job is not done.

### 211. Maintenance data collection

Because the weapon systems we maintain are crucial to our nation's defense, it is imperative that you maintain detailed documentation of all maintenance actions performed on each missile and its support equipment. There are various methods used to document the maintenance or other activities performed in the missile organization. Each document method used has a purpose and is important to the life cycle of the weapon. Maintenance data collection creates a record of all actions performed on a system, component, vehicle, or piece of equipment and allows us to track those maintenance activities. Certain data types can actually show a status of the system which allows management to be more effective in the decision making process. Normally maintenance data collection is completed by using the applicable forms, tags, and most importantly, the IMDS that was discussed earlier in this unit.

#### Purpose

The data provided to the maintenance data collection system is collected through the maintenance data documentation (MDD) process which provides maintenance managers at all levels with information on jobs performed by each organization or work center. The organization can plan, project, schedule, and control parts and equipment as required. Most of the data to be obtained for statistical studies comes from this system and makes it possible to identify problem areas. Management actions can then be effectively exercised to meet and support established operation and maintenance requirements. Now, let us take a look at the importance of MDD and how the process works.

#### Process

The MDD process is described as a system with collection, storage, and retrieval processes. These processes provide the data collection and monitoring of maintenance discrepancies, allow short- and long-term (historical) storage of data, and provide a hard-copy retrieval of data through user inquiry. TO 00-20-2, *Maintenance Data Documentation*, the AFI 21 series, system user manuals, and MAJCOM implementing directives contain rules and procedures concerning data management.

The MDD process serves as the primary source of information for configuration status accounting and is used at all levels of management to do the following:

- a. Identify equipment configuration.
- b. Assure completion of time compliance technical orders (TCTO).
- c. Project workload and scheduling requirements.
- d. Provide digital historical records for designated equipment.

The MDD process allows for the documentation of production data into one of *two* categories: Data that describes maintenance performed *on end* items of *equipment* (i.e., missile) is categorized as *on-equipment*.

- f. Data documented to describe maintenance performed on assemblies, subassemblies, or components *removed from an end* item of *equipment* are described as *off-equipment*.

By documenting within the appropriate categories, both on-base and off-base users will have available data that fully describes where, when, what, and how maintenance production resources are used.

**AFTO Form 350 “Tags”**

AFTO Form 350, Reparable Item Processing Tag, or “tags” (fig. 1–20) as we like to call them, is one of the primary tags you’ll use. It is a two-part form required for items removed from operational use for the purpose of maintenance shop processing. Part I of AFTO Form 350 is the repair-cycle processing tag; Part II serves as the production-scheduling document. A completed AFTO Form 350 serves to identify the origin of an item and contains key data elements needed to document shop actions. Figure 1–20 illustrates a typical AFTO Form 350 tag that is filled out.

**FRONT**

**BACK**

1. JOB CONTROL NO. 110190001		2. ID/SERIAL NO. A0941		3. TM B	3A. BRD	4. WHEN DMC F
5. HOW MAL 381	6. WOB T38B	7. WORK UNIT CODE 13231	8. ITEM OPER TIME	9. QTY 01		
10. FSC 1650		11. PART/LOT NUMBER 243090-501				
12. SERIAL NUMBER 3676		13. SUPPLY DOCUMENT NUMBER				
14. DISCREPANCY						
<b>FRONT</b>						
Pipe Pusher leaking hydraulic fluid						
15. SHOP USE ONLY						
15A. DMIC/ACT ID		15B. SHOP ACTION TAKEN				
TAG NO. 089692		AFTO 350 PT. I				
16. SUPPLY DOCUMENT NUMBER						
17. NOMENCLATURE Pipe pusher						
18. PART NUMBER 243090-501		18A. WORK UNIT CODE 13231				
19. NIK 1650-00-123-4567						
20. ACTION TAKEN R	21. QTY 01	22. RPC USE ONLY				
TAG NUMBER 089692		AFTO 350 PT. II				

23. NSN		34. BRAN CODE		
25. TRANSPORTATION CONTROL NUMBER				
STATUS CHANGED TO				
26. SERVICEABLE				
27. CONDEMNED				
<b>BACK</b>				
28. SUPPLY INSPECTOR'S STAMP				
29. BASE REPAIR CYCLE DATA		YR	JULIAN DATE	TIME
DATE REMOVED	REC'D BY RPC			AWW
TO:				AWP
TO:				
DATE COMPLETED				

Figure 1–20. AFTO Form 350.

The 350 tag will be placed on all components removed from a missile or support equipment and will always be filled out with a pencil. If you ever have questions while filling out the AFTO Form 350 Tag, refer to TO 00-20-2, *Maintenance Data Documentation*, for information on how to properly fill it out.

### Condition tags

Condition tags are used to display the status of a component or piece of equipment to which they are attached. These tags allow easy identification of items and allow the technician to distinguish between unserviceable and serviceable components and equipment. They are light card stock tags or self-adhesive labels for easy attachment to equipment or cartons. Each item condition classification is indicated by a different color tag for easy recognition at a glance. The three condition tags that you should be familiar with are as follows:

#### DD Form 1574

Use the *yellow* DD Form 1574, Serviceable Tag-Materiel, on all new property, on serviceable property, on serviceable property in storage, and on property that has been repaired for turn-in to supply (fig. 1-21).

<b>WARNING</b> Unauthorized persons removing, defacing, or destroying this tag may be subject to a fine of not more than \$1,000 or imprisonment for not more than one year or both. (18 USC 1361)	<b>FSN, PART NO. AND ITEM DESCRIPTION</b> 1450-00-112-2633 VQDXEA323 Support AFT Section Re-Entry System		<b>SERVICEABLE TAG-MATERIEL</b>	
			<b>NEXT INSPECTION DUE/OVER-AGE DATE</b> N/A	<b>CONDITION CODE</b> A
			<b>INSPECTION ACTIVITY</b> FB4417/HMXS	
	<b>SERIAL NUMBER/LOT NUMBER</b> 3265478	<b>UNIT OF ISSUE</b> EA	<b>INSPECTOR'S NAME OR STAMP AND DATE</b> SSgt Fivelevel/s. Fivelevel 12/02/18	
	<b>CONTRACT OR PURCHASE ORDER NO.</b>	<b>QUANTITY</b> 1		
	<b>REMARKS</b> SERVICEABLE UN-USED			

Figure 1-21. DD Form 1574.

#### DD Form 1577-2

Use the *green* DD Form 1577-2, Unserviceable (Reparable) Tag-Materiel, on property that is more economical to repair than to replace (fig. 1-22).

<b>WARNING</b> Unauthorized persons removing, defacing, or destroying this tag may be subject to a fine of not more than \$1,000 or imprisonment for not more than one year or both. (18 USC 1361)	<b>FSN, PART NO. AND ITEM DESCRIPTION</b> 1450-00-111-1440 VQDXE0307 FWD Shroud Support Section		<b>UNSERVICEABLE (REPARABLE) TAG-MATERIEL</b>	
			<b>INSPECTION ACTIVITY</b> FB4417/HMXS	<b>CONDITION CODE</b> F
			<b>REASON OR REPAIRABLE CONDITION</b> Broken Bracket	
	<b>SERIAL NO./LOT NO.</b> AEM-0392	<b>UNIT OF ISSUE</b> EA	<b>REMOVED FROM</b> 69A8284	
	<b>CONTRACT OR PURCHASE ORDER NO.</b>	<b>QUANTITY</b> 1	<b>INSPECTOR'S NAME OR STAMP AND DATE</b> SSgt Fivelevel/s. Fivelevel 12/02/18	
	<b>REMARKS</b> NRTS 1			

Figure 1-22. DD Form 1577-2

You will need to fill out the DD Form 1577–2, Unserviceable (Reparable) Tag-Materiel, and attach it to an unserviceable asset when an item is coded as not reparable this station (NRTS). If an item has a low and/or no percentage of base repair (PBR), it is determined to be NRTS and is considered NRTS 1. The “1” signifies the Action Taken Code, which means the asset is to be shipped back to the applicable depot for repair.

### DD Form 1577

Use the *red* DD Form 1577, Unserviceable (Condemned) Tag-Materiel, on property that is worn or damaged beyond economical repair. If this tag is placed on an item, the item must not be used for any reason (fig. 1–23).

<small>WARNING: Unauthorized persons removing, defacing, or destroying this tag may result in a court-martial, a fine of up to \$1,000 or imprisonment for not more than one year or both. (18 USC 1381)</small>	<b>FSN, PART NO. AND ITEM DESCRIPTION</b> 4935-01-218-1917 VQDXEAS65 Cable Adapter Set		<b>UNSERVICEABLE (CONDEMNED) TAG-MATERIEL</b>	
	SERIAL NUMBER/LOT NUMBER		INSPECTION ACTIVITY FB4417/HMXS	CONDITION CODE H
	UNIT OF ISSUE EA		REASON OR AUTHORITY Broken Connector Pins	
	QUANTITY 1		INSPECTOR'S NAME OR STAMP AND DATE SSgt Fivelevel/S. Fivelevel 12/02/18	
	REMARKS <h1 style="text-align: center;">NRTS 9</h1>			

Figure 1–23. DD Form 1577.

You will need to fill out the DD Form 1577, Unserviceable (Condemned) Tag-Materiel, and attach it to the unserviceable asset when it is not backshop reparable. These assets are not reparable by AFREP or other backshops so they are considered NRTS 9. Once an asset is turned in with a red tag, it is considered condemned and taken to the Defense Logistics Agency Disposition Services (DLADS), formerly known as the Defense Reutilization Management Office (DRMO) to be properly disposed of.

All three supply condition tags are filled out in basically the same way. Refer to TO 00–20–3, *Maintenance Processing of Repairable Property and the Repair Cycle Asset Control System*, for detailed instructions on completing the condition tags and selecting the proper condition codes.

### Data accuracy

Because of the many uses of the MDD process, the system relies on accurate data. Many times you are the first link in making sure the data is correct. It is the responsibility of each performing workcenter supervisor to ensure completeness and accuracy of all maintenance documentation. Keep in mind that if you put garbage in, our units will pull garbage out.

## Self-Test Questions

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

### 209. Deficiency reporting

1. What is the primary purpose of the deficiency report system?
  
2. What is an example of a defect or design flaw?

3. Why is it important to perform an acceptance inspection on newly received equipment?
4. Describe the difference between a critical defect and a major defect?
5. What type of deficiency can *only* be corrected through a design or specification change?
6. Give an example of a product quality deficiency.
7. Explain how you would determine which category to report a deficiency.
8. Why is it critical for a technician who discovered the deficiency to generate the report?

#### **210. Integrated Maintenance Data System**

1. What does IMDS data translate into for commanders and managers?
2. What IMDS function allows you to enter new data or change existing data?
3. What are the two types of retrievals that the IMDS information retrieval function provide?
4. What IMDS subsystem allow users to document, inquire, and retrieve information on maintenance actions?
5. What are the three phases of the IMDS Operational Events subsystem?
6. What IMDS subsystem is commonly used to schedule shotgun qualification training?
7. Who is responsible for reviewing IMDS data on a daily basis?

**211. Maintenance data collection**

1. What does the maintenance data collection process create?
2. How is data provided to the maintenance data collection system?
3. What does a completed AFTO Form 350 tag identify?
4. What are condition tags used for?
5. Explain when each of the following forms are used:

(1) DD Form 1574.

(2) DD Form 1577-2.

(3) DD Form 1577.

**1-4. Weapon Safety**

Most of the world's population realizes the severe consequences of a nuclear war. Just as important as the capability to deliver these nuclear devices is the necessity for an effective nuclear safety program. Nuclear weapons are a status symbol of a nation's power and are given due respect. Thus, more people and nations have become involved in nuclear weapons activities. As the scope of these activities broadened, more people were included to oversee them, creating the need for an effective, widespread nuclear safety program. The political ramifications (national and international) of a nuclear accident make effective nuclear control and safety paramount in preventing nuclear mishaps. In our discussion on weapon safety, you will learn the process of how to identify nuclear certified equipment and the weapon system safety rules that we must constantly be alert to prevent an accident or incident.

**212. Nuclear-certified equipment**

The Air Force nuclear safety certification program evaluates hardware, software, and procedures against specific nuclear safety criteria before use with nuclear weapons. The program's goal is to prevent nuclear weapon accidents and incidents. The Air Force Nuclear Certification Program ensures all procedures, equipment, software, facilities, personnel, and organizations are certified before conducting nuclear operations with nuclear weapons or nuclear weapon systems. Nuclear certification of a unit occurs when the Air Force determines that personnel trained on certified procedures, using

certified equipment and software, in certified facilities have demonstrated the capability to take on or resume a nuclear mission. The Nuclear Weapons Directorate is responsible for listing certified items and usage restrictions on the internet-based master nuclear certification list (MNCL). In-depth analysis and testing goes into designing and developing nuclear certified equipment to provide safety, security, and control across the nuclear enterprise. In this lesson, we will focus on the MNCL, the process of identifying nuclear certified equipment, and some of the restrictions and modifications associated with certified equipment.

### **Master nuclear certification list**

Perhaps you spent some time in a shop like vehicles and equipment where you assisted an MMT team verifying the equipment on their payload transporter against a load-list. You may have noticed the team using a separate list verifying equipment such as “blue gear” which consists of the RS aft ring and RS sling rods, just to name a few. These items are all considered nuclear certified and must be verified before each use to ensure there has not been a restriction placed on the items since last verified. If you recall, this separate list is called a MNCL, and the purpose of a MNCL is to provide an itemized list of all Air Force equipment, hardware, and software that is nuclear designed safety certified and authorized for use with nuclear weapons in accordance with Air Force Instruction (AFI) 63-125, *Nuclear Certification Program*. Nuclear design safety certified or approved items can be added to the MNCL only by HQ Air Force Safety Center Weapons Division (AFSC/SEW) through the Nuclear Weapons Directorate. Changes to the MNCL are completed *only* after evaluation by the proper engineering command. Deficiencies discovered on items listed are reported in accordance with AFI 91-204, *Safety Investigations and Reports*.

The Web-based MNCL is an excellent tool that provides users with rapid updates and changes. Since the MNCL can change on an almost daily basis, we must check it far more frequently than the old hard copy technical order. The MNCL has an automatic search function which allows you to enter nomenclature or national stock number (NSN) to rapidly find equipment and status. It also has a separate function that allows you to search for recent changes.

The general guidance section of the Web site gives general and specific requirements concerning nuclear certified equipment. It also defines common terms, and lists certain items that do and do not require certification. Review this section on the website before using the MNCL.

### **Positive identification**

Before you use any test and handling equipment with nuclear weapons, you must *first* verify it using the MNCL. If the piece of equipment is not listed, do *not* use this equipment with nuclear weapons. Make positive identification by a nameplate, label, appropriate markings, or by official documents. If a discrepancy (for example, characters do not match) exists with any element of the item identification in the MNCL, the item is considered not certified until the discrepancy can be resolved. However, the absence of a data element on the nameplate or label, when all other identifying elements are correct, does not constitute a discrepancy. The MNCL is the sole authority for determining certification status; therefore, no certified item is stamped, etched, painted, or similarly marked on the item structure or data plate to show that it is nuclear certified. Nuclear load restrictions may be marked where appropriate, but you cannot use the marking to verify certification status.

If you do not know the category of the specific item you are searching for, use the MNCL search engine. The search engine is global and queries the entire database by using two methods: keyword search or data range search. Each of these search methods can be performed independently or simultaneously to pinpoint the specific item you are looking for.

Report shows the following identification elements for the item requiring verification (fig. 1-24):

- a. Nomenclature is the name of the item.
- b. Hardware type is the category in which the item is organized under (i.e., subcomponent, support equipment, munitions handling equipment, test equipment, etc.) to show its relationship to the certified item.
- c. Model number is a combination of letters, numbers, and/or characters assigned by the manufacturer to identify the unit as a whole (i.e., A/M 32A-47D, MAU-191/A, etc.).
- d. National item identification number (NIIN) is the last nine digits of the NSN.
- e. Part number is a combination of letters or numbers to specifically identify a whole unit or individual pieces of a whole unit.
- f. Remarks block is reserved for any pertinent information concerning the certified item.
- g. Restrictions are imposed limits in which the certified item can or cannot function under.
- h. Cert Status is the certification status of the item as either “nuclear” (item completed all nuclear certification requirements) or “design” (item has been successfully design certified but has not completed its operational certification requirements and therefore is restricted from nuclear operations).



## USAF Master Nuclear Certification List

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE

### ICBM Hardware

WEAPON SYSTEM	NOMENCLATURE ▲	HARDWARE TYPE	MODEL NUMBER	NIIN	PART NUMBER	CERT STATUS	CRITICAL	Last UPDATED
MINUTEMAN A/M	SEMITRAILER, PAYLOAD TRANSPORTER, TYPE III	ICBM SUPPORT EQUIPMENT	A/M 32A-47D	01-362-8488	882T0000000-020	NUCLEAR	NO	31 Jul 2012
<b>REMARKS:</b> ITEMS WITH ID PLATES SHOWING PART NUMBER 04236/882T0000000-020 ARE AUTHORIZED. ITEMS WITH ID PLATES SHOWING MODEL NUMBER A/M32A-47D ARE AUTHORIZED. MODIFIED RIGHT SIDE ENVIRONMENTAL FLAP (PART NUMBER 200925021) IS AUTHORIZED FOR USE AT VANDENBERG AFB, LF-10 ONLY.								
<b>RESTRICTIONS:</b> REG NUMBERS 93W00008 AND 93W011 ARE NOT AUTHORIZED. PSRE AND RV WILL NOT BE TRANSPORTED TOGETHER.								
MINUTEMAN A/M	SEMITRAILER, PAYLOAD TRANSPORTER, TYPE III	ICBM SUPPORT EQUIPMENT	A/M 32A-47D	01-362-8488	882T0000000-021	NUCLEAR	NO	31 Jul 2012
<b>REMARKS:</b> ITEMS WITH ID PLATES SHOWING PART NUMBER 04236/882T0000000-021 ARE AUTHORIZED. ITEMS WITH ID PLATES SHOWING MODEL NUMBER A/M32A-47D ARE AUTHORIZED. TCTO 36A9-8-58-508 ACCOMPLISHED. MODIFIED RIGHT SIDE ENVIRONMENTAL FLAP (PART NUMBER 200925021) IS AUTHORIZED FOR USE AT VANDENBERG AFB, LF-10 ONLY.								
<b>RESTRICTIONS:</b> REG NUMBERS 93W00008 AND 93W011 ARE NOT AUTHORIZED. PSRE AND RV WILL NOT BE TRANSPORTED TOGETHER.								

Figure 1-24. MNCL.

### Restrictions

Items listed in the MNCL may have restrictions placed against the system or fleet. System restrictions will be clearly marked and readily identifiable in the MNCL listing. A specific nuclear certified item may be restricted from use with nuclear weapons at any time and for any reason, e.g., damage,

modification, or changes to intended usage. Such restrictions do not constitute removal of nuclear certification or system decertification. The restriction is placed to preclude use of a particular item with nuclear weapons. Again, such restrictions will be clearly marked in the MNCL listing under the restrictions block for that particular item and reflect individual item identification information (e.g., item serial number). As you can see in the example shown in figure 1-25, the payload transporter semitrailer is authorized for nuclear certified operations, with the exception of one restriction—PTs 93W00008 & 93W011 are not authorized to transport the Propulsion System Rocket Engine (PSRE) and reentry vehicle (RV) together.

WEAPON SYSTEM	NOMENCLATURE	HARDWARE TYPE	MODEL NUMBER	NIIN	PART NUMBER	CERT STATUS	CRITICAL	Last UPDATED
MINUTEMAN A/M	SEMITRAILER, PAYLOAD TRANSPORTER, TYPE III	ICBM SUPPORT EQUIPMENT	A/M 32A-47D	01-362-8488	882T0000000-020	NUCLEAR	NO	31 Jul 2012
<p><b>REMARKS:</b> ITEMS WITH ID PLATES SHOWING PART NUMBER 04236/882T0000000-020 ARE AUTHORIZED. ITEMS WITH ID PLATES SHOWING MODEL NUMBER A/M32A-47D ARE AUTHORIZED. MODIFIED RIGHT SIDE ENVIRONMENTAL FLAP (PART NUMBER 200925021) IS AUTHORIZED FOR USE AT VANDENBERG AFB, LF-10 ONLY.</p>								
<p><b>RESTRICTIONS:</b> REG NUMBERS 93W00008 AND 93W011 ARE NOT AUTHORIZED. PSRE AND RV WILL NOT BE TRANSPORTED TOGETHER.</p>								

Figure 1-25 MNCL Restrictions.

## Modifications

Modifications include all physical and/or functional configuration changes or new uses to existing nuclear design certified items. Air Force policy requires all modifications to certified items be identified to the air logistics complex item manager. Minor modifications to nonspecialized equipment (e.g., trucks, semi-tractors, trailers, hoists, and cranes) may not require formal certification providing the equipment is still used for its original purpose and the changes are approved by the operational major command (MAJCOM). Do not perform *ANY* modifications to nuclear-certified equipment without proper approval.

### 213. Nuclear weapon system safety rules

When it comes to intercontinental ballistic missiles (ICBM), *safety* is job one! That cliché is old but is the most important lesson you'll ever learn. You have an inherent responsibility to perform your work as safely as possible. Your life and the lives of your fellow workers depend on it. To do your day-to-day work safely, you must understand nuclear weapons require special safety considerations due to the weapons' unique destructive power and the catastrophic consequences of an accident or unauthorized act. These special safety considerations are known as *Weapon System Safety Rules* (WSSR) and are contained in the AFI 91-100 series of publications.

The WSSR fall under the Department of Defense (DOD) Nuclear Weapon System Safety Program. These rules are procedural safeguards that apply to operations with nuclear weapons and nuclear weapon systems. WSSR fall into two categories: general and specific. General safety rules primarily apply broad safety policy, are published in every WSSR manual, and apply at *all* times—even during war. Specific WSSR are ones written for specific weapon systems and may include rules related to design, security, operational and administrative controls, and technical procedures. Unlike the general rules, commanders may deviate from specific rules *in an emergency*. Each of these categories will be explained in more detail soon. We adhere strictly to these rules to protect the weapon system, maintain the public's trust by protecting their health, safety, and the environment.

**NOTE:** Because a nuclear weapon is in DOD custody for the majority of its lifetime, the DOD is responsible for a wide range of operational requirements, including accident prevention and response.

## Nuclear weapon system safety rules

Before we begin our discussion on WSSR, you must first understand the nuclear surety program which these safety rules are derived from. Four surety standards listed in AFI 91-101, *Air Force Nuclear Weapons Surety Program*, form the basis for our entire nuclear surety stance. The personnel reliability program, two person concept policy, how we store, transport, troubleshoot, maintain, and deliver weapons, the communications and security we employ to safeguard nuclear weapons all have their roots in the four DOD standards. Because the various operations involving nuclear weapon systems are much broader than just safety, we refer to them collectively as *nuclear surety*. The main purpose of the AF nuclear weapons surety program is to achieve *maximum* safety consistent with operational needs to prevent zero accidental or unauthorized nuclear weapon detonations. The four DOD surety standards state that there will be positive measures to ensure the following:

- Ensure adequate security of nuclear weapons, pursuant to the requirements of DOD Directive 5210.41, *Security Policy for Protecting Nuclear Weapons*.
- Prevent nuclear weapons involved in accidents or incidents, or jettisoned weapons, from producing a nuclear yield.
- Prevent *inadvertent* pre-arming, arming, launching, or releasing of nuclear weapons in all normal and abnormal environments.
- Prevent *deliberate* pre-arming, arming, launching, or releasing of nuclear weapons, except upon execution of emergency war orders or when directed by competent authority.

Now that you have an overview of the DOD surety standards, let us focus our attention on the safety rules derived from these standards. It is mandatory to follow these safety rules at all times when a nuclear weapon system is involved. The *general WSSR* must be followed at all times, even during war, and are outlined as follows:

- Nuclear weapons will not be intentionally exposed to abnormal environments unless in an emergency.
- Nuclear weapons will not be used for training or for troubleshooting unless allowed by a specific safety rule.
- Do not use nuclear weapons to troubleshoot equipment faults. Use only equipment (e.g. hardware, software, etc.), procedures, and checklists that are consistent with USAF-approved publications for any operation directly associated with nuclear weapons.
- Nuclear weapons may be used for exercises except when explicitly prohibited by specific safety rules.
- Only certified procedures, personnel, equipment, facilities, and organizations, authorized by the appropriate level of authority will be used to conduct nuclear weapon system operations.
- The total number of personnel performing nuclear weapon system operations will be the minimum necessary to safely and correctly conduct the operation).
- 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 and take appropriate action. They must also have knowledge of and understand applicable safety and security requirements.
- Personnel that have physical access to nuclear weapons must be qualified under the personnel reliability program (PRP).
- Physical security of nuclear weapons will be maintained, in accordance with DOD directives.
- Nuclear weapons will be transported as determined by the combatant commander or the Military Department, in accordance with DOD directives.
- Movement(s) will be kept to the minimum necessary to conduct the operation.

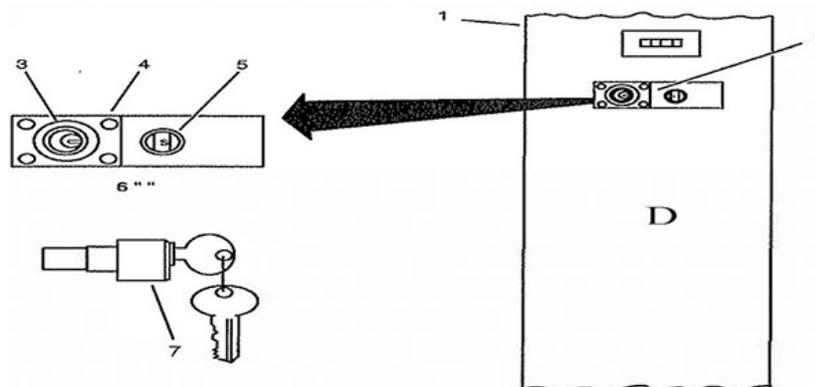
- Nuclear weapons will not be expended unless a valid, properly authenticated nuclear control order conveying release or expenditure authority is received.
- A commander may deviate from a specific rule in an emergency. An emergency is defined as "an unexpected occurrence or set of circumstances in which personnel or equipment unavailability, due to accident, natural event, or combat, may demand immediate action that may require extraordinary measures to protect, handle, service, transport, jettison, or employ a nuclear weapon".

Remember, the AFI 91-100 series publications include the WSSRs for all nuclear operations and they are your reference to ensure you never find yourself in violation of these vital safety rules. Nuclear weapons are a powerful, dangerous asset that we as missile maintainers are privileged to handle. It is your responsibility to follow these rules and others during all nuclear weapon operations.

### Specific WSSR—Operations involving maintenance on an assembled weapon system

AFI 91-114, *Safety Rules for the Intercontinental Ballistic Missile System*, contains the *specific* WSSR for ICBMs and is an instruction you should become more familiar with as you move up in rank and responsibility. Though AFI 91-114 contains numerous specific WSSR, one WSSR you should become very familiar with relates to operations involving maintenance on an assembled weapon. It is extremely important that as soon as possible after entering the LER, the LF's safety control switch (SCS) is manually safed. This is done by installing and locking the SCS lock pin assembly and then removing the key (fig. 1-26). Installing the SCS lock pin assembly opens, or interrupts, electrical circuits leading to critical ordnance devices on the missile and in the launcher. When switched to the SAFE position, the SCS interrupts the following functions:

- Arming of safe-and-arm and arm-disarm devices.
- First stage rocket motor ignition.
- Launcher closure ballistic gas generator functions.
- Articulating arm explosive bolt functions.



- LEGEND
1. LAUNCHER DISTRIBUTION BOX
  2. SAFETY CONTROL SWITCH
  3. RECEPTACLE
  4. SAFETY CONTROL SWITCH HOUSING
  5. SAFE-ARM INDICATOR
  6. KEY
  7. LOCKPIN ASSEMBLY

Figure 1-26. Safety control switch lock pin assembly.

The SCS lock pin assembly is kept in the LF launch support building (LSB) on a day-to-day basis while the LF is unmanned. If the LER needs to be penetrated, a member of the team, usually the team chief, will carry the SCS lock pin assembly until it is time to “safe” the missile. The SCS lock pin is then inserted into the distribution box in the LER. Once it is time to exit the LER, one of the final steps is to remove the SCS lock pin assembly from the distribution box. When the LF is unmanned, the SCS lock pin assembly is then placed back in the LSB to be used again the next time the LER must be penetrated.

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## Self-Test Questions

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

### 212. Nuclear-certified equipment

1. What is the purpose of a master nuclear certification list?
  
2. How do you positively identify a nuclear certified item?
  
3. What action must you take if a discrepancy exists with any element of the item identification in the MNCL?
  
4. Match the following terms in column A with the appropriate definition in column B. Each item in column A can only be used once.

#### *Column A*

- \_\_\_\_ (1) The last nine digits of the NSN.
- \_\_\_\_ (2) The name of the item.
- \_\_\_\_ (3) Reserved for pertinent information.
- \_\_\_\_ (4) Category in which the item is organized under to show its relationship.
- \_\_\_\_ (5) Imposed limits in which the certified item can or cannot function under.
- \_\_\_\_ (6) Combination of letters, numbers, and/or characters assigned by the manufacturer to identify the unit as a whole.
- \_\_\_\_ (7) Is either identified as “nuclear” or “design.”
- \_\_\_\_ (8) Combination of letters or numbers to specifically identify a whole unit or individual pieces of a whole unit.

#### *Column B*

- a. Cert Status.
- b. Hardware type.
- c. Model number.
- d. NIIN.
- e. Nomenclature.
- f. Part number.
- g. Remarks.
- h. Restrictions.

**213. Nuclear weapon system safety rules**

1. What ensures personnel design and operate nuclear programs and nuclear weapons systems to satisfy the safety standards in the Department of Defense?
2. What shall never be used for training or troubleshooting?
3. Which program must personnel be qualified under before having physical access to nuclear weapons?
4. Which AFI series covers WSSRs for all nuclear operations and serves as reference to ensure these rules are not violated?

---

**Answers to Self-Test Questions**

**201**

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

**202**

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. The air is very thin high up in the atmosphere.
7. The protection of the facility, soil, and the seals and blast valves.
8. The size of the weapon, the altitude of the detonation, and the type and condition of the soil.

**203**

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 extra 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.

**204**

1. 10 spring-type shock absorbers.
2. To dampen horizontal movement of the shock-isolated floor, and to provide a walking surface for personnel.
3. In case of an emergency affecting the shock isolator air compressor.
4. Vertical movement.
5. An overpressure.

**205**

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.

**206**

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 which can result in a broken conductor or shielding

**207**

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 attachment points to permit a full range of shock-mounted movement without overstressing the line or clamps.
6. Shock, vibration, and air-blast.
7. It must be replaced with identical items or authorized equivalents.

**208**

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.

**209**

1. To provide deficiency data on hardware, software, mission-critical computer systems, vehicles, clothing, and other government acquired equipment.
2. Deficiency.
3. To determine the condition of newly received equipment and to determine the ability of the item to perform its designed function.
4. An item with a critical defect results in a hazardous or unsafe condition. A major defect is likely to result in failure or reduces the usability of an item for its intended purpose.
5. Design deficiencies.
6. This is when you install or use a brand new component or equipment item and it fails right away or fails within its warranty service period.
7. A deficiency that may cause death or severe injury will be reported as a Category I. Therefore, if a deficiency affects an essential capability or negatively impacts operational safety will be reported as a Category II.
8. The originator is the one responsible for identifying and assessing the deficiency, securing the exhibit, therefore, provides all available details as requested.

**210**

1. How many personnel are needed to do the job, what high-failure parts are needed to keep on hand, and/or what systems are outdated and need upgrade.
2. Database updates.
3. Real-time and background retrievals.
4. Job Data Documentation (JDD).
5. Mission Recording, Mission Accomplishment, and Analysis Phase.
6. Training Management.
7. Workcenter supervisors.

**211**

1. A record of all actions performed in the missile organization and allows us to track each maintenance activity performed on missile and/or support equipment.
2. It is collected through the maintenance data documentation process.
3. The origin of an item and contains key data elements needed to document shop actions.
4. To display the status of a component or piece of equipment to which they are attached.
5.
  - (a) These forms are used to identify the serviceability on all new property.
  - (b) These forms indicate if an unserviceable item or component is more economical to repair than to replace.
  - (c) These forms indicate if an unserviceable item or component is damaged beyond economical repair.

**212**

1. To provide an itemized list of all Air Force equipment, hardware, and software that is nuclear designed safety certified.
2. Nameplate, label, appropriate markings, or by official documents.
3. The item is considered not certified until the discrepancy can be resolved.
4.
  - (1) d.
  - (2) e.
  - (3) g.
  - (4) b.
  - (5) h.
  - (6) c.
  - (7) a.
  - (8) f.

**213**

1. The Air Force nuclear weapons surety program.
2. Nuclear weapons.
3. PRP.
4. The AFI 91-100 series.

**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. (201) What is the period called in which the critical functions of the facility are maintained in a state of readiness without dependence on normal environment control support?
  - a. Emergency survival.
  - b. Extended survival.
  - c. Hardness-critical.
  - d. Mission-critical.
2. (201) Those functions which must occur between the time the initial launch command is initiated and when the missile exits the launch tube is called
  - a. mission-essential.
  - b. hardness-critical.
  - c. launch-essential.
  - d. survival-critical.
3. (201) What would be an example of a hardness-critical item that protects other equipment performing a hardness-critical function?
  - a. Shock isolators.
  - b. Reentry system.
  - c. Ordnance interlocks.
  - d. Cryptographic equipment.
4. (202) A large percentage of the energy from a nuclear detonation results in
  - a. electromagnetic pulse.
  - b. nuclear radiation.
  - c. air blast effects.
  - d. heat and light.
5. (202) Which characteristic greatly influences electromagnetic pulse (EMP) at the launcher and launcher equipment room (LER) liner?
  - a. Boron content of the soil.
  - b. Conduit shielding.
  - c. Gravitational pull.
  - d. Temperature.
6. (202) 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. Electromagnetic burst.
7. (202) 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.

- 
- 
8. (203) The missile suspension and alignment system protects the missile from
    - a. air blast.
    - b. heat and light.
    - c. overpressures.
    - d. ground shock.
  9. (203) What provides protection to the launch control center (LCC) from acoustic effects?
    - a. Blast door.
    - b. Liquid springs.
    - c. Shock-isolators.
    - d. Tunnel junction.
  10. (203) What circuit protection holds the operations of a mission-critical circuit in a known operating mode until after an electromagnetic pulse or radiation has subsided?
    - a. Radiation filters.
    - b. Circumvention/reset.
    - c. Electrical surge arresters.
    - d. Transient response improvements.
  11. (203) The launcher closure provides protection from nuclear radiation by its mass and the boron content of its
    - a. soil.
    - b. steel.
    - c. concrete.
    - d. insulation.
  12. (204) In a Wing 3 or 5 launch support building (LSB) what keeps the suspended floor from striking the LSB walls in a ground shock environment?
    - a. Rubber pad-type shock mounts.
    - b. Spring-loaded hanger supports.
    - c. Flexible hoses and conduits.
    - d. Shock attenuators.
  13. (204) What facility is *not* hardened against a ground shock environment?
    - a. Wing 3 launch control center.
    - b. Wing 1 launch support building.
    - c. Wings 3 or 5 launch support buildings.
    - d. Wing 5 launch control equipment building.
  14. (204) What type of shock isolators do the Wing 3 and 5 launch control centers (LCC) use?
    - a. Air-filled spring.
    - b. Air-filled pendulum.
    - c. Leaf spring hydraulic.
    - d. Liquid-filled pendulum.
  15. (205) What do penetrating lines act as to direct an electromagnetic pulse (EMP) into the launch control center?
    - a. An insulator.
    - b. An antenna.
    - c. A switch.
    - d. A probe.

16. (205) What provides electromagnetic pulse (EMP) isolation between the launch tube and launch equipment room (LER)?
  - a. Launcher closure door.
  - b. Support equipment bonding.
  - c. Lightning protection system.
  - d. Rattle space screen and steel bellows.
17. (205) 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.
18. (206) Which is *not* a basic rule for preserving hardness?
  - 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 (MMOC) 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.
19. (206) When replacing damaged or corroded fasteners, where would you find what the exact duplicate or authorized equivalent part is?
  - a. Illustrated parts breakdown (IPB).
  - b. Contractor maintenance data (CMD).
  - c. Integrated Maintenance Data System (IMDS).
  - d. Missile maintenance operations center (MMOC).
20. (206) Weapon system components have paths that are intentionally built with the minimal resistance to what to protect against the effects of electromagnetic pulse (EMP)?
  - a. Electrical surge arrestors.
  - b. The launch tube liner.
  - c. Carbon block filters.
  - d. The ground.
21. (206) What should you do first, prior to replacing or repairing bonding or grounding connections?
  - a. Strip off all conductive finishes.
  - b. Remove cadmium or zinc plating.
  - c. Remove foreign matter from the areas to be bonded.
  - d. Clean area so it is slightly smaller than the contact area.
22. (207) Which is *not* expected to reduce when hard-mounted equipment is mounted directly to a facility structure?
  - a. Radiation particles.
  - b. Heat and light energy.
  - c. Electromagnetic pulses.
  - d. Shock and vibration loads.

- 
- 
23. (207) How is installed equipment that is generally considered to be fragile or of high value to the weapon system installed?
- Hard-mounted.
  - Strap-mounted.
  - Shock-mounted.
  - Shock-loop mounted.
24. (207) Who can provide technical assistance for all installation hardware or maintenance requirements *not* specifically covered in technical orders (TO) or civil engineering manuals (CEM)?
- Nuclear weapons center.
  - Maintenance team chief.
  - Ogden Air Logistics Complex.
  - Missile combat crew.
25. (208) The purpose of the metal mesh portion of a radio-frequency interference gasket is to
- provide electrical conductivity between the panel and cabinet mating surfaces.
  - provide electrical insulation between the panel and cabinet mating surfaces.
  - provide structure and support to the foam rubber conductor.
  - prevent scuffing of the panel and cabinet mating surfaces.
26. (208) What tool should be used when performing radio-frequency interference (RFI) gasket inspections?
- Caliper.
  - Multimeter.
  - Torque wrench.
  - Magnifying glass.
27. (208) When installing an electrical surge arrester (ESA) vault radio-frequency interference (RFI) gasket, what percentage of the gasket's width must be in contact with the hatch cover?
- 100.
  - 75.
  - 25.
  - 10.
28. (209) Which deficiency report classification would be appropriate if the reported defect is likely to result in failure?
- Minor.
  - Major.
  - Critical.
  - Significant.
29. (209) Which is an example of a product quality deficiency?
- When a component is installed and fails right away.
  - When a component impacts the effectiveness of life cycle support.
  - When the government contracts an agency to develop a component that meets the safety requirements.
  - When judgment and experience indicate the component is likely to prevent performance of the strategic function.

30. (209) What deficiency report category is used for deficiencies that might hinder the maintenance process, but allows job completion?
- Major.
  - Critical.
  - Category I.
  - Category II.
31. (209) What step in the deficiency reporting process reviews deficiency reports for proper categorization, validity, correctness of entries, and accuracy?
- Action point.
  - Support point.
  - Screening point.
  - Originating point.
32. (210) Which is *not* an objective of the Integrated Maintenance Data System (IMDS)?
- Provide more accurate maintenance data to develop concepts.
  - Eliminate and/or reduce nonproductive administrative tasks.
  - Eliminate and/or reduce maintenance related accident reporting.
  - Ensure materiel is serviceable, operable, and properly configured.
33. (210) Which operational event phase of the Integrated Maintenance Data System (IMDS) subsystem provides the capability for periodic reports of mission accomplishment?
- One.
  - Two.
  - Three.
  - Four.
34. (210) Which Integrated Maintenance Data System (IMDS) subsystem provides the capability to order parts for unscheduled discrepancies?
- Training management.
  - Maintenance personnel.
  - Job data documentation.
  - Base supply system interface.
35. (211) What process provides maintenance managers at all levels with information on jobs performed by each work center?
- Maintenance data delivery process.
  - Maintenance data condition process.
  - Maintenance data workload process.
  - Maintenance data documentation process.
36. (211) Which condition tag would you use on a piece of equipment that is considered condemned and *not* repairable?
- Red.
  - Blue.
  - Green.
  - Yellow.
37. (212) What web-based program provides the Air Force an itemized list of all nuclear certified equipment, hardware, and software that is authorized for use with nuclear weapons?
- Master nuclear command list.
  - Master nuclear certification list.
  - Master positive identification list.
  - Master nuclear qualifications list.

38. (212) What term is annotated in the cert status of the master nuclear certification list (MNCL)?
- Nuclear or design.
  - Certified or design.
  - Nuclear or uncertified.
  - Certified or uncertified.
39. (213) What is considered procedural safeguards that apply to operations with nuclear weapons and nuclear weapon systems?
- Nuclear related safety rules.
  - Intercontinental ballistic missile (ICBM) systems safety rules.
  - Weapon system surety rules.
  - Weapon system safety rules.
40. (213) What is the main purpose of the Air Force nuclear weapons surety program?
- To allow deliberate pre-arming, arming, and launching of a nuclear weapon.
  - To allow inadvertent pre-arming, arming, and launching of a nuclear weapon.
  - To achieve minimum safety consistent with operational needs to prevent zero accidents.
  - To achieve maximum safety consistent with operational needs to prevent zero accidents.
41. (213) How many authorized technicians must be present during any operation with a nuclear weapon?
- At least one authorized technician.
  - At least two authorized technicians.
  - A minimum of three authorized technicians.
  - A minimum of four authorized technicians.

## Student Notes

## Unit 2. Publications

<b>2-1. Standard Publications and Technical Orders.....</b>	<b>2-1</b>
214. Categories and types of standard publications.....	2-1
215. Description of the technical order system.....	2-3
216. Typical technical order format.....	2-8
217. Technical order improvement report .....	2-14
<b>2-2. Civil Engineering Manuals.....</b>	<b>2-20</b>
218. Description of civil engineering manuals .....	2-21
219. Format of civil engineering systems and equipment manuals .....	2-22
220. Civil engineering manual improvement report .....	2-29

**P**UBLICATIONS ARE the primary method the Air Force uses to document how the mission is, or should be, completed. Often, you unknowingly comply with requirements you have never personally read because your supervisor has instructed you to do so or you have been trained to do so. The direction you were provided most likely came from an Air Force publication on how something is, or should be, done. Compliance with publications and directions is a habit in the Air Force, but it is vital that you understand where this direction comes from as it can change frequently.

As you learned in your technical training, you cannot perform your duties as a technician without a technical order (TO) or a civil engineering manual (CEM), so it is very important that you learn to navigate your way through these publications to ensure you are doing your job safely and effectively. Through time, you will figure out that there are sometimes better ways of doing things than what the TO or CEM directs; however, you are bound to follow that direction in all circumstances. The only way to improve maintenance efficiency is to submit a TO or CEM improvement report.

This unit introduces you to standard publications and guides you through the Air Force’s TO system and CEM system. These lessons include the process of submitting a TO or CEM improvement report to help you make our publications better.

### 2-1. Standard Publications and Technical Orders

There are literally thousands of publications within the DOD and the Air Force. Most standard publications can be found at the click of a mouse, but the TO system is different. This section will familiarize you with standard publications and will examine the TO system and how a typical TO is laid out. This section concludes with a look at the TO improvement program.

#### 214. Categories and types of standard publications

All standard publications are divided into two main categories: *directive* and *nondirective*. This simply tells you whether a publication contains information that **MUST** be adhered to or whether the information is simply a guide or handbook on how to do something. We’ll break down each category then see how these publications are numbered to make it easier for you to find one of them. Most publications can be found on the Air Force publications website, so we will look at what that website offers.

#### Directive

Directive publications are those necessary to meet the requirements of safety, security, or other areas where common direction and standardization benefit the Air Force. Air Force personnel must comply with these publications as the heading of each of these publications normally contains the following statement: “COMPLIANCE WITH THIS PUBLICATION IS MANDATORY.”

### **Supplements**

Before we discuss other types of directive publications, it is prudent to discuss supplements first. Supplements are publications that extend or add material to other publications issued by higher headquarters or agencies. The key idea to remember about supplements is that they cannot contain guidance that is less restrictive than the parent publication they supplement. For example, AFI 36-2903, *Dress and Personal Appearance of Air Force Personnel*, requires you to wear an outer garment with a knit cap; local supplements cannot authorize you to wear a knit cap without an outer garment. Policy directives and memorandums *cannot* be supplemented.

### **Policy directives**

Air Force policy directives (AFPDs) are orders from the Secretary of the Air Force (SECAF) and contain directive policy statements to initiate, govern, and/or regulate actions within specified areas of responsibility or activities. The SECAF is the only approval authority for AFPDs and thus, they cannot be supplemented by subordinate units. An example of a policy directive is AFPD 21-1, *Maintenance of Military Materiel*. This AFPD simply establishes policy and assigns responsibilities for the maintenance of air and space equipment.

### **Policy memorandum**

The difference between an AFPD and an Air Force policy memorandum (AFPM) is simple—a memorandum is published when there is insufficient time to process a directive. These address critical issues such as national security or safety when action must happen immediately, but there is not enough time to finish the directive. AFPMs expire 180 days after publication, so an AFPD must be in development.

### **Instructions**

Air Force instructions (AFI) are what you will see most of the time. AFIs are orders from the SECAF and are certified and approved by Air Force headquarters staff. AFIs direct action, ensure compliance, and/or give detailed procedures to standardize actions across the entire Air Force. AFIs may be supplemented at any level; however, as you have learned, supplements can only make the AFI more restrictive. An example of an AFI is AFI 21-202, Volume 1, *Missile Maintenance Management*. It directs how missile maintenance is managed, and compliance with it is mandatory.

### **Manuals**

Air Force manuals (AFMAN) are usually extensions of AFIs, providing additional guidance for performing standard tasks, or supporting education and training programs. An AFMAN does *not* necessarily have to fall under an AFI, and can stand alone. A good example is AFMAN 36-2203, *Drill and Ceremonies*, which contains extensive instructions with illustrations on how to perform drill. Your military training instructor at basic training used this publication extensively.

### **Operating instructions**

Operating instructions (OI) are developed for the same purpose of instructions; however, OIs are only developed by a particular unit for use *only* in that unit. When OIs are established, just like AFIs, they direct action and prescribe detailed procedures, but they are only applicable to the unit that created it. They are directive and are mandatory for all personnel in that unit and/or subordinate units.

### **Nondirective**

Nondirective publications are informational and suggest guidance that you can modify to fit the circumstances. Complying with nondirective publications is expected, but *not* mandatory. Air Force personnel use these publications as reference aids or “how-to” guides. The following are some examples of nondirective publications.

### ***Pamphlet***

Air Force pamphlets (AFPAM) are informational, “how-to” publications that may include information for implementing Air Force guidance. They may provide guidance regarding reports, but may not prescribe reports. They may reference forms and provide guidance on completing them, but cannot prescribe the use of the form.

### ***Handbook***

Handbooks are reference books of a particular subject or a compilation of factual data and instructional material not subject to frequent change. A good example of a handbook is Air Force Handbook (AFH) 1, *The Airman Handbook*. This handbook contains information on Air Force history, doctrine, values, customs and courtesies, and is the study material for promotion testing.

### ***Visual aids***

Visual aids are posters or graphic illustrations. They are issued for display on walls, bulletin boards, desks, or other base facilities. There are two kinds of visual aids, permanent visual aids and temporary visual aids. *Permanent* visual aids explain or instruct, such as a chart portraying military insignia. *Temporary* visual aids inform or motivate, such as a poster promoting safe driving. As a rule, temporary visual aids should only be displayed 180 calendar days or less, and this expiration date should be printed at the bottom.

### ***Doctrine documents***

Air Force doctrine documents (AFDD) are statements of officially sanctioned beliefs and warfighting principles that describe and guide the proper use of air, space, and cyberspace forces in military action. These documents are authoritative, but broad in nature and require judgment in applying them. They can be either doctrine documents or tactics, techniques, and procedures documents.

### **Non-Air Force publications**

Non-Air Force publications, as the name implies, are produced by federal agencies outside of the Air Force and are directive, or of interest to, the Air Force. They *do not* include commercial, foreign, state, or local government publications. Common sources of non-Air Force publications include the DOD, Department of Health and Human Services, Department of Labor, other military branches, and the Joint Staff, to name a few.

### **Air Force publications website**

Today, most Air Force publications can be found on the internet in electronic format. This eliminates having paper copies of publications that, for all you know, could be outdated. The Air Force publications website is located at <http://www.e-publishing.af.mil/>. This site is a powerful reference tool for you to use and contains just about any Air Force standard publication you are looking for, as well as thousands of blank forms prescribed by those publications. It also contains several Air Force supplements to DOD publications. The most current version of each publication is maintained on the website. Whenever possible, obtain the newest version rather than using a copy found on your computer or network drive, as these versions may not be up to date.

Some publications contain sensitive information that should not be disclosed to the general public and are thus not in electronic format on the website. When you need one of these publications, simply contact the office of primary responsibility as listed on the website for an electronic copy of it.

## **215. Description of the technical order system**

Throughout your career, you will need to use TOs to complete tasks. Technical orders provide clear, concise instructions on how to perform maintenance safely and effectively. They also provide a wealth of other information that will help and guide you through your maintenance activities. In this lesson, we'll look at the different types of TOs, how they are numbered, and some general policies for using a TO. We'll see how a TO is normally laid out in a later lesson.

## Types of technical orders

There are several different types of TOs that you will encounter in your career. Let us break down each of them. Refer to figure 2-1 for a diagram showing the different types of TOs.

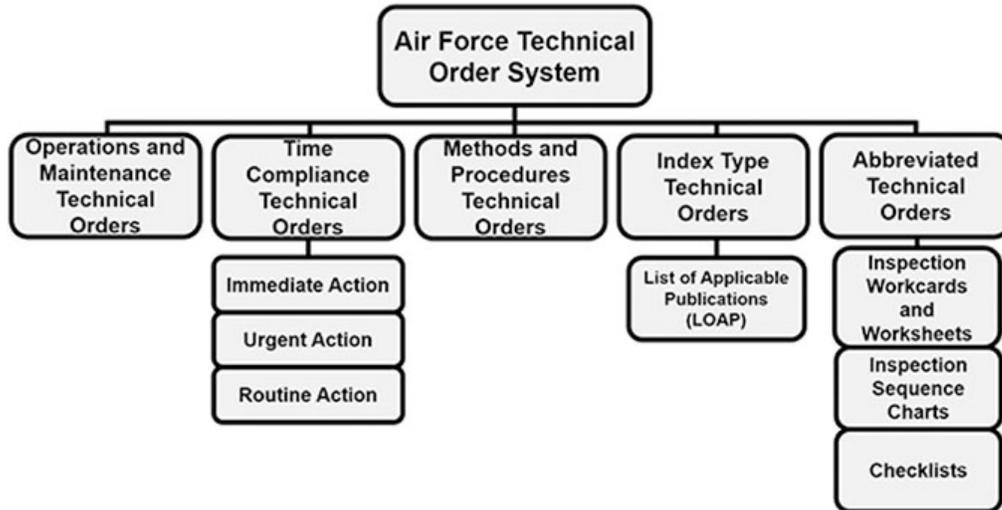


Figure 2-1. Types of technical orders.

### Operations and maintenance

Operations and maintenance (O&M) TOs are what you usually use to follow step-by-step procedures while performing your tasks. They cover the installation, operation, troubleshooting, repairing, removing, calibrating, servicing, or handling of Air Force military systems and end items. O&M TOs must be *available and used* wherever maintenance is being performed.

### Methods and procedures

Methods and procedures TOs contain information that applies to more than one type of weapon system. They are general in nature and might have specific information on how to complete a task, but they are not required to be available and used on the job site.

### Index

Indexes identify needed TOs, group TOs pertaining to specific items of equipment, and show the status of all TOs. Using an index-type TO is the quickest, easiest method to find a TO if you do not know the TO number. Using a list of applicable publications (LOAP) index, you can find any TO applicable to a specific weapon system as well as the items related to that weapon system.

### Abbreviated

Abbreviated TOs are excerpts from one or more basic TOs that organize and simplify instructions. They can come as inspection work cards, inspection sequence charts, or checklists.

Abbreviated Technical Orders	
Type	Description
Inspection work cards	In technical training, you used work cards that told you what periodic inspections needed to be done on the weapon system.  Work cards provide the required guidance, including applicable safety warnings, cautions, and provides specific pass or fail criteria.
Inspection sequence charts	Sequence charts break down an inspection work card and show a planned work schedule or sequence in which inspection work cards can be used.

Abbreviated Technical Orders	
Type	Description
Checklists	Checklists provide abbreviated step-by-step procedures for performing maintenance on the weapon system.  <i>Not every task or maintenance practice will be covered by a checklist.</i>

### *Time compliance technical orders*

The TCTO is the method of directing and providing instructions for modifications to a weapon system and also performing one-time inspections (OTI). Any modification or upgrades will be directed by a TCTO. TCTOs are grouped according to their importance and urgency. The three levels of TCTO urgency, from highest to lowest, are: immediate, urgent, and routine action.

Levels of Time Compliance Technical Orders	
Level	Description
Immediate	<p>An immediate action TCTO (fig. 2-2) is issued to prevent the use of equipment or procedures until hazardous safety conditions can be resolved.</p> <p>This is the highest level of TCTO issued.</p> <p>You will know it is an immediate action TCTO because the words "IMMEDIATE ACTION" are printed in red at the top center of the page and a series of red Xs are printed around the border of the first page.</p> <div data-bbox="474 966 1325 1388" data-label="Image"> </div> <p style="text-align: center;"><b>Figure 2-2. Immediate action TCTO cover page.</b></p>
Urgent	<p>Urgent action TCTOs are issued when potentially unsafe conditions exist that could result in personnel injury, damage to property, or when the condition could reduce combat efficiency if not properly attended to.</p> <p>If an urgent action TCTO is not complied with within its set time limit, the equipment or item must be removed from service until the TCTO for that piece of equipment has been completed. Urgent action TCTOs (fig. 2-3) have the words "URGENT ACTION" printed on the top of the page with a series of red diagonals and red Xs around the border of the first page.</p>

Levels of Time Compliance Technical Orders	
Level	Description
	 <p style="text-align: center;">Figure 2-3. Urgent action TCTO cover page.</p>
Routine	<p>Routine TCTOs are all other TCTOs not covered by immediate or urgent action TCTOs.</p> <p>These could be issued for a system upgrade or to address deficiencies that if not corrected, could eventually develop into something more serious.</p> <p>Routine action TCTOs have no significant identifying markings.</p>

**Preliminary**

While not classified as a type of technical order, it is important to address the preliminary TO. When a new piece of equipment or procedure is developed, the tech data is called a preliminary TO. It *cannot* be used to perform the task yet because it needs to have its procedures verified. This is completed by operational personnel with oversight from the technical content manager. You may have the opportunity to conduct a validation-verification, or “val-ver” with 20 AF and the TO manager. Once the procedures have been tested and approved, the preliminary TO will become an O&M TO to be used for maintenance on the weapon system.

**Technical order numbering system**

Understanding how TOs are numbered will help you immensely when it comes to finding the right TO. Each TO category has its own numbering pattern, so we won’t be covering all possible numbering combinations. TO numbers are composed of groups separated by dashes; each group is further divided into parts. Each part of a group consists of one or more numbers or letters. Use figure 2-4 as an example of the numbering system. The table following figure 2-4 provides additional information about the grouping of numbers used in TO numbers.

Technical Order Numbering System	
Use T.O. <b>21M-LGM30G-2-7-8</b> as an example.	
<b>21M-</b>	
21	Identifies that this T.O. belongs to Category 21, <i>Guided Missiles</i>
M	Identifies that this T.O. is for a <i>missile system</i>
<b>LGM30G-</b>	
L	Identifies that the launch environment is <i>silo-launched</i>
G	Identifies the basic mission is <i>ground attack</i>
M	Identifies that the type of vehicle is a <i>missile or drone</i>
30G	Identifies the missile <i>model</i> and <i>series</i>
<b>2-7-8</b>	
2	Identifies the type of manual, i.e., <i>O&amp;M, abbreviated, index, etc.</i>
7	Identifies the major subsystem is the <i>Environmental Control System</i>
8	Identifies the T.O. series number

Figure 2-4. Technical order numbering system.

Technical Order Numbering System	
Group	Description
1	<p>The first set of numbers/letters before the first dash identifies the category of TO. This sets the standard for how the rest of the TO is numbered. This number corresponds to the supply code assigned to the major system that it applies to. This is how an index TO is built; it will give you all the TOs under that category.</p> <p>Other TO categories you will encounter are 32 (which covers special tools) and 33 (which covers test equipment). Our example uses category 21 and our lesson will focus on how category 21 is broken down.</p> <p>Category 21 is for guided missiles and will always be accompanied by an "M" for missile.</p>
2	<p>Under category 21, the first digit in group 2 identifies the launch environment, second digit identifies the basic mission of the missile, and the third identifies the missile vehicle type.</p> <p>Ours is LGM30G; "L" meaning silo launch, "G" meaning its mission is ground attack, "M" meaning guided missile or drone (which is the only vehicle type).</p> <p>30G identifies the missile model number and missile production series. "30" indicates Minuteman and "G", starting from A, indicates it is the seventh in the Minuteman production series.</p>
3	<p>Under category 21, group 3 identifies the type of inspection, instruction, or procedure.</p> <p>In our case, the "-2" indicates an organizational maintenance manual; an O&amp;M TO.</p> <p>Substitute a "-4" for an illustrated parts breakdown, or "-06" for work unit code manuals.</p>
4 & 5	<p>Groups 4 and 5 are series numbers used to identify different technical orders in a series.</p> <p>Our numbers, "-7" tells us it is for the environmental control system and "-8" is last code to identify its place in the series.</p>

Looking back at our example, 21M-LGM30G-2-7-8, we know that it pertains to a guided missile, silo launched, with a ground attack mission by a Minuteman missile. We know it is an O&M technical order used to work on the environmental control system. Refer to TO 00-5-18, *AF Technical Order Numbering System*, for more information on breaking down other publication categories or what other identifiers under category 21 mean.

### Technical order use

The last items of business we'll cover in this lesson are compliance, what to do if there's a conflict between publications, and finally, TO waivers.

### Compliance

As we've stated earlier, *compliance with TOs is mandatory*. They are just what they are called; "orders." They are published under the authority of the SECAF and failure to comply with a TO could be considered failure to obey a lawful order under Article 92 of the Uniform Code of Military Justice (UCMJ).

If using a TO (except for a methods and procedures TO), it must be available and used in the work area. There are different interpretations of this, but if you are performing a maintenance task, your TO should be open to the procedure you are performing, and you should refer to it and know exactly what step you are on. Sometimes this is not possible when working in a tight space and for other safety reasons you might be working with another person. In this case, use the command and response technique: one technician reads the step; the other performs the step, and then verbally responds that the step was complied with. This ensures steps are not missed and the technician performing the task knows what step in the TO he or she is on.

Lastly, read through the procedure one additional time to ensure that you completed all of the steps. This can save countless headaches and helps to ensure that the job was done completely.

### Conflicts

Sometimes when following a TO, you might come across information that is contradicted by another publication. The following are some rules to remember when dealing with conflicts:

- If a TO contradicts information in an AFI, *the TO always has precedence*. AFIs should *not* contain procedures on how to perform tasks.
- If a TO contradicts Air Force Occupational Safety and Health (AFOSH) standards, go with *whichever guidance is more restrictive*. This ensures the highest safety standards are followed to prevent personnel injury.
- If a specific system TO contradicts a general TO, the *specific system TO always has precedence*.
- Inspection work cards take precedence over technical orders for *accept/reject criteria*. If the TO states that your #2 pencil should be at least four inches long, but the work card states that it must be at least five inches long, your #2 pencil needs to be at least five inches long. If you sharpen it anymore after that, it will no longer meet the work card criteria.

### Technical order waivers

Remember that the TO must be complied with in all cases. You will encounter situations where the TO is incorrect. If you encounter this, you cannot proceed with the task without a TO waiver. Inform your supervisory personnel, who will up channel it to the proper authorities. In most cases, the numbered Air Force can issue TO waivers. If a TO waiver becomes necessary, always ensure that it is followed up with a TO change, as the waiver will have an expiration date.

### 216. Typical technical order format

For ease of use, TOs are divided into organized sections so that technicians can readily find task related information to complete their maintenance successfully. The layout of a TO might vary a little, but this lesson will illustrate how a TO is broken down. Most of you will use this TO extensively in your career.

#### Opening pages

Once you open a technical order, there are several administrative items to understand first. These items will help you understand the specific layout of a TO, where to find information in it, how to use it, and safety precautions that must be observed while performing maintenance.

#### Title page

The first page is the title page. This gives you information such as the TO number and the title of the TO so that you know you have the right book. In the bottom left-hand corner, you will find the basic date of the TO—this is when the TO was first published. The bottom right hand corner tells you what the latest change number of the book is and the date that the change was published. The reason this is important is to ensure that you have the most recent version of the book. Figure 2-5 shows you a title page and its contents.

As you can see from the basic date in the bottom-left corner, this TO was first published on 4 June of 2010. The information in the bottom-right corner states that it is on its third change, the newest of which was published on 7 July 2011.

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T.O. 21M-LGM30G-2-7-8

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**TECHNICAL MANUAL**  
**OPERATION, SERVICE, AND REPAIR INSTRUCTIONS**  
**ORGANIZATIONAL AND DEPOT LEVEL MAINTENANCE**

**LAUNCH FACILITY**  
**ENVIRONMENTAL CONTROL SYSTEM**

**EAS80001 AND EAS80003**

**WINGS I (SQUADRONS I, II, AND III), III AND V**  
**USAF SERIES LGM30G MISSILE**

Basic and all changes have been merged to make this a complete publication.

F42610-98-C-0001

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Published under authority of the Secretary of the Air Force

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**4 JUNE 2010**

**CHANGE 3 7 JULY 2011**

Figure 2-5. Technical order title page.

**List of effective pages**

The list of effective pages lists every single page in the TO and tells you the correct change number for the page. When you want to see what was changed in the latest change, you can reference the change number for each page by looking in the “Change No.” column. This is particularly important because it helps to ensure that you’re familiar with any changes to tasks or additional tools and test equipment you may need. Your work center should inform you of applicable changes, but if you are not sure how to perform a task with the changes in it, you need to find out before performing the task. Figure 2-6 shows you an example of a list of effective pages.

T.O. 21M-LGM30G-2-7-8

LIST OF EFFECTIVE PAGES		INSERT LATEST CHANGED PAGES. DESTROY SUPERSEDED PAGES.			
<p><b>NOTE</b> The portion of the text affected by the changes is indicated by a vertical line in the outer margin of the page. Changes to illustrations are indicated by shaded or screened areas, or by miniature pointing hands.</p>					
<p>Dates of issue for original and changed pages are:</p>					
Original . . . . .	0 . . . . .	4 June 2010	Change . . . . . 2 . . . . . 2 December 2010		
Change . . . . .	1 . . . . .	2 September 2010	Change . . . . . 3 . . . . . 7 July 2011		
<p>TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 742 CONSISTING OF THE FOLLOWING:</p>					
Page No.	*Change No.	Page No.	*Change No.	Page No.	*Change No.
Title . . . . .	3	3-20.1 Added . . . . .	1	4-46 . . . . .	1
A - C . . . . .	3	3-20.2 Blank . . . . .	1	4-47 - 4-56 . . . . .	0
D Added . . . . .	3	3-21 . . . . .	3	4-57 . . . . .	1
E Blank . . . . .	3	3-22 - 3-24 . . . . .	0	4-58 . . . . .	3
i - iii . . . . .	0	3-25 - 3-27 . . . . .	3	4-59 - 4-71 . . . . .	0
iv . . . . .	3	3-28 . . . . .	1	4-72 . . . . .	3
iv.1 Added . . . . .	3	3-29 - 3-30 . . . . .	0	4-72.1 Added . . . . .	3

Figure 2-6. List of effective pages.

**Table of contents**

The table of contents tells you where to find what you are looking for. There is also a list of tables and a list of illustrations to show you where the tables and pictures are. This can be helpful, as most of your periodic inspections are in tables. If you must perform other maintenance, you are normally referenced to the appropriate location from a periodic inspection or a table in the maintenance chapter that breaks down each component. We’ll discuss this more later.

**Foreword**

These pages tell you how to use the TO and gives you specific information on what different terms in the book mean and how to interpret them. This section gives the manual’s content so that you can see how a TO is laid out. Not all TOs are formatted in the way described in this lesson. You can also find a list of publications related to the one you are using.

**Safety summary**

Almost every TO will contain a safety summary. This will give you broad safety precautions to follow that are not identified further in the TO. There might also be a summary of all cautions and warnings throughout the TO so that you can see upfront the safety requirements related to your specific task.

This section must be reviewed before starting any maintenance task.

### Description

Most TOs have a description section that will explain to you how the system operates. When reading this section to understand how something works, following the diagrams to help you gain a better understanding of the operation or process. This will help develop your system knowledge.

### Special tools and test equipment

If you are using a TO to perform maintenance, you will need to know what tools or test equipment you're going to need for the job. The special tools and test equipment section will show you exactly what equipment to use. You will find a table that tells you what special tool to use, its part number, and what the item will be used for. A list of test equipment will tell you the same information, as well as what other equipment is authorized to be used in its place if the original is not available (fig. 2-7). A list of consumables tells you the chemicals that you might use as well as what other supplies you need a good stock of.

T.O. 21M-LGM30G-2-7-8

Table 2-1. Special Tools

Item	Nomenclature	Specification, Part Number, or NSN	Use
1.	Adapter, Crowsfoot (7 / 16-inch)	PN FC014A Snap-On (or equivalent)	Applying torque to emergency fan mounting hardware.
2.	Apron, Rubber	8415-00-082-6108 or 8415-00-634-5023 (or equivalent)	Servicing ECS.
3.	Extension Cord (25-ft)	6150-00-485-6149 (or equivalent)	Applying power to ECS test equipment.
4.	Eyewash Bottle (32-oz)	PN 5BB-121842 Lab Safety (or equivalent)	Flushing eyes.
5.	Faceshield	4240-00-542-2048 (or equivalent)	Servicing ECS.

Figure 2-7. Special tools and test equipment.

Finally, the special tools and test equipment section also provides specific instructions on the use of some specific pieces of equipment. Some maintenance procedures in the TO may tell you, for example, to “install manifold and gauge assembly.” You will need to refer to this section of the TO on the specific procedures on how to do that procedure.

### Operation and checkout

This section begins by telling you what procedures are contained in it and gives you a reference to where they are in the section. This is where you will find procedures on operating the weapon system or component as well as how to perform checkouts on it. This is where most of your periodic inspections are located. The tables in this section are in a four-column format as shown in figure 2-8. Perform the procedure; if you get a normal indication, perform the *next step*. If you get an abnormal indication, perform the *corrective action*. The corrective action normally refers you to complete maintenance or troubleshooting actions because something is broken and it needs to be fixed.

Table 3-2. ECS Emergency Mode Checkout

Step	Procedure	Normal Indication	Abnormal Indication	Corrective Action
1.	Ensure the ECS is in normal operation IAW Paragraph 5.3.1.			
<div style="border: 1px dashed black; padding: 5px; display: inline-block; margin-bottom: 10px;"><b>CAUTION</b></div> <p>Loss of airflow to electronic racks will result in rack failure. If loss of emergency ECS occurs and air handler fan is inoperative, electronic racks shall be shut down immediately (refer to T.O. 21M-LGM30G-2-10). Failure to comply may result in equipment damage.</p>				
1A.	In LDB panel, set circuit breaker CB-25, 27, 29 to OFF.			
2.	Check air handler fan ([1] FO-14, 53 [3][5] FO-27, 55<) status.	Not operating	Operating	Check and repair facility electrical system (refer to CEM 21-SM80X-2-21-X).

Figure 2-8. A procedure in four-column format.

### Trouble analysis

The trouble analysis section gives you step-by-step instructions on how to locate a malfunction. In most cases, you are referred to a specific trouble analysis step by other procedures. If not, you will need to begin with the alarm indications section to see where you should start. The tables in this section are in a four-column format as well, but not all troubleshooting in other TOs will be this way. Some are in a three-column format where there is a corrective action for both a normal and an abnormal indication. Sometimes in troubleshooting, a normal indication on a step eliminates the need to perform the next several steps. One other thing to remember about these procedures is to use them in conjunction with the diagrams. You can more easily find an electrical problem if you know where the procedure is having you check and why.

### Maintenance

The maintenance section breaks down all the maintenance tasks that can be performed on nearly every component in the system you are working on. If you know the specific maintenance you are performing on that site or piece of equipment, you can skip right to this section. For example, if you know that you have to replace the fiber optic repeater adapter in the brine chiller control panel, then look up the procedures in this chapter and press on. The following is how to:

- Find the component replacement and adjustment table (fig. 2-9).
- Find the component designator you are looking for on the table.
- Determine what mode of operation the system must be in to perform maintenance on that component.
- Perform the applicable procedure to establish the required mode of operation
- Proceed to either the replacement or adjustment paragraph listed on the table and complete the procedure.
- Perform a functional checkout upon completion to verify your maintenance actions.

Table 5-1. Component Replacement and Adjustment - Continued

Ref Des	Short Name	Figure Location	Establish Operational Mode and Remove Facility Power (attach Danger Tag) at...		Replace Para	Adj Para
			Operational Mode / Para	Facility Power Source		
FOR-1	Fiber Optic Repeater	FO-7, 5	Emergency Paragraph 5.3.3	CCP-1; CB-1	Paragraph 5.40	None
FOR-2	Fiber Optic Repeater	FO-10, 37	Emergency Paragraph 5.3.3	Launch Tube Heater Control Panel; SW-5 Disconnect cable W673 from J-1 (FO-10, 11); then, attach shorting plug (Table 2-1, 25) to cable W673	Paragraph 5.41	None
FRA-1	Fiber Optic Repeater Adapter	FO-7, 4	Emergency Paragraph 5.3.3	CCP-1; CB-1	Paragraph 5.42	None
FRA-2	Fiber Optic Repeater Adapter	FO-10, 38	Emergency Paragraph 5.3.3	Launch Tube Heater Control Panel;	Paragraph 5.43	None

Figure 2-9. Component replacement and adjustment table.

Using these procedures, you can remove, install, adjust, or service nearly all components in the system. Always remember to perform a functional check, even if the maintenance procedure does not tell you to. Your maintenance actions are not considered complete until you verify that the system is fully operational after your maintenance.

### Diagrams

The last section in this TO covers diagrams. In this section there are illustrations of components, schematic diagrams, and wiring diagrams that cover all aspects of the system. You can use these diagrams for a variety of situations. Follow the schematics for troubleshooting and understanding system operation. The figures usually have a reference from a procedure to show you where to find a particular part of a component or where a component is located. The wiring diagrams are useful when you need to ensure that a component is wired correctly.

**NOTE:** You are not authorized to troubleshoot the system using schematic diagrams alone.

Schematics must be used in conjunction with operation and checkout procedures or trouble analysis procedures. Failure to comply could result in *death or injury* to personnel or *damage* to equipment.

### Technical order changes

We already discussed where to find the latest change number and date in a TO. Changes are a result of improvement reports (which we will see later) that are submitted by technicians such as yourself. Earlier, you also saw that you can look at the list of effective pages to see what change number each page is on, but how do you know what content *within* that page has actually changed? These changes are actually very easy to spot. Changes are annotated with a vertical black line printed in the outside margin next to the content that changed (fig. 2-10). When familiarizing yourself with the task prior to departing for the field, pay close attention to these lines, and make sure that you are familiar with how to perform the changed procedure.

Table 4-3. LF ECS Trouble Analysis - Continued

Step	Fault Isolation	Normal Indication	Abnormal Indication	Corrective Action
1. - Cont.	(4) Observe CONDENSER EXHAUST "B" DPR position.	100 ( $\pm 5$ )% open	Less than 95% open	Perform Functional Checkout - Ventilation Subsystem IAW Table 3-14.<
	o. Visually inspect refrigerant condenser coil.	Condenser coil is clean	Condenser coil is dirty	Clean condenser coil IAW Paragraph 5.111.1.
	p. Adjust hot gas bypass valve IAW Table 5-1.	Brine supply temperature in tolerance	Brine supply temperature out of tolerance	Replace liquid line solenoid valve coil IAW Table 5-1.  Replace brine chiller IAW Table 5-1.

**CHANGED CONTENT**

Figure 2-10. Identifying changed content.

This lesson focused on the organization and contents of the 21M-LGM30G-2-7-8 used to maintain the environmental control system. Be sure to reference the foreword on any TO you are using to see how that particular TO is broken down. All TOs contain the same general contents, but not always in this particular order. Once you understand the format of one TO, it is easy to find what you are looking for in any other TO that you will use.

### 217. Technical order improvement report

As we mentioned earlier, occasionally you may find guidance in a TO that is incorrect, unclear, incomplete, improperly sequenced, or you may know a better way to do a procedure. The Air Force Technical Order (AFTO) Form 22, Technical Manual (TM) Change Recommendation and Reply, provides a way to correct, clarify, include, or set right the information. This lesson covers the purpose, report categories, and procedures for submitting an AFTO Form 22.

#### Purpose

Refer to figures 2-11, 2-12, and 2-13, throughout this lesson. These are the three pages of an AFTO Form 22. TO improvement reports are submitted to correct errors or omissions of a technical nature, which prevent adequate performance of functions required for mission accomplishment. You can also submit an AFTO Form 22 to correct minor inaccuracies of a nontechnical nature that affect the meaning of instructions. Do *not* submit AFTO Forms 22 for typographical or printing errors that do not cause misinterpretation or would normally be corrected during scheduled reviews.

Prior to submittal, your supervisor will review your form to ensure it is a valid recommendation. Next, the AFTO Form 22 is sent to the designated review authority within the unit—usually QA, where the reviewer checks that the proper category is assigned, and selects the proper category or disapproves the recommendation if necessary. Depending on the category of the report, you can expect to get a response from the control point within 60 days.

ATTACH

TECHNICAL MANUAL (TM) CHANGE RECOMMENDATION AND REPLY <small>(Use IAW Completion Instructions and TO 00.5-1)</small>		LCN	OMB NO. 0704-0188
<b>1. PIM (or equivalent)</b> ORGANIZATION _____ NAME _____ PHONE _____ INITIAL SUBMIT DATE _____ <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED E-MAIL _____ <small>Click to sign</small>		<b>2. MAJCOM CCP (After Review, Return to PIM)</b> ORGANIZATION _____ NAME _____ PHONE _____ REVIEW DATE _____ <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED E-MAIL _____ <small>Click to sign</small>	
<b>3. LEAD COMMAND CCP (After Review, Return to PIM)</b> ORGANIZATION _____ NAME _____ PHONE _____ REVIEW DATE _____ <input type="checkbox"/> APPROVED <input type="checkbox"/> DISAPPROVED E-MAIL _____ <small>Click to sign</small>		<b>4. TO MANAGEMENT ACTIVITY (After Receipt, Forward to Evaluator)</b> ORGANIZATION _____ NAME _____ PHONE _____ RECEIPT DATE _____ E-MAIL _____ <small>Click to sign</small>	
<b>5. LOCAL CONTROL NUMBER (LCN)</b> _____	<b>6. PRIORITY (Check One)</b> <input type="checkbox"/> EMERGENCY <input type="checkbox"/> URGENT <input type="checkbox"/> ROUTINE		<b>7. CHANGE TYPE (Check One)</b> <input type="checkbox"/> CORRECTION <input type="checkbox"/> IMPROVEMENT
<b>8. INITIATOR</b> NAME _____ RANK _____ PHONE _____ DATE _____ E-MAIL _____ <small>Click to sign</small>		<b>9. INITIATOR SUPERVISOR</b> NAME _____ RANK _____ PHONE _____ DATE _____ E-MAIL _____ <small>Click to sign</small>	
<b>10. PUBLICATION NUMBER</b> _____	<b>11. BASIC DATE</b> _____	<b>12. CHANGE NUMBER</b> _____	<b>13. CHANGE DATE</b> _____
<b>14. WORK PACKAGE/WORK CARD ID</b> _____	<b>15. PAGE NUMBER</b> _____	<b>16. PARAGRAPH NUMBER</b> _____	<b>17. FIGURE/TABLE NUMBER</b> _____
<b>18. SHORT DESCRIPTION OF DEFICIENCY</b> _____ _____ _____			
<b>19. DEFICIENCY</b> _____ _____ _____			

Figure 2-11. AFTO Form 22, Page 1.

LCN:	
20. RECOMMENDED TM CHANGE	
21. SAVINGS/YR - DOLLARS	22. SAVINGS/YR-MANHOURS
23. EVALUATOR <i>(After evaluation, forward to supervisor)</i>	24. EVALUATOR/SUPERVISOR <i>(After review, return to TO Management Activity)</i>
NAME _____	NAME _____
RANK _____ PHONE _____	RANK _____ PHONE _____ REVIEW DATE _____
RECEIPT DATE _____ EVALUATION DATE _____	E-MAIL _____
E-MAIL _____	E-MAIL _____
<a href="#">click to sign</a>	<a href="#">click to sign</a>
25. DISPOSITION	26. DISPOSITION/REMARKS
<input type="checkbox"/> APPROVED <input type="checkbox"/> DEFERRED <input type="checkbox"/> ABEYANCE <input type="checkbox"/> ADVISEMENT <input type="checkbox"/> DUPLICATE <input type="checkbox"/> DISAPPROVED <input type="checkbox"/> OTHER	
	VERIFICATION REQUIRED BY <input type="checkbox"/> PERFORMANCE <input type="checkbox"/> DESK-TOP ANALYSIS
	27. IDEA BENEFITS ARE <input type="checkbox"/> INTANGIBLE <input type="checkbox"/> TANGIBLE - AMOUNT _____
28. CONTINUATION	

AFTO FORM 22, 20170309

Figure 2-12. AFTO Form 22, Page 2.

ROLE	AFTO 22 ABBREVIATED COMPLETION INSTRUCTIONS*
WUC/LCN	WUC or LCN if applicable.
INITIATOR (Block 8)	<ul style="list-style-type: none"> <li>• Complete blocks 6-7 and 10-20. Complete blocks 21, 22 and 27, if applicable.</li> <li>• Complete block 8 and digitally sign. Forward signed form and any required attachments to supervisor</li> </ul>
Initiator Supervisor (Block 9)	<ul style="list-style-type: none"> <li>• Review blocks 6-7, 10-22 and 27 for validity, accuracy and completeness. Make necessary changes and enter corresponding comments in block 28.</li> <li>• Complete block 9, and digitally sign</li> <li>• Forward signed form and all attachments to PIM (or equivalent).</li> </ul>
PIM (or Equivalent) (Block 1)	<ul style="list-style-type: none"> <li>• Review blocks 6-7, 10-22 and 27 for validity, accuracy and completeness. Make appropriate changes and enter corresponding comments in block 28</li> <li>• Enter Local Control Number in block 5.</li> <li>• Enter organization information and e-mail address (preferably an organizational e-mail) into block 1, 2, and 3.</li> <li>• See routing information, via AFNET at <a href="https://cs3.eis.af.mil/sites/00-TO-00-59/default.aspx">https://cs3.eis.af.mil/sites/00-TO-00-59/default.aspx</a></li> <li>• Enter the Initial Submit Date and digitally sign block 1</li> <li>• Forward signed form, and all attachments, to the first reviewer</li> <li>• Enter dates of subsequent reviews in block 28.</li> <li>• Forward to the TO Management Activity in block 4.</li> </ul> <p>Note: Follow up with the TO Management Activity if a disposition is not received within 48 hours for an Emergency recommendation</p>
MAJCOM and Lead Command CCP Reviewer (Blocks 2 and 3)	<ul style="list-style-type: none"> <li>• Review blocks 6-7, 10-22 and 27 for validity, accuracy and completeness. Make appropriate changes and enter comments in block 28</li> <li>• Complete block 2 or 3, as appropriate, including review date. Digitally sign</li> <li>• Returned signed form, and all attachments, to PIM (or equivalent) (block 1)</li> </ul>
TO Management Activity (Block 4)	<ul style="list-style-type: none"> <li>• Complete block 4 and digitally sign</li> <li>• Forward signed form, and all attachments, to evaluator (block 23)</li> </ul>
Evaluator (Block 23)	<ul style="list-style-type: none"> <li>• Enter receipt date in block 23</li> <li>• Review blocks 6, 7, 10-22, and 27 for validity, accuracy and completeness. Make appropriate changes and enter corresponding comments in block 28</li> <li>• Change type (block 7) will not be changed without the approval of the submitting MAJCOM CCP</li> <li>• Recommended disposition in block 25</li> <li>• Provide appropriate verification and disposition remarks in block 26</li> <li>• Complete block 23, including entering evaluation date, and digitally sign</li> <li>• Forward completed form and all attachments, to supervisor</li> </ul>
Evaluator Supervisor (Block 24)	<ul style="list-style-type: none"> <li>• Review recommended disposition, complete block 24 and digitally sign.</li> <li>• This authority may be delegated to the evaluator. If so delegated, document in block 28, along with the first level supervisor's name and e-mail address.</li> <li>• Return completed form to the TO Management Activity, initiator, PIM, and other activities.</li> </ul>
* FOR AFTO FORM 22 DETAILED COMPLETION INSTRUCTIONS, SEE TO 00-5-1	

AFTO FORM 22, 20170309

Figure 2-13. AFTO Form 22, Page 3.

## Report priorities

The three priorities for submitting an AFTO Form 22 are *emergency*, *urgent*, and *routine*.

### Emergency

Emergency reports require immediate action to correct a TO deficiency which, if not corrected, *would* result in a fatality or serious injury to personnel, or extensive damage or destruction of equipment or property. This type of recommendation demands immediate action. The responsible technical content manager (TCM) either issues an interim TCTO or rapid action change within 48 hours (72 hours for work stoppage) of receiving the AFTO Form 22.

### Urgent

Urgent recommendations require action on a TO deficiency which, if not corrected, *could* cause personnel injury or damage to equipment or property. All TCTO deficiencies are submitted as an *urgent* priority. Identification of, or replacements for, Environmental Protection Agency (EPA) hazardous material (HAZMAT) and ozone depleting chemicals are submitted as urgent as well.

### Routine

Routine reports require action on TO deficiencies which do not fall into emergency or urgent categories. These can even include minor typographical errors, word omissions or printer errors, but only if they cause a critical misinterpretation or affect the meaning of instructions that would impede the mission. The TCM will use the AFTO Form 22 to respond to all routine reports within 45

calendar days of receiving the report. Generally, updates will be published (including printing and distribution) by the responsible agency within one year of receipt of the report.

### **Procedures**

As with any other digital form you use, always be sure that you're using the most current version by visiting <http://www.e-publishing.af.mil>. Since each recommended improvement must be evaluated individually, only one improvement per AFTO Form 22 is usually submitted. An exception to this is when the same error occurs more than once in a TO. Then, identify all locations on a single AFTO Form 22. Another exception is when your AFTO Form 22 improves an inspection manual (-6 TO). Your report may include all locations that need to be changed, such as the work cards. Brief summaries of the deficiency and recommended change are required in the narrative section of the form. Complete the AFTO Form 22 digitally and submit via e-mail. Your reviewing authority will handle it from there and provide you feedback on the process as it occurs.

Be sure to follow-up with the reviewing authority, and once an improvement is stamped approved by all agencies, ensure that you get a copy of it so you can use the suggestion program to your benefit.

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## **Self-Test Questions**

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

### **214. Categories and types of standard publications**

1. In regard to a supplement's parent publication, what condition *must a* supplement meet?
2. What is the main difference between a policy directive and policy memorandum?
3. Who are operating instructions directive and mandatory for?
4. What rules apply when posting temporary visual aids?
5. If a publication you are looking for contains sensitive information that should not be disclosed to the general public, where could you obtain an electronic copy of it?

### **215. Description of technical order system**

1. What publication *must* be used whenever maintenance is being performed?
2. What is the main difference between O&M TOs and methods and procedures TOs?
3. What information does a list of applicable publications index provide?

4. What are TCTOs used for?
5. How can you identify an immediate action TCTO?
6. What action must occur if an urgent TCTO is not complied with before its time limit?
7. What has to happen before a preliminary TO becomes an O&M TO?
8. What type of information would you find in a category 32 TO?
9. Describe the *command and response* technique.
10. What type of criteria does inspection work cards take precedence over technical orders for?
11. How do you proceed if you find a TO is incorrect and you cannot perform the task correctly?

**216. Typical technical order format**

1. How does knowing when a TO was last changed help you?
2. Why is it important to review TO changes prior to a dispatch?
3. When is the safety summary section of the TO reviewed?
4. While you are reading system descriptions, how will following along in the diagrams help you?
5. In a four-column format checkout procedure, how do you proceed if you get a *normal* indication?

6. Where should you start trouble analysis if you were not referred to a specific step by another procedure?
7. What procedure must be performed prior to actually performing a maintenance or adjustment procedure?
8. When can you use schematic diagrams for troubleshooting?
9. How can you identify changed content on a TO page?

### **217. Technical order improvement report**

1. What are reasons to submit an AFTO Form 22?
2. What should QA do if an AFTO Form 22 is categorized incorrectly or is inaccurate?
3. What must a technical content manager issue within 48 hours of receiving an AFTO Form 22 in the *emergency* category?
4. When would typographical errors be corrected with an AFTO Form 22?
5. What information is required in the narrative section of the AFTO Form 22?
6. Why would you need a copy of the AFTO Form 22 once all agencies have approved it?

## **2-2. Civil Engineering Manuals**

Real property installed equipment (RPIE) is government-owned equipment physically attached to or built into an Air Force facility. Normally, RPIE is manufactured for commercial use, but is procured through the military construction efforts of various contractors.

In this section, we will discuss the civil engineering manuals (CEM) that provide operation and maintenance instructions for RPIE. Although similar in format to TOs, CEMs are written to cover RPIE at a specific wing. We will also discuss the purpose and specific procedures for submitting an AFGSC Form 272, RPIE Improvement Report.

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## 218. Description of civil engineering manuals

Knowing where to find the information you need to perform a task or order a replacement part is essential. The information you gain in this lesson will help you understand the different types of CEMs. You will also learn the CEM numbering system, which can save a lot of time when trying to find information on the component you are working with.

### Types of civil engineering manuals

There are three types of CEMs: system manuals, equipment manuals, and master change logs (MCL). The system and equipment manuals are closely related and are used together in most cases. An MCL is the CEM version of a TCTO, and serves the same purpose.

#### *System manuals*

System manuals provide instructions for operation and maintenance of a RPIE system, and are generally laid out like a TO. System manuals are prepared for experienced maintenance personnel. Standard maintenance practices are *not* included. Detailed information specific to a component, unit, or subsystem is in the equipment manual and is sometimes repeated in the system manual. When information is needed, such as when you need particular information about a component, you will need to refer to the equipment manual.

Typically, a system manual contains two volumes. Volume 1 contains procedures normally performed by a missile maintenance technician (you). Volume 2 contains procedures normally performed by a civil engineering (CE) technician. Our discussions will focus on Volume 1.

#### *Equipment manuals*

You should recall that the system manual is used for operation and maintenance of an entire system. When you isolate a fault to a component and need further information on that component to make a better determination, you need to refer to the equipment manual. The combination of CEM system manuals and equipment manuals provide complete coverage for the RPIE system.

Most manu

facturers prepare operational and maintenance data sheets on the equipment they build. The Air Force saves money by using this available data. Think of an equipment manual as a collection of commercial owner's manuals.

Equipment manuals contain the commercial data provided by the manufacturer, so they are also a good place to research replacement parts. Not all, but most, of the commercial data in the equipment manual will provide replacement part numbers. If they do not have this information, at least you have a place for your supply personnel to look when helping you research needed parts.

#### *Master change logs*

An MCL serves the same purpose as a TCTO. While there aren't different levels of MCLs like there are for TCTOs, the urgency is clearly communicated through command channels if needed. MCLs will contain all of the information needed to complete a modification or one-time inspection, including how to procure the parts, what parts to procure, and the step-by-step procedures for performing the modification or inspection. An MCL's progress is tracked in the IMDS exactly like a TCTO. Once completed, command authorities must be formally notified via a completion package that the MCL is done.

### Identifying numbers

You may have noticed that the identifying numbers of the CEMs are similar to those of TOs. Each CEM number is divided into three or more parts with each part separated by dashes. Let's look at the parts of the identifying numbers for CEM 21-SM80A-2-21-2 and 35R-1-551-2.

Note that a system manual uses a two-digit number to identify the system, while the equipment manual has a three-digit number. The equipment manuals are not coded to the ICBM or model. Remember, the equipment manuals are written for the commercial equipment.

CEM Identifying Number Parts			
System Manual Type 21–SM80A–2–21–2		Equipment Manual Type 35R–1–551–2	
<i>Element</i>	<i>Identifies</i>	<i>Element</i>	<i>Identifies</i>
CEM 21	System Manual (Minuteman)	35R	Equipment Manual (Minuteman).
SM80A	the missile model, design, and series.	–1	the missile model, design, and series.
–2	the type of manual: (i.e., Description, Operation, and Maintenance).	–551	the weapon system: (Miscellaneous Systems).
–21	a specific system: (i.e., Power Generation and Distribution).	–2	the wing or squadron (Minot). <i>This does not correspond directly to the wing number.</i>
–2	the wing or squadron (Minot). <i>This does not correspond directly to the wing number.</i>		

## 219. Format of civil engineering systems and equipment manuals

CEMs use a standardized format; however, the format of a system manual is very different than that of an equipment manual. Understanding the differences and understanding how to use each type of manual will help you locate and interpret information quickly and efficiently. Let's see how both manuals are organized.

### Format of a typical system manuals

You'll find the format of most system manuals is much like the format of an O&M TO. Remember, our discussion concerns a typical format. Some system manuals may not have every section described here. The first pages of a typical system manual include a title page, a table of contents, an introduction, a list of effective pages, illustrations, tables, and safety precautions that all serve the same function as they do in a TO. We'll focus on the individual sections of the 21–SM80A–2–21–2 CEM. This is the most common format and the CEM you will use the most in your career.

### Description

The description section of a CEM is much like a TO's description section. It contains comprehensive information on how the system works. Use the diagrams when reading the description to enhance your systems knowledge.

### Component lists

A key part of this section is the component lists. Every CEM will have a list of most components, complete with where they are located, where in the manual you can find an illustration of them, and part information that will help you order replacement parts. Other key information in a component list is the individual sequence number. These sequence numbers are used to locate items in the equipment manual, as we will see later in this section. It is important to note that not all components are on these lists, which can make researching replacement parts somewhat difficult.

### Illustrations

There is a section of the CEM for diagrams, but the description section contains broader illustrations. You might find block diagrams to show how an overall system is connected, or you might see some

of the major components of the system illustrated. This information is also helpful when understanding how the system operates.

**Special tools and test equipment**

This section contains instructions for operating particular pieces of equipment, as well as a table showing all the special tools, test equipment, and consumables used throughout the manual. You are normally referred to this table when a procedure says to use a certain item. The table will give you ordering information on the tool/equipment and explain what it is used for.

Like the description section, there are illustrations here as well. These illustrations show you particular pieces of equipment, and provide additional information on how to fabricate locally manufactured tools or equipment.

**Operation and checkout**

The purpose of the operation and checkout section is to provide tables that show you a step-by-step list of procedures on how to perform a checkout of a subsystem or component. A CEM checkout procedure is written in a three-column format. With the three-column format, you perform the step and look for a normal indication. It does not tell you what an abnormal indication will be.

**NOTE:** If you get any indication other than the normal indication, you will perform the corrective action.

These corrective actions can be somewhat vague at times. They sometimes refer you to other troubleshooting or maintenance procedures, while at other times they provide specific maintenance steps to perform to obtain a normal indication, or it may just be a “laundry list” of what could be wrong. If it does not refer you to a procedure, it is acceptable to perform the corrective action while complying with standard maintenance practices. Figure 2-14 shows you an example of a CEM’s three-column format.

Table 3-20. LFSB DEU Water Temperature Switch Gage Checkout and Adjustment

STEP	PROCEDURE	NORMAL INDICATION	CORRECTIVE ACTION
<div style="border: 1px solid black; padding: 2px; display: inline-block; margin-bottom: 5px;">CAUTION</div> <p>Water temperature switch gage indicating needle has 24 vdc applied at all times. When adjusting contacts, do not short allen head adjustment screws to ground.</p> <p style="text-align: center;"><b>NOTE</b></p> <p>All lights reflected in the NORMAL INDICATION column are located on the MPP unless otherwise indicated.</p>			
1.	Set DEU switch on MPP to DISABLE.	DEU ..... ON DEU INHIBITED ..... ON STBY PWR FAIL ..... ON AUTO ..... OFF	Replace MPP (table 5-1).
2.	Set DEU immersion heater circuit breaker No. 1 in panel LDN to OFF and attach WARNING tag.		
3.	(Allis-Chalmers only) Drain DEU coolant to a point below water temperature switch gage sensor.		
4.	Remove water temperature switch gage sensor from DEU.	When sensor cools, MAIN FUEL TANK LOW ... ON	Rotate low temperature contact adjustment screw clockwise until light comes ON.  Check and repair wiring. Replace MPP (table 5-1).

Figure 2-14. A procedure in three-column format.

**Troubleshooting**

The troubleshooting section provides procedures for troubleshooting some of the more common problems that you'll encounter. Most procedures are grouped into tables to relate problems with different systems. You can turn directly to those tables to find your problem if you are not referenced from another procedure.

The 21-SM80A-2-21-2 has a fault matrix and flow chart. The fault matrix will guide you to a particular problem. Figure 2-15 shows a fault matrix that you likely have seen and used before. Note that not all CEMs have a fault matrix. If yours doesn't you will simply go to the troubleshooting index and select a trouble number that aligns with the indicators on the Minuteman Power Processor (MPP).

FAULT REFERENCE NUMBER																					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
		X		X	(X)	X		X	X	X		(X)	(X)	AVAIL	COML PWR						
			X			(X)	(X)	(X)	(X)	(X)	(X)	X		X	X	X		(X)	(X)	ON	
X	F	X	X			(X)	(X)	(X)	(X)	(X)	(X)							(X)		FAIL	
X	X	X		X	(X)															AVAIL	STBY PWR
X	X	X		X	X															ON	
				X	(X)	X	X	X	X	X	X	(F)		X	X	X		(X)	X	FAIL	
												(F)						(X)		DEU BATTERY	
					X															NON REQD STBY PWR	
				X																NON REQD DEU RUN	
						X	X	X	(X)	(X)	(X)							(X)	X	DEU INHIBITED	
	X																			FAIL TO TRANS COML PWR	
								X										(X)		FAIL TO START	
									X									(X)		LOW LUBE OIL PRESS	
										X										HIGH COOLANT TEMP	
											X									ENG OVERSPEED	
														X						FUEL DAY TANK LOW	
															X					MAIN FUEL TANK LOW	
																X				SUMP HIGH LEVEL	
																				RESET	
		F	F		F	F							F							DEU	
																				POWER	
X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	(X)	X	X	SYSTEM CHECK
				F	F	F							(X)					(F)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		

X = MPP INDICATOR ON	(X) = MPP INDICATOR ON OR OFF
F = MPP INDICATOR FLASHING	(F) = MPP INDICATOR ON OR FLASHING
	= LF ONLY

Figure 2-15. Fault matrix.

As an example, let's look at Fault number 1, on the far left.

An "X" in the column means that the corresponding light on the MPP is *illuminated*. Therefore, if you were standing in front of this MPP, you would see the following indicators illuminated:

- The MPP's power on light.

- The COMMERCIAL POWER FAIL light.
- The STANDBY POWER AVAILABLE light.
- The STANDBY POWER ON light.

From these indicators, you know that the MPP is powered on, that commercial power has failed for some reason, and that standby power (the diesel generator) is providing power to the site. It is worth noting that you would already have known most of this was happening due to the fact that the diesel generator would have been running when you arrived on site.

CEMs without a fault matrix will still provide you with a fault or trouble number, they just won't have the visual representation as pictured below.

### *Maintenance*

The maintenance section of the CEM gives instructions for adjusting or replacing components. Some system manuals will not have this section, so you might have to refer to the equipment manual. Like the TO we looked at in previous lessons, this CEM has a component replacement and adjustment table. It includes the name of the component and where it is located. The table also tells you what power source the facility should be running on and what mode of operation the system needs to be in. For example, you would not want the diesel generator to start up while you were performing maintenance on it, so the procedure directs you to disable it. Refer to the paragraph listed for a replacement or adjustment and get to work. Figure 2-16 shows you part of the component replacement and adjustment table.

Table 5-1. LCEB and LFSB Component Replacement and Adjustment (Continued)

COMPONENT	LOCATION	ESTABLISH OPERATION MODE FOR MAINTENANCE AND TURN OFF FACILITY ELECTRICAL POWER AS FOLLOWS:		REPLACE PER PARA	ADJ PER PARA/TBL
Overtemperature Switch	LCEB Diesel Engine	Commercial Power	Set DEU switch on MPP to DISABLE	5-35	TBL 3-8
Overtemperature Switch (Penn Controls Model A70JG-1)	LCEB Diesel Engine	Commercial Power	Set DEU switch on MPP to DISABLE	5-35	TBL 3-9
Radiator (Allis-Chalmers)	LCEB/LFSB Diesel Engine	Commercial Power	Set DEU switch on MPP to DISABLE	5-31	N/A
Radiator (Cummins)	Diesel Engine	Commercial Power	Set DEU switch on MPP to DISABLE	5-78	N/A
Radiator Sight Glass (Cummins)	LFSB Diesel Engine	Commercial Power	Set DEU switch on MPP to DISABLE	5-90	N/A
Relay K1	LCEB/LFSB Automatic Switching Unit	No Power	Obtain sufficient battery-powered lighting	5-8	N/A

Figure 2-16. Component replacement and adjustment table.

This section also contains illustrations that accompany most maintenance procedures. Sometimes, they are placed with the procedure and sometimes they are at the end of the section.

### *Diagrams*

The diagrams section contains all of the required schematics and wiring diagrams. There are extensive wiring diagrams to help you in replacing components or verifying wiring while troubleshooting.

Of special note, unlike a TO, you are authorized to use CEM schematics for troubleshooting without written procedures from the checkout or troubleshooting sections. One caution on this—you need to *follow the procedures first*. The complexity of the system means that it can essentially have an infinite number of faults, and it would therefore be impossible to write a CEM that had troubleshooting procedures for every problem that you could encounter. Always remember that your schematics are available as a backup when the procedures are exhausted or have led you astray. When you are performing step-by-step procedures, always trace the steps you are being told to perform through in the schematic so that you can understand how and why the CEM is directing you to check something. If the written steps in the book don't sync up to the schematic, this may be an indicator that the troubleshooting steps are leading you astray.

### *Civil engineering manual changes*

CEMs are not perfect and you will find errors that need to be corrected. There is a good chance that changes have been made to any given CEM that you're using. Here is how to identify them.

### *Changed pages*

When a CEM is changed, the list of effective pages is updated. You can see what change each page is on and, like a TO, the page has a vertical black bar on the side next to what was changed on that page.

### *Interim changes*

Sometimes, the page itself is not changed. Instead an interim change is posted to the CEM until the book is updated again. In front of the title page, you will see what interim changes are posted to the CEM along with the reason for the change and a list of pages added to the CEM by this interim change.

When performing procedures, if you come across an interim change page opposite the page you are working from, review it to see if you need to perform the steps on the original page or those on the changed page. The bottom of the change page tells you in what circumstances you should use the change page instead of the original. Figures 2-17 and 2-18 show you an example of this. You can refer to the civil engineering manual interim change (CEMIC) cover page in the front of the CEM to see what the MCL is for (in this example, diesel replacement program). If the diesel has been replaced on the site you are working on, perform the steps on the change page. If the site you're working at still had an older model diesel, you would use the procedures as normal.

Table 3-20. LCEB and LFSB DEU Water Temperature Switch Gage Checkout and Adjustment (Continued)

STEP	PROCEDURE	NORMAL INDICATION	CORRECTIVE ACTION
<p><b>Perform step 6 as normal</b> <b>Steps 7, 8, &amp; 9 are performed differently</b></p>			
6.			
7.	(LF only) Establish temperature of 120°F at water temperature switch gage sensor.	MAIN FUEL TANK LOW .... OFF	Rotate low temperature contact adjustment screw counterclockwise until light just goes OFF.
8.	(LF only) Establish temperature of 100°F at water temperature switch gage sensor.	MAIN FUEL TANK LOW .... ON	
9.	Establish temperature of 220°F at water temperature switch gage sensor.	<p>HIGH COOLANT TEMP ..... ON STBY PWR FAIL ..... ON</p> <p>(LCEB) STBY F light FLASHING and yellow routine alarm SOUNDS on AAP.</p> <p>(LF only) Remote GMR 5 fault reporting.</p>	<p>Rotate high temperature contact adjustment screw counterclockwise until light just comes ON.</p> <p>Check and repair wiring. Replace MPP (table 5-1).</p> <p>Table 4-5, trouble 1.</p> <p>Table 4-5, trouble 1.</p>

**When to use this page**



After accomplishment of MCL 1064  
3-76

Figure 2-17. Interim change page.

CEM INTERIM CHANGE			
<b>1. TITLE</b> Power Generation and Distribution	<b>4. CEMIC NO.</b> 21-SM80B-2-21-2-1064 (Vol I)		
<b>2. CEM NO.</b> 21-SM80B-2-21-2, Vol I		<b>5. CEMIC ORIGINAL ISSUE DATE</b> 1 February 2009	
<b>3. CEM BASIC DATE</b> 15 February 1996		<b>6. CEMIC CHANGE NO.</b> 1	
<b>7. CEMIC CHANGE DATE</b> 1 October 2009			
<b>8. INSERT ATTACHED CHANGE/ADDED PAGES AS FOLLOWS:</b>  <p><b>DISTRIBUTION STATEMENT:</b> Distribution authorized to U.S. Government agencies and their contractors for administrative or operational use, dated 1 October 2009. Other requests for this document shall be referred to AFSPC MES, 250 S. Peterson Blvd., Peterson AFB CO 80914-4554.</p> <p><b>DESTRUCTION NOTICE--</b>Destroy by any method that will prevent disclosure of contents or reconstruction of the document.</p> <p style="text-align: center;"><b>FILING INSTRUCTIONS:</b></p> File this CEMIC after hard copy Change 20 has been filed. File CEM Interim Change Notice(s) sequentially in front of latest CEM Change Notice with highest CEMIC number on top. File interim change pages to face affected hard copy pages.			
<b>INTERIM CHG PAGE NO.</b>	<b>INTERIM CHG NO.</b>	<b>INTERIM CHG PAGE NO.</b>	<b>INTERIM CHG NO.</b>
v thru vi-----	0	5-101 -----	0
xi-----	0	5-103 -----	0
xiA-----	0	6-25(6-26 Blank) ---	0
1-7-----	0	*6-37(6-38 Blank) ---	1
1-17-----	0		
1-20 thru 1-21-----	0		
*1-22-----	1		
3-24-----	0		
3-26 thru 3-33-----	0		
3-35 thru 3-36-----	0		
3-75 thru 3-77-----	0		
4-16 thru 4-17-----	0		
4-45-----	0		
5-24-----	0		
5-31 thru 5-32-----	0		
5-100-----	0		
<b>9. REMARKS:</b>  			
<b>10. FINAL RELEASE AUTHORITY</b>		<b>11. VERIFICATION REQUIREMENTS</b>	
		<input type="checkbox"/>	
		<input type="checkbox"/> ADDITIONAL VERIFICATION REQUIRED	
		<input type="checkbox"/> VERIFIED AT	
		<input checked="" type="checkbox"/> VERIFICATION NOT REQUIRED	
<b>12. REASON FOR CHANGE:</b> a. To reflect configuration changes required after accomplishment of MCL 1064 (MAF LCEB Diesel Engine Replacement). b. To incorporate MES Data (1241).			

**Shows you what the MCL is that would require you to use interim change page**

Figure 2-18. Interim change cover page.

### Format of equipment manuals

Equipment manuals are a collection of manufacturer's instructions and commercial data sheets for system components. All equipment manuals are laid out exactly the same. The introduction section of the manual is similar to the system manual. It contains a title page, complete with basic date and change date. It has a list of effective pages showing every page in the manual and what change number it is on. The two major components of the equipment manual are the vendor data reference tables and the commercial data.

#### Vendor data reference table

The vendor data reference tables show you every component in the system, with the exception of common hardware. In this table, you will find a description of the component, part information (part numbers, national stock numbers, or model numbers) and the page number in the equipment manual where you can find the part.

We mentioned that in a system manual, the component list contains a sequence number. The vendor data reference table also contains sequence numbers. When looking for a specific part in the equipment manual, refer to the list of components from the system manual first. Match the sequence number on the component list in the system manual to the sequence number on the vendor data reference table to help you find the correct part. Figure 2-19 shows you part of a vendor data reference table with the sequence number.

#### Commercial data

The component information you are looking for in an equipment manual will be in the commercial data portion of the CEM. This data is arranged alphabetically for ease of use. Using the vendor data reference table and sequence numbers, you should be able to find the data sheets you are looking for without any problems.

CEM 35R-1-551-2

VENDOR DATA REFERENCE TABLE (Continued)

NOMENCLATURE AND DESCRIPTION	SEQUENCE OR REFERENCE DESIGNATOR NO.	IDENTIFICATION NO. (NSN, MODEL, P/N, ETC.)	VENDOR OR MFR CAGE NO. (H4/H8)	PAGE NO.
REGULATOR, Oil Level, DEU	3201-02J 3204-02J	Model RB Model RAB NSN 6680002363996	1PAMO	D-3
REGULATOR, Voltage	3201-18B 3204-08B	P/N 90-39100-100 P/N W10817950GVREG	97520	B-3, R-4, R-7 thru R-11, R-14
RELAY, Auxiliary Cranking (R7)		P/N 4513207 (replace with P/N SAW-4415)		A-205, A-283 A-328C
RELAY, K1		P/N KRP11DG-24VDC	77342	P-39
RELAY SOCKET, K1		P/N 27E122 NSN 5935007638699	77342	P-40

Figure 2-19. Vendor data reference table.

## 220. Civil engineering manual improvement report

Just like a TO, you may find something in a CEM that is incorrect, unclear, incomplete, or improperly sequenced. The AFGSC Form 272 gives you a way to correct or add information. Also, like an AFTO Form 22, taking the time to submit a CEM change can also earn you extra money through the suggestion program. This lesson covers the purpose and procedures for submitting an RPIE Improvement Report.

## Purpose

CEM changes are limited to those essential for weapon system reliability, safety, and protection of personnel and equipment. Changes must be consistent with good judgment, hardware, demand, technician experience, and economy. CEM changes will *not* be made to temporarily bypass system components or to change the content of a CEM MCL. The chief missile engineer will ensure close review of recommendations for changes and agree with only those that present realistic requirements. Submission of a RPIE improvement report is required to cover the following circumstances:

1. Modifications to missile facilities and equipment that require changes to operating or maintenance instructions, or changes to system descriptions and illustrations contained in existing CEMs.
2. Replacement of equipment or components with items functionally identical to the original item. The item may be of different manufacture date or model, which outdates the manufacturer's brochures or commercial data referenced in existing systems or equipment manuals.
3. Improvements required for emergency war order, emergency procedures, and safety of personnel and equipment.
4. Recommendations to improve clarity or completeness of operation and maintenance instructions.
5. Recommendations to correct errors in original data to match the actual as-built configuration of equipment.

Recommendations for CEM improvements may be submitted by anyone.

## What you should do beforehand

*Before* you take the time to complete an AFGSC Form 272, it would be in your best interest to talk to your supervisor and your local QA evaluators to find out if a change for this content has already been submitted.

## Procedures

The following procedures will provide you with a step-by-step walk-through on how to complete an AFGSC Form 272. Always ensure that you have the latest version of the form from the Air Force E-publishing Website mentioned earlier. These instructions can also be found on the rear of the form. Reference figures 2-20 and 2-21 as we go along.

### *Block 1—To*

Block 1 is the “To” block, and on the latest version of this form, the block has been auto-filled for you. If a newer version of the form is released after this CDC is published, you will need to obtain this information by calling the phone number listed in the instructions on the rear of the form.

### *Block 2—From*

Block 2 is the “From” block. Since you're initiating the report, you might think that this is you. However, per the instructions on the rear of the form, this is actually the technical order distribution officer (TODO) or technical manual change monitor (TMCN). Whichever your organization uses, you will need to obtain their office symbol and mailing address, and enter the information into block 2.

### *Block 3—Unit control number*

This block is the “Unit Control Number” block. This is completed by the missile engineer, which will be done after you have authored the AFGSC Form 272, and your supervisor and QA have both approved it. The missile engineer will add a local control number, which is used for tracking the change, as well as decide whether the change is “routine” or “emergency.”

<b>RPIE IMPROVEMENT REPORT</b>			
1. TO: AFGSC MES/MESI 250 S. PETERSON BLVD PETERSON AFB CO 80914-4554		2. FROM:	
3. UNIT CONTROL NUMBER		<input type="checkbox"/> ROUTINE <input type="checkbox"/> EMERGENCY	4. MANUAL NUMBER
5. BASIC DATE OF MANUAL	6. PAGE NUMBER	7. PAGE CHANGE NUMBER AND DATE	8. PARAGRAPH, FIGURE, OR TABLE NR.
9. BRIEF SUMMARY OF SYSTEM DEFICIENCY/RECOMMENDED CHANGE/REASON FOR CHANGE <i>(Continue on reverse if needed)</i>			
10. REPORTED BY:			
A. INITIATOR		SIGNATURE	DATE (YYYYMMDD)
B. INITIATOR'S SUPERVISOR		SIGNATURE	DATE (YYYYMMDD)
11. COORDINATION:			
A. UNIT QUALITY ASSURANCE		SIGNATURE	DATE (YYYYMMDD)
<input type="checkbox"/> APPROVE <input type="checkbox"/> DISAPPROVE			
B. UNIT TECHNICAL/SYSTEM ENGINEER		SIGNATURE	DATE (YYYYMMDD)
C. UNIT MAF MANAGEMENT		SIGNATURE	DATE (YYYYMMDD)
<input type="checkbox"/> APPROVE <input type="checkbox"/> DISAPPROVE			
12. REVIEWED BY:			
A. MISSILE ENGINEERING		SIGNATURE	DATE (YYYYMMDD)
<input type="checkbox"/> APPROVE <input type="checkbox"/> DISAPPROVE			
13. THIS CHANGE IS AUTHORIZED FOR INTERIM USE WHEN SIGNED BELOW. AFGSC MES ASSIGNED CONTROL NR.			
14. SIGNATURE OF COMMANDER	DATE (YYYYMMDD)	15. SIGNATURE OF BASE CIVIL ENGINEER	DATE (YYYYMMDD)

AFGSC FORM 272, 20100119

*(Continue on reverse)*

Figure 2-20. AFGSC Form 272 (front).

<b>RPIE IMPROVEMENT REPORT (Continued)</b>	
<b>18. REMARKS</b>	
<b>RPIE IMPROVEMENT REPORT GENERAL INSTRUCTIONS</b>	
<p>a. Block 1: Completed and coordinated form will be mailed to the address in Block 1 or E-mailed to AFGSC MES/MESI. E-mail address can be obtained by calling DSN 692-2720 or DSN 692-2815.</p> <p>b. Block 2 (Initiator): Enter the Technical Order Distribution Office (TODO) or local Technical Manual Change Monitor office symbol and completed mailing address.</p> <p>c. Block 3 (Missile Engineer): Enter local control number and mark appropriate block for Routine or Emergency Improvement Report.</p> <p>d. Block 4 (Initiator): Enter the complete Civil Engineer Manual (CEM) or Civil Engineer Manual Interim Change (CEMIC).</p> <p>e. Block 5 (Initiator): Enter the basic date appearing on the title page of the CEM. The basic date for a CEMIC is in Block 5 of the cover page for the CEMIC.</p> <p>f. Block 6 (Initiator): Enter the page number(s) affected.</p> <p>g. Block 7 (Initiator): If the deficiency involves a page identified with a change date, enter the number and date of the change for the page involved.</p> <p>h. Block 8 (Initiator): Enter the specific paragraph(s), figure(s), or table(s) number(s) affected.</p> <p>i. Block 9 (Initiator): Enter whether the AF Form 272 was submitted as a correction or as an IDEA program suggestion. Enter a concise description of the system deficiency, recommended change(s) to eliminate the deficiency or improve the condition, and reason for change. If new vendor or manufacturer brochures are required for equipment manuals, procure one original and submit as an attachment. If necessary, continue in Remarks block or on bond paper, as required. Attach all additional paperwork to Improvement Report.</p> <p>j. Blocks 10A and 10B (Initiator or Initiator's Supervisor): Enter Name, Grade, Duty Phone, Office Symbol of Initiator or Initiator's Supervisor. Initiator shall sign and date form. Initiator's Supervisor shall review AFGSC Form 272 then sign and date form. Comments may be added in Remarks block.</p> <p>k. Blocks 11A and 11B (Quality Assurance or Engineering): Enter Name, Grade, and Duty Phone of Quality Assurance or Engineering representative that performed review. Quality Assurance representative shall ensure that local procedures have been complied with for review of AFGSC Form 272 then sign and date form. Engineering representative shall sign and date form. Comments may be added in Remarks block.</p> <p>l. Block 11C is only used when improvement report affect 21-SM80-19 Series CEMs. Wing Missile Alert Facility Management Representative will review form then enter Name, Grade, Office Symbol, Duty Phone. Representative shall sign and date form. Comments may be added in Remarks block.</p> <p>m. Block 12A (Missile Engineering): Enter Name, Grade, and Duty Phone of Missile Engineering that performed review. Representative shall sign and date form. Comments may be added in Remarks block.</p> <p>n. Blocks 13 thru 15: The RPIE Improvement Report may also authorize interim use of a recommended improvement as a local CEMIC. Authorization for interim use requires AFGSC MES (Commander MES or designated representative), Wing Commander (or designated representative), and Base Civil Engineer Commander (or designated representative) approval. Enter AFGSC MES assigned control in Block 13. Wing Commander (or designated representative) and Base Civil Engineer (or designated representative) shall sign and date in Blocks 14 and 15. For further information on local CEMICs refer to AFGSCI32-1005 (CEMs).</p> <p>o. Block 16: Remarks block may be used as additional space to continue Block 9, to add comments concerning improvement Report, or for any additional comments requiring inclusion on Improvement Report. If additional space is necessary, ensure one copy of any attachment(s) is included with Improvement</p>	
AFGSC FORM 272, 20100119 (REVERSE)	

Figure 2-21. AFGSC Form 272 (rear).

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**Block 4—Manual number**

Block 4 is where you will enter the complete number of the CEM or CEMIC that you're submitting the change for. This information is extremely easy to find, as it is at the top corner of nearly every printed page in the CEM. Be sure to provide the *entire* CEM number. For example, "CEM 21-SM80A-2-21-2, Volume II."

**Block 5—Basic date of manual**

Block 5 is where you will enter the *basic date*. For a CEM, this information can be found on the title page, which is typically the very first page you'll see when you open up the front cover. For a CEMIC, this is the date in block 5 of the first page.

**Block 6—Page number**

This is where you'll enter the page, or range of pages, that will be affected by the change. If you're only trying to change one step, this will be a single page number. If you are trying to modify an entire procedure, enter the entire range of pages that will be affected.

**Block 7—Page change number and date**

Block 7 is only used when you're proposing a change to a page or pages that have already been changed in the past. If, in the bottom margin of the page or pages, there is the word *change*, followed by a number, put this in block 7. Next, you'll need to find the date of the change. Turn back to the front of the CEM, and on one of the first few pages, you'll find a page that lists all of the change numbers and their dates. Find the date that corresponds to the change number on the bottom of the page, and include it in block 7.

**Block 8—Paragraph, figure, or table number**

Block 8 is where you'll list the exact paragraph number, figure number, or table number of the change that you'd like to make. The format of paragraph, figure, and table numbers are all the same. Make sure to specify which of the three it is. The paragraphs below explain where to find each.

**Paragraph number**

The step you're proposing changes to is likely one of many steps within a paragraph. The paragraph number is closest to the left margin of the page, and is a number followed by the paragraph heading. For example: "2-16. Power System Jack box Installation and Removal."

Some CEMs have the paragraph heading in bold print, underlined, or in all capital letters, but the meaning is the same. From the example above, you would insert the word "Paragraph" or "Para," followed by the paragraph number "2-16" into block 8 of the form.

**Figure number**

If you're proposing changes to a figure, the figure number will always be located under the figure itself. You don't need to list the actual name of the figure, just the figure number. Again, make sure to preface the figure number with the word "Figure."

**Table number**

If you're proposing a change to a table (the pages with the long vertical columns), you will find the table number located at the top-left of the page, followed by the name of the table. Put this number in block 8, prefaced by the word "Table."

**Block 9—Summary of deficiency, recommended change, and reason for change**

This block is where you're going to spell out your proposed change, word for word, as if you were writing the procedure yourself. You will spend the majority of your time with the AFGSC Form 272 working in this block. The block heading suggests that you provide a "brief summary" of what you would like changed, but the instructions on the rear of the form ask for more clarity. Here is where

you will enter whether the change is being submitted as a correction or a suggestion program submission.

Block 9 is also where you will enter a description of the deficiency, your recommended change, and the reason for the change. To make sure that the individuals at missile engineering know exactly what you want changed, you should loosely format this section just like a step in the CEM. Examples will be provided on how to create changes for paragraphs, figures, and tables in a way that will relay the information the most effectively. Let's take a look at examples of changing a paragraph, a figure, and a table.

### *Changing a paragraph*

Format the change for a paragraph exactly like the CEM shows it, but with your change inserted. Don't worry about copying the entire procedure word for word; that's not necessary. You will want to list the steps before and after the step you're trying change so that other individuals who view the form can easily tell what you're requesting to change. This form doesn't have all of the functionality of a Microsoft Word document, so you may need to get creative at times. Refer to the following example:

#### **Suggestion program submission.**

**DESCRIPTION OF DEFICIENCY:** In step q. of Paragraph 5-74, the technician is directed to torque the battery lead fastening nuts to 60 in.-lbs.

**RECOMMENDED CHANGE:** Change step q. to direct the technician to torque the battery lead fastening nuts to 80 ft.-lbs.

**REASON FOR CHANGE:** Every other procedure in this CEM lists the battery lead fastening nut torque as 80 in.-lbs. Please see the suggested change below:

5-74. LF diesel electric unit (DEU) Voltage Regulator Removal and Installation.

p. Rotate...

q. Reconnect DEU battery leads and torque fastening nuts to 80 in.-lbs.

r. Apply...

As you can see, you don't need to list every single step leading up to the step you want to change. You already gave a brief synopsis of what you want changed, as well as an example of how you would like it to look. This is obviously an over simplified example, but any change to a paragraph would take on a similar format. Be as concise as possible when explaining the change you're proposing, as well as the reason for it. This will prevent the submission of your AFGSC Form 272 being delayed or returned due to questions from other individuals or agencies.

### *Changing a figure*

Proposing a change to a figure is more difficult due to the fact that a figure is a picture or a drawing. The AFGSC Form 272 isn't as user-friendly as an AFTO 22 as it doesn't allow the user to attach documents. Since the form is emailed between agencies, you have the option of sending a photo or an image that you've drawn in the email attachment. If the change is as simple as a mislabeled component in a figure, simply state that in block 9. See the following example:

#### **Suggestion program submission.**

**DESCRIPTION OF DEFICIENCY:** The component in Figure 5-3 labeled "(22) REAR CONTACT MOUNTING SCREW" is labeled incorrectly.

**RECOMMENDED CHANGE:** Change the component labeled "(22) REAR CONTACT MOUNTING SCREW" to "(22) MOTOR MOUNT CAPSCREW."

**REASON FOR CHANGE:** The incorrect labeling of this component may cause the technician to install and/or order incorrect parts, and could result in equipment damage.

If you are sending attachments with this change, it is a smart idea to list their names here.  
 Example: **Please see the accompanying attachments FIGURE1.JPG and FIGURE2.JPG**  
 (or similar).

### Changing a table

Changing a table involves a bit more creativity due to the fact that tables are formatted with vertical lines separating the columns. No formatting is allowed in the AFGSC Form 272, so you'll be using extra spaces, underscores, and vertical lines to get your point across. However, creating a table in a Microsoft Excel or Microsoft Word document might help to make the process simpler. The point is not the formatting; no change will be rejected because of that. The point is to clearly illustrate what you want changed, and why. Your shop or your local QA evaluators might already have an established process. Check with them if you are unsure. An example of a change to a CEM table built with Microsoft Excel is shown in figure 2-22.

CEM 21-SM80A-X-X-X

Table 4-6. LF DEU Troubleshooting (Continued)

PROCEDURE	NORMAL INDICATION	ABNORMAL INDICATION	CORRECTIVE ACTION
g. Connect jumper wire...	...	...	...
h. Connect jumper wire between relay K10-1 and K10-3 in engine control panel, and check voltage between terminals 2 and 6 on governor controller.	Approximately 12 VDC.	Not approximately 12 VDC.	Proceed to step i. Replace governor controller (table 5-1).
i. Check voltage between...	...	...	...

**Figure 2-22. Sample change to a table using Microsoft Excel.**

As you can see in figure 2-22, only pertinent information is included. On the AFGSC Form 272, you still need to include the same information as you would for a change to a paragraph or figure. See the following example:

#### **Submission for CORRECTION.**

**DESCRIPTION OF DEFICIENCY:** In the NORMAL INDICATION and ABNORMAL INDICATION columns of Table 4-6, step h., the technician is directed to check for approximately 8 VDC.

**RECOMMENDED CHANGE:** Change NORMAL INDICATION and ABNORMAL INDICATION columns of Table 4-6, step h. to direct the technician to check for approximately 12 VDC.

**REASON FOR CHANGE:** Checking for 8 VDC instead of 12 VDC could cause a technician to erroneously remove/replace a functioning governor controller, or leave a malfunctioning governor controller installed. Please see the suggested change in the attached Microsoft Excel document.

Regardless of the change you're trying to make, including too much information in block 9 is preferred over not including enough. Be as explicit and descriptive as you can. Lastly, if new vendor or manufacturer manuals are required for the change, you'll need to send copies of those along with your AFGSC Form 272. These can typically be downloaded from the internet or requested in digital format directly from the vendor or manufacturer.

### **Block 10—Reported by**

#### **Block 10A—Initiator**

Enter your name, grade, duty phone number and office symbol, and then sign and date the form.

***Block 10B—Initiator’s supervisor***

Your supervisor will review your work, and make remarks, if applicable. They’ll then add their name, grade, duty phone number, and office symbol, and then sign and date. Your supervisor can add comments in the remarks block if they desire to do so.

***Block 11—Coordination******Block 11A—Unit quality assurance***

Block 11A is completed by the QA evaluator that reviewed your submission. They’ll either approve or disapprove your request, then they’ll enter their name, grade, and duty phone number, and then sign and add the date. Note that even if the AFGSC Form 272 is disapproved by QA, it will still continue to the next agency. The evaluator may leave comments in the remarks block as well.

***Block 11B—Unit technical/system engineer***

Block 11B is completed by your unit’s technical or system engineer. They will enter their name, grade, and duty phone number, and then sign and add the date. They may leave comments in the remarks box.

***Block 11C—Unit MAF management***

If your proposed change involves any CEM in the 21–SM80–19 series, the wing missile alert facility (MAF) management representative will need to review it. They will enter their name, grade, office symbol, and duty phone number, and then sign and add the date. They will approve or disapprove the request. They may also provide comments in the remarks block. Even if the request is disapproved, it still continues to Missile Engineering.

***Block 12—Reviewed by***

Here is where the missile engineer will enter their name, grade, and duty phone number, and then sign and date the form. The missile engineer can approve or disapprove the request, and add comments in the remarks section. Note that if the AFGSC Form 272 is disapproved by the missile engineer, the change will not continue any further.

***Block 13—AFGSC MES assigned control number***

If the change is authorized, this block is where Missile Engineering will annotate a control number.

***Block 14—Signature of commander***

Your wing commander will sign and date in block 14.

***Block 15—Signature of base civil engineer***

Your wing’s civil engineer will sign and date in block 15.

This has been a step-by-step breakdown of each of the blocks on an AFGSC Form 272. Remember that instructions can also be found on the rear of the form, under the heading *RPIE IMPROVEMENT REPORT GENERAL INSTRUCTIONS*. The instructions on the newest version of the AFGSC Form 272 will always supersede the instructions in this CDC.

***AFGSC Form 272–1, Improvement Report Reply***

After your change has been reviewed, Missile Engineering will send you an AFGSC Form 272–1, Improvement Report Reply. This form lists the evaluator who reviewed your submission, whether your change was approved, disapproved, or put on hold, and comments regarding your submission, as well as other information. It is highly advisable that you keep copies of the AFGSC Form 272 and 272–1, with any attachments you made in case the originals are misplaced.

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## Self-Test Questions

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

### 218. Description of civil engineering manuals

1. What does a system manual provide?
2. What is an equipment manual a collection of?
3. What information does a MCL contain?

### 219. Format of civil engineering systems and equipment manuals

1. What can make researching replacement parts in a CEM somewhat difficult?
2. What do the illustrations in the special tools and test equipment section show you?
3. What should you do if you receive any indication other than a normal indication when performing a checkout in a three-column format?
4. What should you do if the corrective action of a checkout does not refer you to specific procedures?
5. If a system manual does not have a maintenance section, where would you find maintenance instructions?
6. When can you use CEM schematics for troubleshooting without following written procedures?
7. Where do you refer to see what MCL an interim change page applies to?
8. What information is contained in the equipment manual vendor data reference table?
9. How is the commercial data in an equipment manual arranged?

**220. Civil engineering manual improvement report**

1. What are changes submitted for CEM limited to?
2. What should you do *before* starting the process of authoring an AFGSC Form 272?
3. What information goes into block 4 of an AFGSC Form 272?
4. When will block 7 of an AFGSC Form 272 be used?
5. Where is the number of a figure located in a civil engineering manual?
6. When submitting a change to a table in a civil engineering manual, what might make the process simpler?
7. What information is entered into block 10B of an AFGSC Form 272?
8. What information is contained in an AFGSC Form 272-1?

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**Answers to Self-Test Questions****214**

1. A supplement cannot be less restrictive than its parent publication.
2. A memorandum is published when there is insufficient time to process a directive.
3. All personnel in the unit and/or subordinate unit who developed them.
4. They should only be displayed for 180 days or less and the expiration date should be printed on the bottom.
5. The office of primary responsibility listed on the website.

**215**

1. O&M TOs.
2. Methods and procedures TOs are not required to be available and used at the job site.
3. Any TO applicable to a specific weapon system and its related items.
4. Directing and providing instructions for modifications and the performance of one-time inspections.
5. "IMMEDIATE ACTION" is printed in red at the top center of the first page and a series of red Xs are printed around the border of the first page.
6. The equipment or item must be removed from service until the TCTO is completed.

7. A validation-verification must be performed on its procedures.
8. Procedures on special test equipment.
9. One technician reads the step; the other technician completes the step, and then verbally responds to indicate that the step was complied with.
10. Accept/reject criteria.
11. Inform your supervisory personnel to obtain a TO waiver.

### 216

1. It ensures that you have the most recent version of the book—TO.
2. To ensure that you're familiar with any changes to tasks or additional tools and test equipment you may need.
3. Before starting any maintenance task.
4. It will help develop your system knowledge.
5. Perform the next step.
6. Alarm indications section.
7. Perform the applicable procedure to establish the required mode of operation.
8. Only when used in *conjunction* with trouble analysis procedures.
9. A vertical black line will be printed next to the changed content.

### 217

1. To correct errors or omissions of a technical nature, which prevent adequate performance of functions required for mission accomplishment.
2. Select the correct category or disapprove the recommendation.
3. An interim TCTO or rapid action change
4. If they cause misinterpretation or affect the meaning of instructions that would impede the mission.
5. Brief summary of deficiencies and recommended change.
6. So that you can use the suggestion program to your benefit.

### 218

1. Instructions for operation and maintenance of a RPIE system.
2. Commercial owner's manuals.
3. All of the information needed to complete a modification or one-time inspection.

### 219

1. Not all components may be listed in the component lists.
2. Particular pieces of equipment or how to fabricate locally manufactured tools or equipment.
3. The corrective action listed.
4. Do what the corrective action says while complying with standard maintenance practices.
5. Equipment manual.
6. When procedures have been exhausted or are leading you astray.
7. The CEMIC cover page.
8. Description of the component, the part information (part numbers, national stock numbers, or model numbers), the page number where the component information is located, and the sequence number.
9. Alphabetically.

### 220

1. CEM changes are limited to those essential for weapon system reliability, safety, and protection of personnel and equipment.
2. Talk to your supervisor and local QA to see if a change has already been submitted for this content.
3. The complete number of the CEM or CEMIC that you're submitting the change for.

4. When a change is being proposed to a page in a CEM that has been changed in the past.
5. The figure number is located beneath the figure.
6. Creating a simple table in Microsoft Word or Microsoft Excel to mimic a table in a CEM.
7. Your supervisor's name, grade, duty phone number, office symbol, signature, and date.
8. Name of the evaluator who reviewed the change, whether it was approved, disapproved, or put on hold, and comments regarding the submitted change.

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

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## 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.**

42. (214) At what organizational level are operating instructions (OI) developed for use?
- Major command.
  - Element.
  - Wing.
  - Unit.
43. (214) What is the purpose of a permanent visual aid?
- Explain or instruct.
  - Inform or motivate.
  - Promote or endorse.
  - Direct or implement.
44. (214) You should reference the Air Force Publishing website for publications rather than using a copy found on a computer or network drive because
- the website versions contain more information.
  - the website maintains the most current version.
  - paper copies are only used for the revision process.
  - the website contains sensitive information that is not in your paper copies.
45. (215) What information does a methods and procedures technical order (TO) contain?
- Status of all time compliance technical orders (TCTO).
  - Troubleshooting steps for specific military systems and end items.
  - General information that applies to more than one weapon system.
  - Excerpts from one more TOs that organize and simplify instructions.
46. (215) What information does an inspection work card contain?
- Step-by-step procedures.
  - Specific pass or fail criteria.
  - Planned work schedule or sequence.
  - Abbreviated step-by-step procedures.
47. (215) What happens when an urgent time compliance technical order (TCTO) is *not* completed within its set time limit?
- The equipment or item must be removed from service.
  - An improvement report must be filed to change the TCTO.
  - A periodic inspection must be completed on the equipment or item.
  - The item must be returned to Depot to complete the required actions.
48. (215) Before a preliminary technical order (TO) can be used for maintenance on the weapon system, it must
- be incorporated into the list of applicable publications.
  - be approved for interim use by the base missile engineer.
  - be accompanied by a technical order waiver from your supervisor.
  - have its procedures verified with oversight from the technical content manager.

49. (215) What determines how a technical order will be numbered?
- The series of production the weapon system is in.
  - When it is received by the technical order library.
  - The sequence identified in the index technical order.
  - The first set of numbers/letters that identify the category.
50. (215) When using a technical order (TO), which is the *best* way to ensure that all steps were completed?
- Read through the procedures one additional time.
  - Perform an operational checkout to verify the system works.
  - Check the inspection work card to ensure the procedure was done.
  - Have a second technician perform the procedure to check your work.
51. (215) When a conflict between a technical order (TO) and an Air Force Safety and Health (AFOSH) standard exists, you must use
- whichever guidance is more restrictive.
  - a combination of the two procedures.
  - the AFOSH guidance.
  - the TO guidance.
52. (216) What information is located in the bottom right-hand corner of a technical order's (TO) title page?
- When the TO was first published.
  - The title and TO number assigned.
  - The category of the TO and what it is used for.
  - The latest change number and the date it was published.
53. (216) What information is provided on a technical order's (TO) list of effective pages?
- Pages that contain diagrams and illustrations.
  - Where specific information is located in the TO.
  - A list of all the pages that apply to a specific component.
  - A list of all the pages and the latest change number for the page.
54. (216) What information would you find in the special tools and test equipment section of a technical order (TO)?
- Instructions on using some specific equipment.
  - Where to find procedures on using special tools.
  - The amount of a consumable required for a task.
  - Preoperational checkout instructions for all equipment.
55. (216) When performing a checkout in a technical order (TO) with a four-column format, how do you proceed if you get an abnormal indication?
- Proceed to the next step.
  - Perform the corrective action.
  - Refer to the alarm indications table.
  - Perform component replacement and adjustment.
56. (216) What important information is contained in the component replacement and adjustment table of a technical order (TO)?
- Instructions for performing maintenance.
  - A definition for all reference designators.
  - Where components are physically located.
  - What mode of operation the system must be in.

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57. (217) Prior to submitting an Air Force Technical Order (AFTO) Form 22, who reviews it to ensure it is a valid recommendation?
- Section superintendent.
  - Flight commander.
  - Quality assurance.
  - Supervisor.
58. (217) What priority is selected on an Air Force Technical Order (AFTO) Form 22 for a technical order deficiency which, if *not* corrected, would result in a fatality or serious injury to personnel?
- Urgent.
  - Category I.
  - Emergency.
  - Category III.
59. (217) You would use what priority to submit an Air Force Technical Order (AFTO) Form 22 for a deficiency in a time compliance technical order (TCTO)?
- Emergency.
  - Standard.
  - Routine.
  - Urgent.
60. (217) After a routine technical order (TO) improvement report is received by the technical content manager (TCM), the technical order (TO) update is generally published
- within 1 year.
  - within 48 hours.
  - with the next publication review.
  - with the next publication revision.
61. (217) Under what circumstance can you submit more than one correction on a technical order (TO) improvement report?
- If authorized by quality assurance (QA).
  - The report is an emergency priority.
  - The same error occurs in more than one TO.
  - The same error occurs more than once in the same TO.
62. (218) What two types of civil engineering manuals (CEM) are usually used together?
- System manual and equipment manual.
  - Inspection manual and equipment manual.
  - Master change log and equipment manual.
  - Interim change and equipment manual.
63. (218) What information is provided in a civil engineering manual (CEM) master change log (MCL)?
- Contents of an interim change package.
  - Procedures for performing one-time inspections.
  - Instructions on submitting an improvement report.
  - Operations and maintenance procedures for maintaining the system.
64. (219) What key information is contained in a system manual component list to help you locate a component in the equipment manual?
- Part information.
  - Figure reference.
  - Sequence number.
  - Reference designator.

65. (219) When you encounter an interim change page in a civil engineering manual (CEM), how can you tell which procedure to perform?
- Always* perform steps on the interim change instead of the original page.
  - Check the list of effective pages to see if this is the current page to follow.
  - A black bar in the margin next to the steps means you perform the procedure.
  - Instructions at the bottom of the interim change page will tell you when to perform it.
66. (220) Civil engineering manual (CEM) improvement reports are submitted for all *except*
- replacing components.
  - changes to ensure system reliability.
  - correcting violations of federal regulations.
  - temporarily bypassing system components.
67. (220) What information is populated into block 2 of an Air Force Global Strike Command (AFGSC) Form 272?
- Initiator's office symbol and mailing address.
  - Quality assurance (QA) evaluator's name and date.
  - Technical distribution officer's (TODO) or technical manual change monitor's (TMCM) office symbol and mailing address.
  - Chief missile engineer's office symbol and mailing address.
68. (220) What information is entered into block 6 of an Air Force Global Strike Command (AFGSC) Form 272?
- Page or range of pages that will be changed.
  - Figure number that will be changed.
  - Procedure that will be changed.
  - Rationale for proposed change.
69. (220) What information is populated into block 9 of an Air Force Global Strike Command (AFGSC) Form 272?
- Missile engineer's office symbol and mailing address.
  - Quality assurance (QA) evaluator's duty phone number.
  - Initiator's name, grade, and duty phone number.
  - A description of the deficiency.
70. (220) Who completes block 11A of an Air Force Global Strike Command (AFGSC) Form 272?
- Missile engineer.
  - Unit technical engineer.
  - Quality assurance (QA) evaluator.
  - Missile alert facility (MAF) management representative.

## Unit 3. Maintenance Fundamentals

221. Troubleshooting techniques.....	3-1
222. Hardware .....	3-8
223. Electrostatic discharge control.....	3-11
224. Hydraulic systems.....	3-13
225. Pneumatic systems.....	3-16

**M**AINTENANCE INVOLVES much more than simply turning wrenches. To become a successful maintenance technician, you need to learn several other skills that are basic to your specialty. Mechanical skills will not solve many of the problems you encounter in the missile field that will prevent you from ensuring that the weapon system is reliable and ready to go at a moment's notice.

In this unit, we explore a few maintenance practices that will help you succeed in this career field and ensure that technicians maintain the weapon system in optimal condition. We will also explore some of the maintenance support programs that you need to understand, as you will use those programs or be involved in them. Understanding this unit is critical to ensuring your ability to properly troubleshoot faults and use some of the equipment required to do so. Lastly, you will learn about the theory and operation of hydraulic and pneumatic systems.

There are several maintenance practices that you need to learn in addition to knowing the ins and outs of your specialty. This section we will explore some basic troubleshooting techniques and examine the diagrams that can help with that process.

### 221. Troubleshooting techniques

One could say that finding a fault is the process of working your way from the most obvious solution to the least obvious one. Your ability to effectively troubleshoot equipment could mean the difference between an easy day and a very long day in the field troubleshooting a simple fault. In this lesson, we'll cover the most effective methods for isolating malfunctions in electrical circuits. We'll discuss the different types of electrical malfunctions, as well as how to isolate them with a multimeter. Then we'll look at some of the common electrical components in the weapon system and how to identify problems with them. Using these tools, coupled with your experience, will help you tackle any system malfunction.

#### Troubleshooting steps

Electrical troubleshooting is the step-by-step process for analyzing, locating, and correcting malfunctions. The purpose of troubleshooting is to isolate a fault or malfunction, and return the system back to its normal operating condition as quickly as possible. Troubleshooting is largely a mental endeavor that can be very taxing and exhausting at times. To be effective at it, you have to have the proper mental state and follow a logical order of fault isolation. Here are some things to keep in mind as you get started.

Troubleshooting Recommendations	
No.	What to do
1	Do <i>not</i> jump to conclusions; follow a troubleshooting path until it has been exhausted or leads to the fault. To troubleshoot effectively, you must follow a systematic procedure, not haphazard "here-and-there" checking. This will help you track down the fault in a minimum amount of time.
2	Use your experience wisely. Just because you have seen this fault in the past does not automatically mean it is the problem this time. Don't get stuck thinking this is the only answer. This will cause you to overlook additional faults or the actual fault entirely.

Troubleshooting Recommendations	
No.	What to do
3	Be open to suggestions. Sometimes a new set of eyes can help identify an overlooked fault. Use the experience of others in conjunction with your own.
4	Be wary of fatigue. Troubleshooting can be taxing and at times frustrating for most individuals. Take breaks or give someone else a try because most individuals have a hard time following a logical process when they are tired or frustrated.
5	Most importantly, the TOs and CEMs have schematics, and you should use them in conjunction with your procedures. When following procedures, know where in the system the procedure is having you check and analyze why. This will aid in your logical process and allow you to mentally eliminate components or circuits as potential problems.
6	Use the TO and/or CEM and use your head! You have to use both of them and you cannot abandon either one in your troubleshooting efforts. Do not follow the TO or CEM blindly without knowing what you are checking. Use what you have been taught to know when the procedure is not following the path you should be on.

Troubleshooting the many intricacies of the Minuteman III weapon system ECS and power generation and distributions systems is not something you will immediately master. Troubleshooting requires a logical plan to identify the fault, a good understanding of basic electrical theory, and an understanding of the specific equipment that you're working with. There are six fundamental steps to troubleshooting. They are listed below in the order they should be completed:

1. Perform a preliminary check.
2. Perform an operational check.
3. Locate a troubleshooting procedure and corresponding schematic.
4. Locate the malfunction.
5. Perform corrective action.
6. Perform a final operational check.

Let's look at each one in more detail.

### *Perform a preliminary check*

The first step in troubleshooting is to perform a preliminary check. The purpose of a preliminary check is mainly to discover if there are any obvious indicators that are present that might point you in the right direction. This can involve several things, but remember that you cannot start probing or making corrections without first referring to your TO or CEM. The following are some things to look for in your preliminary check.

Use your senses of hearing, sight, smell, and touch as follows:

- Listen to the system. Determine what components are operating or not operating. Listen for chattering relays, louder than usual motors, or out of balance fans. Just listen for anything that does not sound like it is supposed to. After spending enough time on various MAF and LF, you will become very aware of how the various systems are supposed to "sound." This will give you a good starting point for your troubleshooting.
- Look at the system. Check electrical components for signs of damage from overheating. Look for charred wires. If your system has clear glass fuses, check those fuses with a flashlight to see if they are blown. Visually inspect the wiring to ensure it is all tightly connected and the

insulation is intact. Check for corrosion on components. Check for fluid leaks. Check circuit breakers and switches to ensure they are in the proper position. Check alarm indicators, such as the lights on the input/output modules or the light-emitting diodes on the MPP. A good visual inspection starts you on the right road and might even reveal the fault itself. Just be careful! Sometimes what you see is the result of a fault and not the actual fault itself (i.e., a blown fuse is usually the result of a fault and not the fault itself).

- Smell for abnormal odors. This probably sounds funny, but when an electrical malfunction has occurred, you will likely be able to smell it when you enter the room or area. Burnt wires or motor windings have a very pungent and particular odor.
- Lastly, touch the different components if necessary. If you are unsure a fan or motor is operating, putting your hand on the motor will tell you if it is operating. If a component that normally operates very smoothly is suddenly vibrating badly, you may have located a problem.

As a safety precaution, keep in mind that the system might be energized and there are several moving parts that could injure you. Make careful checks, but remember that you cannot start probing or working on the system until you have referred to a TO or CEM.

### *Perform an operational check*

Regardless of whether your preliminary check turned up any obvious clues or not, your next step is to perform an operational check. The purpose of an operational check is to discover the first part of the system that does not operate normally. If objects “A” and “B” start normally, but “C” does not, you obviously don’t need to pay any mind to objects “A” and “B.” There is obviously some sort of issue with object “C.” For example, if you begin an operational checkout of the PTAPU, you may find that it won’t even start. Or, you may find that it does start, but doesn’t run for very long before shutting down. You shouldn’t waste your time troubleshooting the battery and the starter because the APU *already* runs. Sometimes an operational checkout isn’t possible. For instance, if the LF ECS is not operating, you cannot perform an operational check and must skip this step.

Most systems have an operational checkout or an inspection procedure that can be followed. It is important to perform this step when you can because it will help duplicate the fault. Here are some things to consider when performing an operational check during troubleshooting:

- If you find a problem, do *not* overlook it because you don’t think it could be the problem.
- If you find an abnormal indication, consider whether it is possible your test equipment is faulty and not the equipment under test. This is not too common, but sometimes faulty equipment can make you think you found a problem. Just be aware of it.
- Use your senses again during the operational checkout. For example, if you start the PT APU, check it over and look for visual problems, and listen for abnormal noises or notice unusual odors.

If you encounter an abnormal indication, perform the corrective action listed in the TO or CEM. If you cannot perform an operational checkout, you’ll need to locate a troubleshooting procedure.

### *Locate a troubleshooting procedure and corresponding schematic*

Sometimes, locating a troubleshooting procedure and finding the schematic to accompany it is easy. If troubleshooting the MAF or LF ECS, a troubleshooting table in the TO asks what mode of operation the system is in and what alarm conditions exist to help direct you to a procedure. If troubleshooting the power system, the CEM has a fault matrix or fault list to align your MPP indications to a specific troubleshooting procedure. Others are in table format with a simple list of what the problems are and what could be the cause. In a lot of cases, when performing an operational checkout, the corrective action for an abnormal indication in the TO or CEM will refer you to a troubleshooting procedure.

Remember to locate the schematic for the system you are troubleshooting. When using the troubleshooting procedures, always follow the schematic and understand what you are checking and why. This will help greatly in the process.

### *Locate the malfunction*

The fourth step in troubleshooting is where you'll actually locate the malfunction, and this will usually be the most difficult step. This is where you combine your experience and system knowledge with the procedures and schematics you are using. Here are some useful hints on actually locating the malfunction:

- Draw out the circuit you are working on so you don't get muddled with looking at the entire schematic. Once you're familiar with your schematics and diagrams, you probably won't need to do this anymore.
- Using the schematic, understand what the procedure is directing you to check and why. This will eliminate components once they pass their checkout and will also help you recognize when the procedure is not leading you in the right direction. Remember, with a TO, you must use the procedures in all situations, but with a CEM, you can troubleshoot using schematics alone if your procedures do not lead you to the problem.
- Refer to the TO or CEM descriptions for how a circuit should operate. This will also help you identify when a circuit or component is not operating as it should. Remember that a description of the system is typically found in the front of the TO or CEM.
- When troubleshooting a large system with just the schematic, break the system down into smaller parts. Instead of checking directly at the source of power, check power at the component that should be receiving power. If that component is receiving power, you know the rest of the circuit has power and you won't need to check every single test point along the way.
- If the component is receiving power, but not repositioning or operating as it should, isolate it and take resistance measurements. This will tell you if the coil on a motor starter or other electrical component is defective or not.

Once you locate the malfunction, you must now fix it.

### *Perform corrective action*

Once you locate the malfunction, you must complete the corrective action. When you're doing this, make sure that you perform a neat, and permanent-type repair using TO or CEM approved parts and methods. Do not use a "band-aid" or temporary-type fix; otherwise, you or another team may have to return and re-do the repair when the problem returns.

### *Perform another operational check*

At this point, you have successfully troubleshot the system, located the malfunction, and have repaired it. Now it's time to verify your work. Using procedures in your TO or CEM, always perform another operational checkout on the system you just repaired. If you fail to perform this step, there is no way of verifying that you have fixed the actual problem. There also may be other problems that could have been overlooked. If the operational checkout is successful, your mission is complete and you have restored the system to operational status.

### **Electrical malfunctions**

To aid in your troubleshooting effort, you must be able to recognize some common electrical malfunctions and how to find them. The two most common electrical problems you will encounter are opens and shorts.

## Opens

An open is an incomplete path for current flow within the circuit. An open can be caused by a broken wire, a blown fuse, a relay or switch that doesn't close, or when any other device in the circuits fails to provide a complete electrical path. Naturally, if there is an open, there can be no current flow. As a result, the component or device supposed to receive power doesn't and won't operate.

To find the exact location of an open circuit, you'll want to use a multimeter. There are two methods of using a multimeter to locate an open.

### Checking for open circuits using voltage checks

To find an open using the voltage setting on your multimeter, power must be applied to the system. Check voltage with your positive lead to the power side and your negative lead to a ground. Using a schematic, find what test points are on the circuit you suspect is open and test each point until you find 0 volts. The open circuit is between the last applied voltage reading and the first 0 voltage reading. Pretty simple, right?

To help in this, you must understand what "difference of potential" means. If you use a multimeter to test between two different points on the same wire that has 120 volt alternating current (VAC) on it, your meter *will not* show 120 VAC or even 240 VAC, Why is this? The reason is stated above. Multimeters test for a *difference in potential* or differences in voltage. Since you're testing in two places on the same wire, there is no difference in potential, or voltage. The same 120 VAC is on the wire at both spots you're testing. Now, take this same concept and apply it to a wire that has 120 VAC on it, and a ground point that has zero VAC on it. What is the *difference* in voltage? You would be correct if you said 120 VAC, because that is the difference between 0 VAC and 120 VAC. That is how your multimeter works. The difference is displayed on your multimeter is the difference in the voltage between your positive test lead and your negative test lead. It is easiest to check from a positive terminal to a ground terminal. If your ground system is intact, you should have no voltage on it. Figure 3-1 better illustrates this. When you use a multimeter (fig. 3-1) to measure difference in potential, check for open circuits using resistance checks.

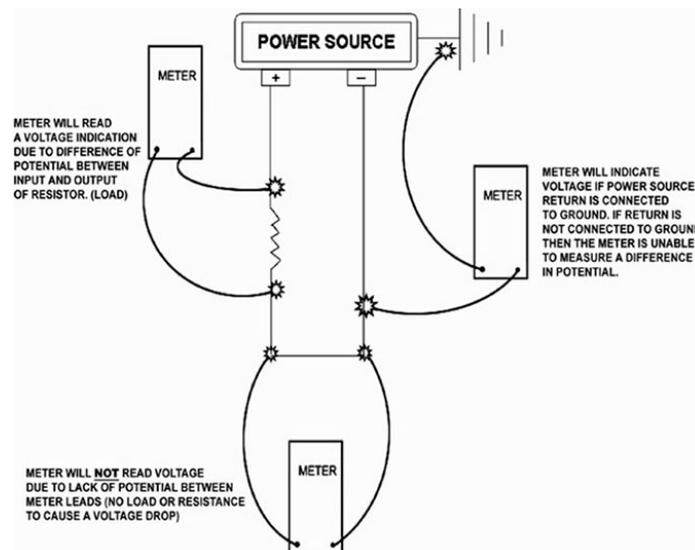


Figure 3-1. Using a multimeter to measure difference in potential.

To find an open circuit using the resistance setting on your multimeter, remember that power must not be applied to the circuit. Isolate the circuit or component being tested by removing the wiring from either the positive side or the negative side. Check the first test point in your circuit to any other test point in the circuit. A reading of 0  $\Omega$  (ohms) indicates an open does *not* exist between the two points you have your multimeter connected to. Continue checking from the start of the circuit, all the way

through the end of the circuit until you finally get a reading of open loop (“OL”), which indicates that you’ve found the open in the circuit. When you receive an OL indication, the open circuit exists between the two points where your leads are connected

### Shorts

Shorts in a circuit are a little harder to find. The way our systems are designed, there are protective devices that open to prevent a short from damaging the system. Usually, you first have to locate the open and then try to find a short to find out why it opened. For example, if you discover an open fuse, in almost every case, a short caused excessive current, which in turn caused the fuse to open (blow) to remove power from the circuit. Do *not* replace a fuse until you find a short or verify the absence of one.

There are three types of shorts you might encounter; direct shorts, cross shorts, and shorted controls.

#### Direct short

A direct short occurs when positive and negative conductors make direct contact. During normal circuit operation, current flows between positive and negative, but there are resistive devices that use the current, such as a motor. When a direct short bypasses the resistive device, the current draw is excessive. If the excessive current continues long enough, fuses will blow or wires will melt until the circuit opens, interrupting the current flow.

Direct shorts can be located with a multimeter. Turn power off to the unit. Isolate parts of the circuit from each other by separating wires and connect one test lead to a ground terminal. All of the ground terminals in the system you’re working on are generally interconnected through direct metal contact or other wiring. For instance, if you were to set your multimeter for resistance, and checked between one ground point in the brine chiller control panel, and another point all the way over in the air handler control panel, you would show 0 Ω (continuity). It helps to remember the phrase “A ground is a ground, is a ground.” Use the ground terminal on the resistive device in the circuit for as a ground. Check resistance between the ground terminal and the positive conductor. If OL is indicated, a short does *not* exist between the point you are checking and ground. Continue isolating and reconnecting each part of the circuit while checking each part with a multimeter. Once you get a 0 Ω indication, you have found the location of your short (or continuity where there should be none) in your circuit.

#### Cross short

A cross short occurs when the positive conductors of two or more independent circuits make contact. This usually does not result in excessive current, blown fuses, or melted wires; it simply applies power to a circuit that was not supposed to have power. Figure 3–2 illustrates what occurs during a cross short. In the figure, the cross short is indicated, showing you that both lamps are illuminated when only one switch is actually closed.

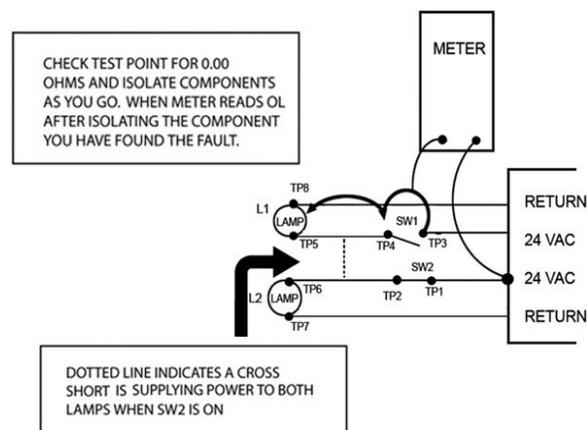


Figure 3–2. Using a multimeter to locate a cross short.



### *Coils and windings*

Coils and windings can be found in motors, transformers, and relays. With power removed from the circuit, isolate the component by disconnecting the incoming wiring. Measure the resistance between the incoming terminals and the ground terminals on the component. In some cases, you will not find the resistance value in the TO or CEM. You might find a data plate on the motor or transformer giving you a nominal value, or you might need to refer to manufacturer specifications to find it. However, a reading of OL definitely represents an open coil or motor winding. Remember that the coil is the resistive load in the circuit. It is what actually uses the voltage and current provided by the power source to perform work. A resistance check on a properly functioning coil will show *some* amount of resistance. A faulty coil will show an excessive amount of resistance or OL. If you cannot find the correct resistance value in a TO or CEM, use the resistance value from a known operational coil, which may be found in another part of the system or in your spare parts kit. The Air Force uses the same model wherever possible, especially in the various ECS panels.

If you're troubleshooting a motor winding, it is invaluable to test the resistance of the winding in one phase against the others. Use the brine pump as an example. If the "A" and "B" phase windings have 40 ohms of resistance, and the "C" phase winding has 900 ohms, you can plainly tell that the "C" phase winding is bad. The brine pump will need to be replaced.

You also cannot forget to test each phase to see if it is shorted to *ground*. If "A" and "B" phase motor windings show 1 megohm to ground, but "C" phase shows 15 ohms to ground, you can plainly tell that the "C" phase winding is shorted to ground or to the case of the motor. The brine pump will need to be replaced. Always investigate when one coil or winding does not have the same resistance readings that other identical coils or windings have. "One of these is not like the others!"

If you are troubleshooting a coil or motor winding using an ammeter, make sure to keep in mind that when a motor or component is first starting up, it draws a much higher amperage, which then drops back to its normal operating amperage. This condition is generally referred to as the *startup current*. Unless the TO specifically tells you to measure startup current draw, do not mistake this high amperage on startup as an abnormal indication. Whenever possible, you should perform amperage checks when the system is running normally and not in the middle of starting up.

### *Switches, circuit breakers, or contacts*

You can check these components with power on or off; if you check with power on, measure the difference of potential between the input and output wires of the component. Approximately 0 volts indicates the switches or contacts are closed (no difference of potential between the incoming and outgoing terminals). If your switch or breaker is closed, and your multimeter measures a large difference in potential, this is a telltale sign that the component isn't working correctly.

If checking with no power applied, isolate the wiring and check resistance between the terminals with the switch or contacts closed. It should read 0  $\Omega$ . If checking it with the switch or contact open, it should read OL.

In this lesson you have learned about the process for troubleshooting electrical components. You may not be a troubleshooting phenomenon at first, but with sound techniques and practice, you will become very good at it. Most of the methods you have learned in this lesson can also be applied around the house and can even save you money on vehicle maintenance.

## **222. Hardware**

There are several lug nuts that hold the wheels onto your car or truck. They are made from very strong materials, and they are made to keep your wheels attached to your car in a variety of environments. Now, think of the tiny screws that hold your cellphone, laptop, or other electronic device together. They don't need to bare a load like the lug nut holding your car's wheel on does, and are therefore made of much softer and lighter metal. Now imagine, if through an error, your lug nuts were replaced with nuts that *looked* like normal lug nuts, but weren't made of the correct type of

metal. It wouldn't be long before the threads stripped out and you lost a wheel. The weapon system is no different. It requires different types, strengths, and configurations of hardware depending on different factors. If the correct hardware is not used, or it is procured from an unauthorized source, problems with hardness would no doubt occur.

As you have already seen through your technical training—as a 2M0X2, you will use a *lot* of hardware. Your job requires that you take many components apart and reassemble them. The majority of the time, you'll be using bolts, washers, and nuts. All of these items can be grouped under the heading *hardware*. In this lesson, we will cover the characteristics of the hardware you'll commonly be using, followed by information on some other ways we secure fasteners. When replacing hardware, make sure to always verify the proper configuration in a technical order, civil engineering manual (CEM), or IPB. This will aid in maintaining the site's built-in hardness and survivability. We will cover bolts, nuts, and washers, and conclude by discussing quick-release pins.

### Aerospace hardware

The missile is the only part of the weapon system that will leave the ground and take flight. For that reason, the hardware used on the missile (or an aircraft) is called *aerospace* hardware. Aerospace hardware is just like regular hardware, but it must meet more strict standards, and be made of lighter and stronger materials. For example, it doesn't matter how much the nuts weigh that fasten the ESA doors to the walls of the lower LER. However, every single gram of weight matters on a missile or aircraft. As a 2M0X2, you will rarely, if ever, be concerned with actual aerospace hardware. It is important that you understand the terminology though.

Hardware used in the Minuteman III weapon system is distinct and serves specific purposes. You must remember that all hardware needs to be ordered through the supply system using codes and stock numbers listed in your technical data. Even if you have seen the same nut, bolt, or washer in a bin at your local hardware store doesn't mean that it is fit for use in the weapon system. In the hardness lesson from Volume 1, you learned that some pieces of hardware must be of a specific strength or be a specific dimension to properly serve their purpose during a nuclear event. A piece of hardware from the local hardware store may seem to be an exact replacement, but would almost certainly fail if it was exposed to the extremes of a nuclear environment. Remember that all of our replacement hardware must come from authorized sources.

### Bolt

A bolt is a fastener (fig. 3-4) that is essentially a cylindrical body with a thread spiraling around it. One side of the cylindrical body has a *head* on it. The head is shaped so that a wrench or a socket will fit snugly on it so that it can be tightened. The purpose of a bolt is to fasten one or more objects together. Since the threads spiral around the body of the bolt, twisting it into a set of matching threads on another object will cause it to engage, and “thread” in. There has to be something on the opposite side of the head for the threads on the bolt to thread into. When you're working with a bolt, you will find that this is done one of two ways:

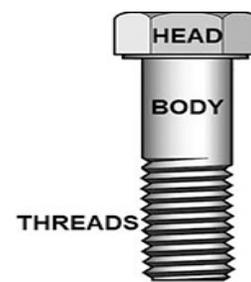


Figure 3-4. Bolt.

### Threading the bolt into hard-mounted threads

These threads are physically attached to the structure. Sometimes, you will see this is done as simply as welding a nut to the panel. Other times, there are threads physically cut into the panel. You put the object that you want to secure in place, and then place the bolt through the object and into the threads. The object being fastened typically does *not* have any threads. The bolt just goes straight through it. You can see an example of a nut threaded into hard-mounted threads in figure 3-5. An advantage of this method is that there is no nut to possibly lose. A disadvantage is that if the threads on the

structure become too worn or strip out, a larger hole must be drilled and have threads cut into the structure. The original bolt will no longer fit, and a larger one will need to be used.

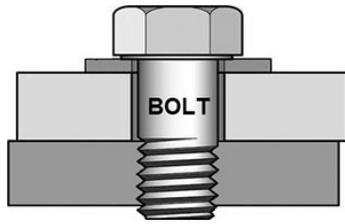


Figure 3-5. Hard-mounted threads.

### Threading the bolt into a nut

A nut (discussed in detail later) (fig. 3-6) is used when two or more objects need to be “sandwiched” together. You place the bolt through the front of the objects, and then thread the nut onto the threads of the bolt protruding out of the other side. Once it’s time to tighten the bolt/nut combination, you might find that when you’re tightening the nut, the head of the bolt begins to spin, or vice versa. This can be remedied with a *backing wrench*, which is simply the use of another tool to hold the head of the bolt stationary while you tighten the nut. Naturally, this problem would not occur with hard-mounted threads.

## Nut

As discussed earlier (fig. 3-6), a nut is an object that a bolt or other threaded object threads into with the main intent of securing or compressing one or more objects together. The threads on a bolt are on the outside of its body—that means that the threads on a bolt must be on the inside of its body. Just like the head of a bolt, the outside of a nut’s body is shaped so that a wrench or socket can fit onto it so that it can be tightened. Now that you have an understanding of what a nut is for, let’s discuss the common types of nuts.

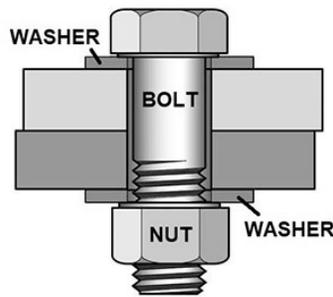


Figure 3-6. Nut.

### Wing nut

A wing nut isn’t shaped so that a wrench or socket can fit onto it. Instead, it has two “wings” that can be grasped between your thumb and forefinger, which is how it is tightened. Since wing nuts can be removed and installed by hand, without the use of any tools, they are quick and convenient. You will occasionally encounter a wing nut on a panel, etc., but not very often.

### Castellated nut

A castellated nut, castle nut, or slotted nut has slots cut into the top so that once it’s tightened, it can be secured into place using safety wire or a cotter pin. The safety wire or cotter pin goes first through one side of the slotted nut, then through a hole drilled through the bolt, and then through a slot on the opposite side of the nut. The purpose of a castellated nut is to prevent the nut from turning or vibrating loose.

### Locking nut

A locking nut is just like a regular nut, but it has a plastic or nylon insert on its threads. As the bolt is tightened into the nut, the bolt’s threads cut into the insert, creating friction, and “locking” the nut into place. The threads are only cut into the plastic insert once, which means that if the locking nut is removed, it must be replaced with a new one.

## Washer

A washer is a thin, disc-shaped piece of metal with a hole in the middle (fig. 3-6). The body of the bolt goes through the washer. The washer is positioned between the head of the bolt and the item being fastened, or between the nut and the item being fastened, or both, depending on the configuration. A washer’s job is twofold; it distributes the load of the bolt or nut, and since it doesn’t spin when the fastener is being tightened, it helps to keep surfaces from getting scratched or gouged due to the twisting motion of the fastener. Washers can be made of many different materials, and be many different sizes and thicknesses. As with all other hardware in the system, you must make sure

that you replace washers with authorized duplicates and use the proper configuration. For instance, if there are two washers underneath the head of the bolt as listed in your IPB, you have to make sure that you install two new washers when you replace the hardware.

### Quick-release pin

Another piece of hardware (fig. 3-7) that you will no doubt encounter is the quick-release pin (QRP). QRPs are most commonly used where equipment needs to be assembled or disassembled rapidly. The equipment being held together by the QRP is

“sandwiched” between the head of the QRP at one end, and metal retainers at the other end. To install or remove the QRP, the release button on the head must be pressed, which then allows the retainers to fall into the body of the QRP. The button is spring loaded so that it returns to its original position when it is released, with the retainers locked in the outward position. It is important to inspect all QRPs to ensure that there is smooth motion and no binding when

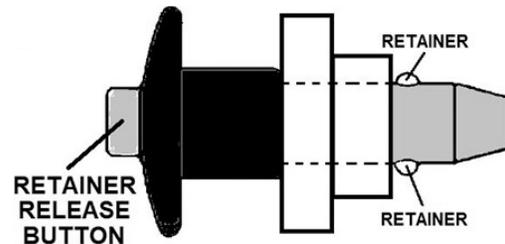


Figure 3-7. Quick-release pin.

depressing or releasing the retainer release button. A great example is the many QRPs used to assemble the guided-missile maintenance platform (GMMP). This GMMP is the piece of equipment technicians use to traverse (left or right), or go to the bottom of the launch tube. Since the GMMP supports technicians far above the launch tube floor (about 90 feet), it is considered a piece of life support equipment. Therefore, always use your technical orders when assembling the GMMP in the LER.

In this lesson you got a basic explanation of hardware and the most common types you'll encounter when performing maintenance. Remember that hardware must be procured through authorized sources, and that it must be replaced in the proper configuration.

## 223. Electrostatic discharge control

In this lesson, you will learn about electrostatic discharge (ESD). There are many sensitive components that a 2M0X2 handles that can be damaged by ESD. Improper handling of these sensitive components can cost the Air Force money in replacement costs, and cost you lost time on the job. Pay close attention during this lesson, and you won't have to worry about the effects of ESD.

### Description

ESD is defined as a sudden flow of electricity between two electrically charged objects. All objects can carry an electrical charge. On a day-to-day basis, most objects live in a state of equilibrium, meaning they have a neutral charge. They have neither a positive charge nor a negative charge; again, they are *neutral*. It is important to remember that nature wants to retain this neutral equilibrium.

Think of an object. That object is you. Now, you have socks on, and you've been scooting your feet across the living room carpet. You don't know it, but by doing this your entire body is building up *static electricity*. Static electricity is simply that; a static or stored charge. Let's say you reach for a door knob ...ZAP! The positive charge you built up between the material that your socks are made from and the material the carpet is made from has been equalized into the metallic door knob.

Another great example of ESD is a lightning strike. This is a much larger-scale example, but the idea is the same. The charge of the surface of the Earth and the charge in the atmosphere are not in equilibrium. Once the difference becomes too great, lightning strikes the Earth to even everything out. This transfer of static electricity is called ESD. It can build up to be tens of thousands of volts, and it is this ESD that can be damaging to sensitive electronics.

### Effects of electrostatic discharge on sensitive electronics

The door knob mentioned above isn't going to be harmed by your ESD because it's just a hunk of metal. However, if you were to discharge that same voltage into an ESD sensitive circuit card, it

would overload and possibly damage some of its electrical components. The circuits on that card were meant to operate at a certain steady voltage. Large surges from an ESD are unexpected, and could cause damage to the card.

It is also important to know that you won't always know when you've transferred your static charge into a component. When you reached for your door knob in the example above, there was a very evident "zap", and you probably felt it too, through the tip of your finger. A very small discharge, too small for you to even notice, can damage a sensitive component. That is why, as technicians, we always take precautions to discharge any static charge we may be carrying *prior* to handling ESD sensitive devices.

### Identifying electrostatic sensitive components and procedures

ESD sensitive components are stored in special packaging that is designed to protect them. This special packaging will typically be in the form of antistatic bags. Antistatic bags will have either a metallic hue or a pink hue. In addition to the packaging, all ESD sensitive components will have the ESD sensitive logo printed on the bag, or on a sticker attached to the bag. There are two different commonly used symbols for ESD sensitive components, but both have the same meaning (fig. 3-8).



Figure 3-8. Symbols indicating electrostatic discharge sensitive devices.

To make it even easier, your technical order will indicate if a procedure includes an ESD sensitive device with the designator **\*\*ESD\*\*** (fig. 3-9).

#### 5.5 BRINE CHILLER CONTROL PANEL MODULE (BI-1 OR BO-1).

5.5.1 **Removal.** Remove module (FO-4, 60 or 66) as follows:

- a. Open brine chiller control panel.
- b. **\*\*ESD\*\*** Remove defective module by gently releasing terminal base module locking latch (70) and removing module from terminal base (72).

5.5.2 **Installation.** Install module (FO-4, 60 or 66) as follows:

- a. **\*\*ESD\*\*** On terminal base, ensure keyswitch (71) is set to position 8 for binary input module or position 9 for binary output module.
- b. **\*\*ESD\*\*** On terminal base, ensure flexbus backplane connector (69) is fully extended. If required, push flexbus backplane connector to extend.

Figure 3-9. Technical order procedure with an electrostatic discharge sensitive component.

### Discharging static electricity

Now you know that your technical order will tell you if a step in a procedure uses an ESD sensitive device. You have one of two options available to you for discharging any static charge you may have built up prior to handling the ESD sensitive device:

#### Option 1

Option 1, as outlined in TO 00-25-234, *General Shop Practice Requirements for the Repair, Maintenance, and Test of Electrical Equipment*, is to simply ground yourself to any metal portion of the cabinet or panel that you'll be installing the component in. This is done by touching a metal (preferably unpainted) surface with your bare skin. For example, if you're installing a module into the

brine chiller control panel, a great place to ground yourself is the unpainted portion of the panel where the radio-frequency interference (RFI) gasket rests. You will need to maintain bare skin contact with that surface the entire time that you're handling the module.

### **Option 2**

Option 2 is to use an ESD wrist strap. Before we proceed any further, it is extremely important to know that you *cannot* use an ESD wrist strap in a panel with electricity applied to it (you will typically have power removed from any cabinet or panel where you are removing or replacing an electrical component though). The ESD wrist strap has a metallic area that touches the skin on your wrist. The strap is connected to a length of wire that is attached to a clip. The clip is placed somewhere on a bare metal surface in or on the cabinet or panel you'll be working in. The ESD wrist strap serves the same purpose as grounding yourself to the cabinet or panel with your bare skin, with the added convenience of being able to use both of your hands. Use whichever method works best for you.

### **Avoiding contact with ESD-sensitive parts**

There is another option outlined in the safety summary of all ECS TOs. That option is to simply *avoid contact* with any exposed connector pins. This option works very well with some of the modules in the ECS, because they're made up of a plastic shell with small electrical pins on the rear. It is very easy to handle the module without touching the pins. However, options 1 or 2 will still need to be used for ESD sensitive components that are not encased to the point where they can be handled without touching any of the electronics.

In this lesson you learned about ESD control. If you pay attention to the markings on components and the steps in your TOs and CEMs, you cannot go wrong. You will be warned well ahead of time when you will be dealing with ESD-sensitive components. Your only job after that is to choose which method you will use to ground yourself, or you can choose (in some cases) to keep from touching the ESD-sensitive parts of the component.

## **224. Hydraulic systems**

Have you ever wondered how a small hydraulic car jack (fig. 3-10) can lift the immense weight of an automobile simply by pumping the jack's handle? Have you ever seen construction equipment easily moving many tons of dirt or rocks? Hydraulic systems are what make this possible, and in this lesson we will focus on the basics of how these systems operate.

### **Hydraulic system theory**

Hydraulic systems operate on the principle that a liquid cannot be compressed, and a force applied anywhere within a confined body of liquid will be transferred equally throughout all parts of that body of liquid (fig. 3-11). The hydraulic system must be completely sealed off from the atmosphere and have no leaks to be fully effective.

As you can see from the figure above, downward pressure on the piston on the left side of the hydraulic system transfers through the liquid and over to the bottom of the piston on the right side of the system, forcing it upward. Pretty simple, right?



**Figure 3-10. Hydraulic automobile jack.**

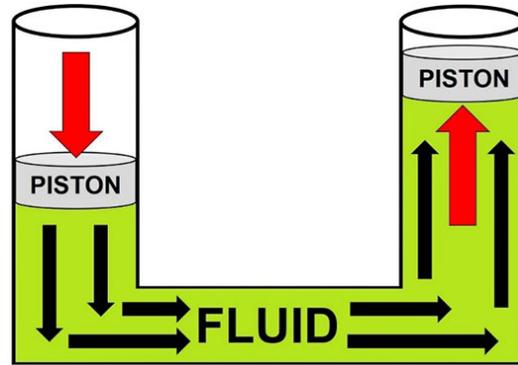


Figure 3-11. Simple hydraulic system.

### Hydraulic system operation

As you have seen, hydraulic system theory is very simple. Pressure on one part of a confined body of fluid will be transferred to all other parts of the body of fluid in equal amounts.

The two pistons in figure 3-12 have exactly the same dimensions and surface area, and the cylinders that they move up and down in have the same dimensions as well. This means that the downward force applied to one side of the system will be transferred to the other side of the system in an equal amount. If the piston on the left moves downward 6 inches, the piston on the right will move upward exactly 6 inches. This hydraulic system would have a 1 to 1 (1:1) ratio, and this particular configuration only illustrates how a hydraulic system functions, and does not offer any sort of mechanical advantage or multiplication of force. So how, then, can pumping the handle of the car jack with only the weight of a person's upper body lift an automobile that weighs 500 lbs.? The primary function that a hydraulic system provides is to act as a *force multiplier*, and any tool that reduces the force needed to perform a task is considered the same.

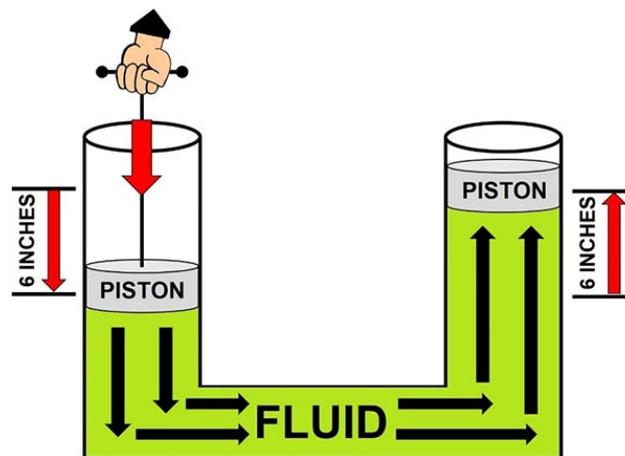


Figure 3-12. 1 to 1 ratio hydraulic system.

The hydraulic system represented in figure 3-13 is one where force is being multiplied, meaning that the output force is greater than the input force. To do this, the area of the input piston must be smaller than the area of the output piston. We are going to apply 100 pounds (lbs.) of force to the input piston, which has an area of two square (sq.) inches (in.) 100 lbs. of force divided by the two square inch area of the input piston equals 50 lbs. per square inch (psi). This 50 psi of force is exerted equally throughout the entire body of the fluid, and applied to the larger 12 sq. in. area of the output piston. Some quick math will show that 50 psi of force, multiplied by the 12 sq. in. area of the output piston, equals 600 lbs. of lifting force exerted by the output piston. You have created 600 lbs. of upward force, which will overcome the automobile's weight of 500 lbs. Note that 500 lbs. of force would *not*

be adequate enough to actually lift the automobile due to the fact that the input force would not be *greater* than the weight of the automobile; the two forces would be equal. If you would like to research this subject further, this information is derived from *Pascal's Law*.

Due to the difference in area between the input and output pistons, the output piston will only move a fraction of the distance that the input piston does. To find this ratio, divide the area of the larger piston by the area of the smaller piston. The 12 sq. in. area of the output piston, divided by the 2 sq. in. area of the input piston, equals six, or a 6:1 ratio. Now you know that for the output piston to move just one inch, the input piston will need to move six inches. If you wanted to raise your automobile five inches, your jack handle would need to move 30 inches! This is impractical, which is why hydraulic jacks have instead been designed to be pumped many times versus the handle needing to move several feet.

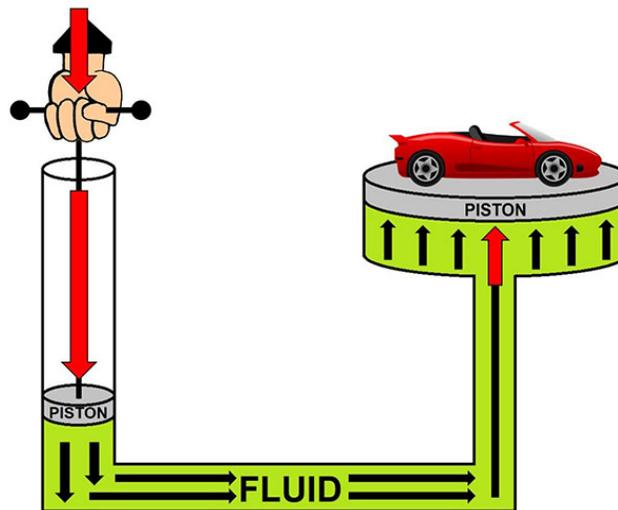


Figure 3-13. Multiplication of effort within a hydraulic system.

The same concept is demonstrated using a lever on a fulcrum to lift a heavy weight (fig. 3-14). Notice how the user must move the lever a very large distance, but the 1,000-lb. weight only moves upward a very short distance? This enables the user to move heavy objects that they could never have moved under their own strength.

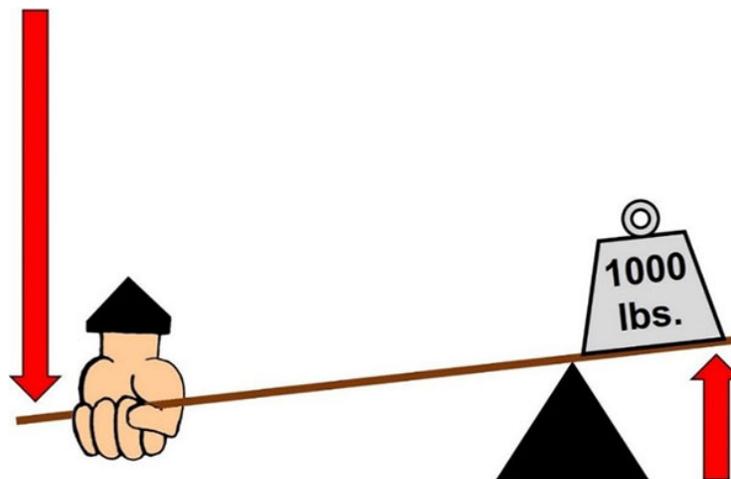


Figure 3-14. Lever system.

The automobile jack is a great example of a hydraulic system in action, but not all systems are operated by hand. For example, construction equipment (fig. 3-15) uses motor-driven hydraulic pumps that actuate complex systems capable of lifting many tons. You will learn about these more complex systems in your 7-level career development course volume.



Figure 3-15. Hydraulic actuators on heavy equipment.

### Hydraulic system precautions

When working with hydraulic systems, there are certain precautions that you and your team members should be aware of. These systems use fluid under extreme pressures to perform work, and these pressures may be high enough to puncture skin. If you discover a leak while the system is in operation, *never* attempt to plug the leak or cover it with another object. Remove power from the system or discontinue its use, and let your task supervisor know that you've discovered a leak.

If the need arises to clean up hydraulic oil, be sure to use the proper personal protective equipment (PPE), and dispose of soiled rags and absorbent material in accordance with your technical orders or other appropriate guidance.

This lesson focused on how hydraulic systems use pressurized liquid to perform work, and familiarized you with some of the applications that use them. In the next lesson we will learn about pneumatic systems.

### 225. Pneumatic systems

Pneumatic systems use principles that are very similar to hydraulic systems. However, instead of using fluid pressure to do work, pneumatic systems use a pressurized gas. A bicycle pump is a great example of a simple pneumatic system at work (fig. 3-16). Note that throughout this lesson the terms *gas* and *air* are used interchangeably.

#### Pneumatic system theory

Pneumatic systems operate on the same principles that hydraulic systems do, but a gas (usually air) is used as the medium to complete work. Unlike a liquid, air can be compressed into a smaller volume. An example of this is when you inflate a football, basketball, bicycle tube, or even a balloon. You take the pressure of the outside air, and then compress it into a smaller *volume* inside of the inflatable object. In the simplest of terms, pneumatic systems perform work by using pressurized gas in a confined area to apply force to an object (fig. 3-17).



Figure 3-16. Bicycle pump.

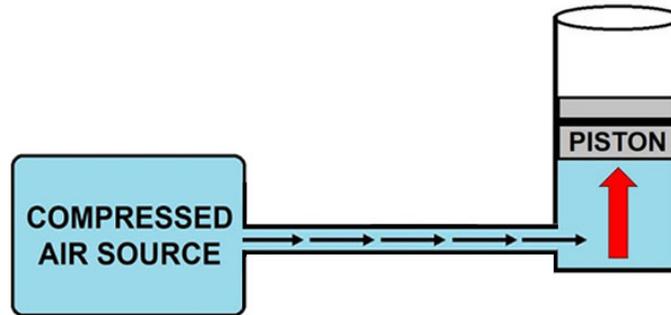


Figure 3-17. Basic pneumatic system.

### Pneumatic system operation

The input force in a pneumatic system is equal to the pressure of the compressed air source. The compressed air source used in pneumatic systems is typically at a constant pressure, say 25 psi, which is then applied evenly throughout the system. A valve or other metering device will allow the air pressure to pass through and actuate the object that will be performing work. When a pneumatic system is at rest, i.e., *not* performing work, there is no path between the compressed air source and the mechanism that would be actuated by the compressed air (fig. 3-18). For example, the fluid in a hydraulic system only transfers force. A compressed gas, on the other hand, will continue to exert force within the system until the pressure is released (vented).

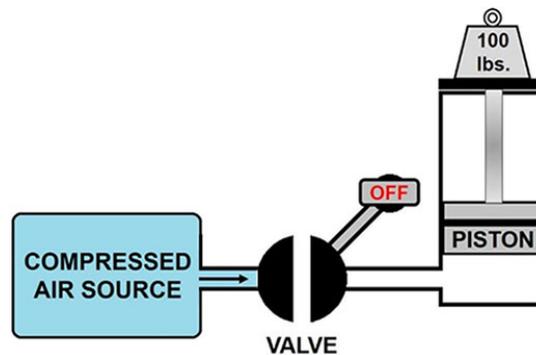


Figure 3-18. Pneumatic system at rest.

When air pressure is needed to actuate the mechanism performing the work, the valve or metering device will allow the compressed air to flow through (fig. 3-19). If a pneumatic system is being used on an assembly line in a factory; for example, this process could happen several times per second. Speed of actuation is where pneumatic systems outshine hydraulic systems. Pneumatic systems can actuate much quicker due to the fact that a gas is much less resistant to flow than a fluid. Pneumatic systems are typically used in factories and processing plants where quick, precise, and repetitive motions are needed.

A key item to remember is that there is typically no “back and forth” flow of air in a pneumatic system. The air that is used to perform the work is vented to the atmosphere once it has performed the work, and new compressed air is supplied by the compressed air source. This venting is also what makes pneumatic systems much louder than hydraulic systems. Good examples of this are the pneumatic drill that your dentist uses and the pneumatic impact wrench used in mechanic’s shop. Both produce high levels of noise.

You can apply some of the same math from Pascal’s law to the pneumatic system in figure 3-20. To move the 100 lb. weight upward, *more* than 100 lbs. of force will need to be applied to the bottom of the output piston.

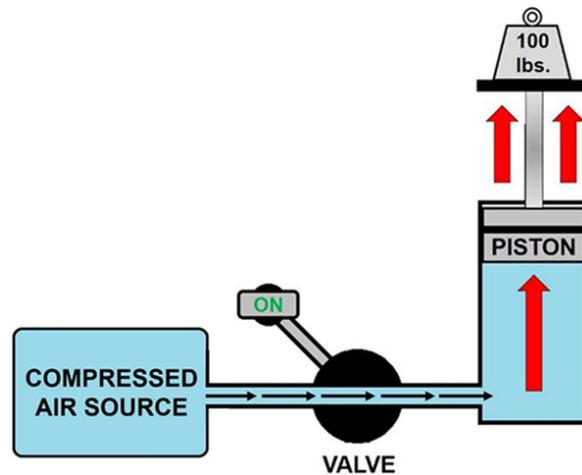


Figure 3-19. Pneumatic system performing work.

Let's say that the compressed air source supplies a constant 25 psi of pressure throughout the system. If the piston has an area of two sq. in., you would have 25 psi of pressure acting on that two sq. in. area—25 multiplied by two equals 50 lbs. of force is *not* enough to lift the 100 lb. weight. Even if you increased the area of the piston to four sq. in., the weight would not move. The reason for this is that 100 lbs. of force will only *equal* the weight to be lifted. Just like with the hydraulic car jack in the last lesson, the upward force must be greater than the downward force provided by the object you're trying to move. If a piston with a five sq. in. area was used, multiplied by the 25 psi supplied by the compressed air source, 125 lbs. of force would be applied to the bottom of the piston. The 125 lbs. of upward force will slowly, but surely, move the 100 lb. weight. The greater the difference between the applied force and the force required, the *faster* the work will be completed.

As an example, think of yourself pushing a broken down automobile down a flat road. Alone, you can probably provide enough force to get the car rolling very slowly; however, if five of your friends join you behind the automobile to help out, it would get rolling much easier, and you could get it rolling at a faster speed as well.

### Pneumatic system precautions

There are dangers inherent to pneumatic systems that you and your team members should be aware of. If you discover a leak in a pressurized air line, *never* attempt to cover or repair it. Remove power from the system or discontinue its use, and let your task supervisor know that you've discovered a leak.

Pressurized air can stir up dust and debris, can accelerate objects to high speeds, and can be very loud. You may even use compressed air for cleaning. Always be sure to use the proper PPE, such as eye and hearing protection, prescribed in your technical orders. Compressed air, even at low pressure, should *never* be used to remove debris from skin or clothing. The reason for this is because small air bubbles may enter perfectly healthy skin because it is porous; cuts or wounds increase the likelihood. These air bubbles can then make their way to the heart or brain, and may cause personnel injury or death.

This lesson focused on how pneumatic systems use pressurized air to perform work, and familiarized you with some of the applications that use these systems. You will learn about more complex pneumatic systems when you complete your 7-level career development course volume.

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## Self-Test Questions

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

### 221. Troubleshooting techniques

1. What does it mean to not jump to conclusions while troubleshooting?
2. What is the most important troubleshooting recommendation?
3. How would you likely be able to tell if there were burned wires before ever seeing them?
4. What do the fault matrixes and fault lists in your technical data help you to do?
5. What will aid in troubleshooting by providing a technician with an outline of how the system should operate?
6. What type of repairs should technicians always make?
7. When checking for an open using voltage checks and you have discovered an open circuit, what will your multimeter indicate?
8. When checking for an open using the resistance function of a meter, where would the location of an open be indicated?
9. What is a cross short?
10. What is a shorted control?
11. When you are taking a resistance reading across a coil or motor winding, what does an “OL” reading indicate?

12. Why should you always take amperage readings on a system when it is running normally, and *not* in the process of starting up?
13. What does it mean when you measure a large difference in voltage potential across a closed circuit breaker or switch?

### **222. Hardware**

1. What is the difference between regular hardware and aerospace hardware?
2. Where must all replacement hardware come from?
3. What is the purpose of a bolt?
4. What is a disadvantage of hard-mounted threads?
5. Why is the use of a wing nut quick and convenient?
6. What is the purpose of a washer?
7. What action allows the retainers to fall into the body of a QRP?

### **223. Electrostatic discharge control procedures**

1. What is a large-scale example of electrostatic discharge?
2. What is important to know about the effects of electrostatic discharge?
3. What two icons warn of electrostatic discharge sensitive components?

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- 
4. What is Option 2 for the control of electrostatic discharge?
  5. What is another method of controlling electro-static discharge that is mentioned in your safety summary?

### 224. Hydraulic systems

1. What attributes must a hydraulic system possess to be fully effective?
2. What characteristics would a 1:1 ratio hydraulic system possess?
3. Why would 100 lbs. of downward force on one side of a hydraulic system fail to move a 100 lb. weight on the output side of the system?
4. In what way is a lever and fulcrum similar to a hydraulic system?
5. If you discover a leak in a hydraulic system, what should you *never* attempt to do?

### 225. Pneumatic systems

1. What happens to a volume of air when it is compressed?
2. Where does the compressed air or gas in a pneumatic system go after it has performed work?

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## Answers to Self-Test Questions

### 221

1. Follow a troubleshooting procedure until it is exhausted or leads to the fault.
2. Use the schematics and diagrams in conjunction with your procedures to help you troubleshoot.
3. You would be able to smell them because they have a very pungent odor.
4. Help you to determine a starting point for troubleshooting if you don't already have one.
5. The system descriptions found in the technical data (TO or CEM).
6. A neat and permanent-type repair.
7. Between the last applied voltage and the first 0 voltage reading.
8. Between the two points your leads are connected to when you receive an OL indication.
9. When the positive conductors or two or more independent circuits making contact.

10. When the contacts of a switch or relay are stuck together.
11. The coil or motor winding is open.
12. Because amperage readings won't be accurate due to a higher start up draw.
13. The circuit breaker or switch is faulty. There should be no difference in potential across a closed switch or breaker.

**222**

1. It must meet more strict standards, and be made of lighter and stronger materials.
2. Authorized sources.
3. To fasten one or more objects together.
4. If they strip out, a larger hole will need to be drilled and new threads cut.
5. They're installed and removed by hand without the need for tools.
6. It distributes the load of the nut or bolt, and it helps to keep surfaces from getting scratched or gouged.
7. Pressing the release button on the head of the QRP.

**223**

1. A lightning strike.
2. You will not always know you won't always know when you've transferred your static charge into a component.
3. A triangle with a depiction of a hand that looks as if it is picking up an object. A circle that contains three arrows that all originate outside of the circle and point to the inside of the circle.
4. The use of an ESD wrist strap.
5. Simply not touching the electrical connectors on an ESD sensitive device. Simply *avoid* contact with any exposed connector pins.

**224**

1. The system must be completely sealed from the atmosphere, and have no leaks.
2. The exact amount of force that was applied to one side of the system would be transferred to the other side of the system. The output piston would move exactly as far as the input piston.
3. Because the input force would be *equal* to the weight of the object, but would not be enough to actually move the object in the opposite direction (stalemate).
4. The input piston will move a larger distance than the output piston; the side of the lever that force is applied to will travel farther than the object being lifted by the lever.
5. Attempt to plug the leak or place an object over it.

**225**

1. The volume of air becomes *smaller*.
2. The air or gas is typically vented to the atmosphere; more compressed air or gas is provided by the compression source.

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

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## 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.**

71. (221) What steps *best* illustrate the troubleshooting process?
  - a. Analyze, locate, and identify.
  - b. Assume, locate, and identify.
  - c. Analyze, locate, and correct.
  - d. Listen, touch, and smell.
72. (221) When troubleshooting, the purpose of a preliminary check is to
  - a. locate the fault as quickly as possible.
  - b. become aware of the sounds various systems make.
  - c. discover any easily detectable or obvious indicators.
  - d. move from the least obvious to the most obvious solution.
73. (221) After a fault has been isolated and repaired, what is the next step in the troubleshooting process?
  - a. Locate a corresponding schematic.
  - b. Perform another operational check.
  - c. Perform another preliminary check.
  - d. Begin taking voltage measurements.
74. (221) What is the definition of an open circuit?
  - a. An incomplete path of resistance within a circuit.
  - b. A complete path for current flow within a circuit.
  - c. An incomplete path for current flow within a circuit.
  - d. A total capacitance that is equal to total voltage within a circuit.
75. (221) If you find a blown fuse during troubleshooting, you should
  - a. check it in both directions.
  - b. find a short or verify the absence of one.
  - c. replace the fuse to see if the circuit operates.
  - d. verify the amperage rating against other fuses.
76. (221) What statement *best* describes a shorted control?
  - a. Two or more independent circuits making contact.
  - b. Switch opens removing the power in the OFF position.
  - c. Positive and negative conductors making direct contact.
  - d. Contacts of a relay remaining closed after the power is removed.
77. (221) Which multimeter indication means that a fuse is blown?
  - a. 120 volts.
  - b. 0 ohms.
  - c. 0 volts.
  - d. OL.

78. (221) What is the fault when you are checking the resistance of the motor windings in the brine pump to ground with a multimeter, and the windings A and C show low resistance, while winding B shows “OL”?
- Winding B is open.
  - Winding B is shorted.
  - Windings A and C are shorted together.
  - Windings A and C are shorted to the motor case.
79. (221) When checking a circuit breaker with a multimeter set to measure voltage, what is indicated if your meter reads 0 volts, alternating current (VAC) with your positive lead on the input and the negative lead on the output of the circuit breaker?
- The circuit breaker contacts are closed.
  - The neutral bus has been disconnected.
  - There is a large difference in potential.
  - There is a direct short in the circuit breaker.
80. (222) What type of hardware is used on missiles and aircraft?
- Flight.
  - Projectile.
  - Aerospace.
  - Aerodynamic.
81. (222) What piece of hardware has a cylindrical body with a spiraling threaded section?
- Lock washer.
  - Quick-release pin.
  - Bolt.
  - Nut.
82. (222) What is used to keep a nut from free-spinning while tightening a bolt into it?
- Lock nut.
  - Lock washer.
  - Backing wrench.
  - Safety wire.
83. (222) What is used to keep a castellated nut from vibrating loose?
- Safety wire.
  - Nylon insert.
  - Sufficient torque.
  - Stud.
84. (222) Quick-release pins (QRP) are *most* commonly used
- for rapid assembly or disassembly.
  - to permanently fasten objects together.
  - when a nut and bolt combination is not practical.
  - when a washer is required on both sides of the fastened object.
85. (223) What designator will alert a technician that a technical data procedure includes the use of electrostatic discharge (ESD) sensitive devices?
- The safety summary will list all pages that contain ESD procedures.
  - ESD logos will appear before each ESD component procedure.
  - Each ESD step is listed in the table of ESD procedures.
  - “\*\*ESD\*\*” appears prior to each ESD step.

86. (223) Option 1 for controlling electrostatic discharge is to
- use an electrostatic discharge wrist strap.
  - touch a metal surface with your bare skin.
  - avoid all contact with the sensitive component.
  - touch an electrostatic discharge tester with your bare skin.
87. (224) Upon what principle does a hydraulic system operate?
- Force is distributed equally throughout a contained body of liquid.
  - The volume of a liquid can be reduced to produce force in a system.
  - Air can be compressed and moved to another part of a system to complete work.
  - A liquid can be compressed at one end of a system, and decompressed to do work at the other end.
88. (224) Why must a technician *never* attempt to plug or cover a leak in a hydraulic system?
- The high temperatures of hydraulic fluid can cause severe burns.
  - Hydraulic system pressures can be high enough to puncture skin.
  - The noise generated by hydraulic system leaks can cause hearing damage.
  - Hydraulic system leaks can stir up dust and debris, possibly causing eye damage.
89. (225) Pneumatic systems are able to provide force faster than hydraulic systems because
- hydraulic systems offer multiplication of force; pneumatic systems do not.
  - pneumatic systems offer multiplication of force; hydraulic systems do not.
  - fluids are more resistant to flow than gases.
  - fluids are less resistant to flow than gases.

## Student Notes

## Unit 4. Materiel Management

226. Basic principles of materiel management .....	4-1
227. Supply discipline .....	4-6
228. Illustrated Parts Breakdown.....	4-8
229. Determining supply system priorities .....	4-14
230. Preparing Air Force supply forms .....	4-16

**T**he Air Force supply system is a very large and complicated business. It must satisfy the needs of all organizations in the Air Force—from diaper pins to parts for spy satellites, and from paper clips to ballistic missile launching systems. Nevertheless, as far as you are concerned, the most important function of supply is to make sure you have the supplies to meet your workcenter needs. At this very moment, you may be responsible for some of these items.

Although you do not carry an AFSC in the “supply” or “materiel management” career field, materiel management is a big part of your job. The aerospace vehicles and equipment you maintain must be kept serviceable and this cannot be done without supplies. The main objective of the Air Force Materiel Management system is to support all activities by providing all necessary supplies and equipment. A secondary objective of almost equal importance is to conduct supply operations so as to conserve all items of materiel, ensuring the Air Force gets the maximum possible benefits at the lowest cost. In using ways to conserve, the Air Force is acting the same way you do when you buy groceries, clothing, and other personal items; you both try to get the most value for your money. Therefore, regardless of your specific job assignment, you are a key figure in the supply system.

### 226. Basic principles of materiel management

It is mind boggling to think of all the millions of items in the supply system. If there were not a regular procedure for the requisition, receipt, storage, stock control, issue, shipment, identification, and accounting for supplies within an Air Force organization, there surely would be chaos. In a sense, base-level supply is the heart of materiel management and stock, more commonly referred to as the *supply system*. The supplies that a base needs are assembled at base supply for the convenience of the base organizations. Therefore, it is easy to see the inconvenience it will cause organizations if they had to deal directly with all of the supply sources used by the government today. In this lesson, we will cover some of the basic principles of the supply system.

#### Maintenance supply concept

The Air Force supply distribution system is larger and more complex than most distribution systems used in the civilian world. It must procure, stock, and issue millions of different items to thousands of customers worldwide. Furthermore, the need for speed of delivery and economy of operation—along with the need for immediate response to the diversified and changing needs of its customers—requires an alertness and flexibility greater than any civilian system.

#### Standard Base Supply System

The Air Force supply system, or Standard Base Supply System (SBSS), is an extensive operation. SBSS is the standard base level (retail) inventory accounting and ordering management system for the Air Force. It involves basic transactions such as fulfilling issue requests for supply items, requisitioning items through the inventory control points (wholesale) to fill base level shortages. With the SBSS, you have the ability to track every item in the supply system through standardized programs and procedures. The entire SBSS was designed to meet the customer’s needs. Although the system may at first seem complex, SBSS programs and procedures are all extensions of the basic supply requirements to order, receive, store, control, and issue property. The SBSS is comprised of three distinctly different documents, AFI 23-101, *Air Force Materiel Management*, Air Force Manual

(AFMAN) 23–122, *Materiel Management Procedures*, and Air Force Handbook (AFH) 23–123, *Materiel Management Handbook*.

- AFI 23–101 provides direction for determining and stocking materiel requirements, cataloging, ordering, sourcing, receiving, delivering, and return/disposal of items. Additionally, it breaks down the roles and responsibilities of all individuals and sections.
- AFMAN 23–122 streamlines the processes for each function and describes how to complete the required actions within supply. It also provides direction for performing predominantly retail management processes associated with determining stock requirements, inventorying, and storing materiel.
- AFH 23–123 provides the step-by-step breakdown on how to process required actions in the computer systems.

Having the basic knowledge of these manuals and publications will allow you to research issues and resolve problems quickly.

### National stock number

A national stock number is a numeric code applied to each item currently used, bought, stocked, or distributed by the Department of Defense (DOD) (fig. 4–1). When a national stock number (NSN) is assigned to an item, data is assembled to describe that item. Some data elements include information such as an item name, manufacturer’s part number, unit price, and physical and performance characteristics. NSNs are an essential part of the DOD supply chain used in acquisition, managing, moving, storing, and disposal of materiel. The NSN consists of a 13-digit number and is comprised of two parts: the *Federal Supply Classification* (FSC) and the NIIN.

### Federal Supply Classification

The FSC code is a series of four digits at the beginning of the NSN that designates the general commodity grouping of the item of supply. Presently, the structure of the FSC consists of 78 groups, which are further subdivided into 645 FSC classes. The first two digits of the FSC are the Federal Supply Group (FSG), which identifies the commodity of an item (ex, 10-Weapons, 11-Nuclear Ordnance, 18-Space Vehicles).

NIIN consists of nine digits. The first two digits of the NIIN are the National Codification Bureau (NCB) code, which identifies the country assigning the number. Examples of the NCB codes are United States (00–01), Germany (12), Canada (21), and United Kingdom (99). The last seven digits are nonsignificant in that they do not determine the position, sequence, or relation of the item of supply to other items. They serve to symbolize, to fix the identity of the item by numerical means, and to identify it from all other items. Remember, in addition to the Air Force, the NSN is designed for use by other federal agencies such as the Army and Navy.

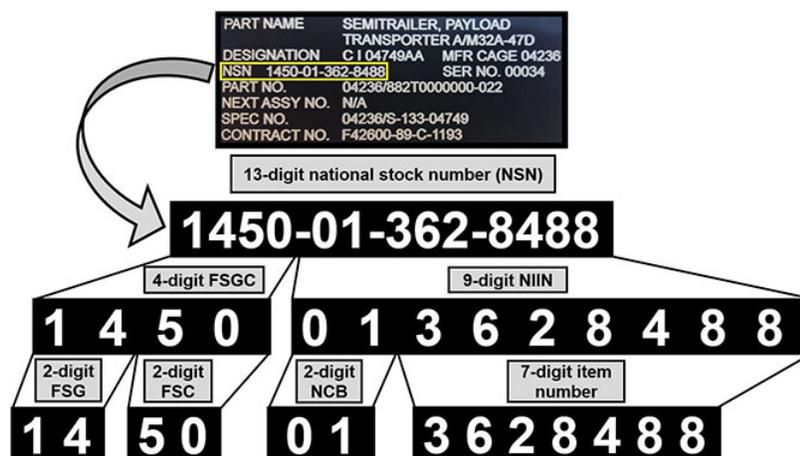


Figure 4–1. National Stock Number.

## Classes of supply

There are millions of items in the supply system that are identified under a supply classification system. This system allows all branches of the armed forces, as well as any US government agency of a North Atlantic Treaty Organization (NATO) country, to order the same item of equipment under a common NSN. The materials come from a variety of sources to satisfy customer needs. The chart below provides you with a basic understanding of the 10 classes of supply used to facilitate supply and planning.

Classes of supply		
Class	Major Classification	Subclassification
I	Subsistence	A—Air (in-flight rations) B—Refrigerated subsistence S—Nonrefrigerated subsistence (less combat rations) C—Combat rations
II	Clothing, individual equipment, tentage, organizational tool sets and tool kits, hand tools, and administrative and housekeeping supplies and equipment.	B—Ground support materiel E—General supplies F—Clothing and textiles M—Weapons—Industrial supplies
III	Petroleum, oils, and lubricants (POL). Petroleum fuels, lubricants, hydraulic and insulating oils, preservatives, liquid and compressed gases, bulk chemical products, coolants, de-icing and antifreeze compounds, together with components and additives of such products, and coal.	A—Air W—Ground (surface)
IV	Construction. Construction material to include installed equipment, and all fortification/barrier material.	
V	Ammunition. Ammunition of all types (including chemical, biological, radiological, and special weapons), bombs, explosives, mines, fuses, detonators, pyrotechnics, missiles, rockets, propellants, and other associated items.	A—Air W—Ground
VI	Personal demand items (nonmilitary sales items)	
VII	Major end items. A final combination of end products, which is ready for its intended use; such as, launchers, tanks, mobile machine shop, and vehicles.	A—Air B—Ground support materiel D—Administrative vehicles G—Electronics K—Tactical vehicles L—Missiles M—Weapons N—Special weapons
VIII	Medical materiel including medical peculiar repair parts.	

Classes of supply		
Class	Major Classification	Subclassification
IX	Repair parts (less medical peculiar repair parts). All repair parts and components to include kits, assemblies, and subassemblies, reparable and nonreparable, and required for maintenance support of all equipment.	A—Air B—Ground support materiel D—Administrative vehicles G—Electronics K—Tactical vehicles L—Missiles M—Weapons N—Special weapons T—Industrial supplies
X	Materiel to support nonmilitary programs; that is, agricultural and economic development (not included in Classes I–IX).	

### Part numbers

Part numbers are defined as a combination of numbers, letters, and symbols assigned by a designer, a manufacturer, or vendor to identify a specific part or item of materiel. These numbers are also used either by themselves or in conjunction with other part numbers to identify an item of production or an item of supply. Part numbers may include manufacturer's drawing, model, type, or source control number. These numbers can usually be converted to NSNs by using the master cross-reference lists (MCRL) or the Federal Logistics (FED LOG) data system. However, any one NSN can have multiple part numbers associated with it due to multiple manufacturers assigning their own part number to an item that has the same capability as other manufacturers' items.

### Expendability, recoverability, reparability, category codes

Expendability, recoverability, reparability, category (ERRC) codes are designator codes used to categorize Air Force inventory into various management groupings according to how the item may be disposed of, recycled, or repaired. This code directs actions such as if an item can be placed on bench stock for immediate shop use, or if it is a due-in from maintenance (DIFM) item, a one-for-one swap of a bad item for a good item so the bad item can be repaired. The ERRC designators are a three-position code which designate whether an item is expendable or not (can be thrown away or must be recycled), and which level in the supply system (depot, intermediate, or base) repairs and/or condemns the item. For example, XB3 designates an item as an expendable inexpensive item that cannot be repaired and may be disposed of if broken, such as the plastic connector dust caps used on cables. If the dust cap had a crack along the edge that kept it from seating properly on the connector, the item would be thrown away and a new cap installed. Remember that you are charged with being a good steward of resources, so just because an item is XB3, do not sweep up and throw away good dust caps that have been found on the floor of the shop or in a PT van. Place these good items back in stock so they can be properly reused. It is hard to imagine a supply transaction or decision that is not influenced in some way by the ERRC codes.

The three positions of the ERRC designator code are described as follows:

ERRC Codes	
Position	Description
1st	Identifies the expendability of the item (X = expendable, N = nonexpendable).
2nd	Identifies the highest authorized repair level (B = base or user, F = field, D = depot).
3rd	Identifies the cost category in which an item belongs. Items are identified as investment (INVEST) or expense (EXP). Investment items are expensive and are coded with a "1" or a "2." When supply issues these items, there will be some type of accounting for the item. In most cases, investment items are paid for by the depot, MAJCOM, or Air Force. Expense indicates an inexpensive item. When supply issues these items, accounting is usually not required (Exception: XF items require accountability). Expense items are paid for with base-level funds, and the code is usually a "3."

The most common types of ERRC codes include XD2, XF3, and XB3.

- XD2—Unserviceable/Repairable items may be sent to a backshop or to the Depot for possible repair. Despite that this code has an expendable identifier (X) in the first position, the third character is a "2" indicating there is a level of accountability for the item, so it cannot be thrown away at your (base) level. Only the depot (second character—D) can make the determination to dispose of the item. Use a DD Form 1577-2, Unserviceable (Repairable) Tag-Materiel, for these assets.
- XF3—Unserviceable/condemned items may be sent to the Air Force enhancement program (AFREP) for possible repair, but the majority of these items are sent to the Defense Reutilization and Marketing Service (DRMS) for scrap. XF3 assets are coded DIFM because of the cost and sensitivity of the asset. Use DD Form 1577, Unserviceable (Condemned) Tag-Materiel, for these assets.
- XB3—Expendable at Base level assets that are unserviceable are sent to DRMS and serviceable assets which are turned in, will either go back into stock, or go to lateral support (other Air Force organizations). A unit will recoup the money for serviceable turn-in (TIN). Use DD Form 1574, Serviceable Tag-Materiel, for serviceable XB3 assets.

### **Bench stock**

A bench stock consists of supplies and parts that are kept on hand in a work center to enhance maintenance productivity. The main objective of a bench stock is to decrease maintenance time by reducing the time workcenter personnel spend waiting for spare parts. Thus, reducing the base supply workload by consolidating frequent small issues to a work center into less frequent bulk issues. These stock items range from nuts and bolts costing a few cents, to repair parts costing several thousand dollars. The "XB3" ERRC designator these stock items are assigned is the basis for items placed on bench stock. Most importantly, these items should be available in the immediate work area so that uninterrupted maintenance can continue and the delivery of items to users can be expedited. The quantity of an item in a bench stock should not exceed a 30-day supply unless you receive authorization from base supply.

### **Issue and replenishment**

Users of the bench stock merely sign-out items from the bench stock monitor as they need them. As a result of the usage, bench stock items must be replenished periodically. The bench stock monitor will physically inventory each bench stock item at least once a month to make sure that an adequate supply of items is on hand at each location. Stock should be replenished when the quantity on hand is below 50 percent of that authorized. If a due-out card is in the bin, this indicates the part is already on order with base supply. In addition to the monthly inventory, the bench stock monitor makes a weekly walk-through inspection to replenish out-of-stock items. The work center must devise a system for

flagging items when the on-hand inventory is below 50 percent of what is authorized monthly. The flag will tell anyone at a glance which bench stock items need to be replenished.

In this lesson, you learned about the basic principles of materiel management, which is more commonly referred to as the supply system. In summary, our supply system helps to greatly improve the reliability of the weapon system by ensuring parts for both scheduled and unscheduled maintenance are available when they are needed. High reliability and alert rate ensure that America's ICBM force remains a credible deterrent.

### **227. Supply discipline**

The primary mission of the Air Force supply system is to furnish the right supplies, at the right place, at the right time, in the right amount, and at the least possible cost. Personnel in each part of the organization's structure are required to account for their assigned property. Without these controls, there would be untold opportunity for waste and carelessness. In this lesson, we start by discussing supply discipline.

#### **Understanding supply discipline**

Supply discipline is mandatory for all personnel and essential to conserve, protect, and maintain available government systems, equipment, and supplies for operational requirements. Subordinate commanders are responsible to their commanders for prudent management, control, storage, and cost effective use of government property under their jurisdiction. You exercise supply discipline by doing the following:

- Promptly repair or turn in unserviceable (reparable) items and unserviceable items that cannot be locally repaired.
- Promptly act to request changes of authorization of equipment when a function is reduced, eliminated, or when a mission change occurs.
- Eliminate the hoarding of any supplies or equipment, and ensure the prompt return of unneeded items.

One of the most critical aspects of maintaining good supply discipline is assigning responsibility for equipment users. By ensuring property is assigned and 100 percent accounted for, commanders increase their chance of maintaining supply discipline. The following are a few tools used to assign responsibility for property:

- The custodian authorization/custody receipt listing (CA/CRL) is also known as the (R14 listing) used to ensure accountability is established for all applicable equipment items in the work place. A work center usually has a primary and an alternate equipment custodian that verifies the CA/CRL by physically locating and verifying that they possess the exact equipment listed. Incorrect items listed or items not found must be reported immediately. Once the CA/CRL is correct, the custodians sign the document acknowledging that all items under their responsibility are accounted for. If a custodian change is made and any items are missing during the inventory, it will be the previous custodian(s) who will be held responsible.
- Fraud, waste, and abuse (FWA) is a potential problem that can drain significant resources and ultimately rob American taxpayers. The FWA program saves valuable resources by identifying illegal, inefficient, and wasteful practices by users and may hold them accountable for costs.
- Hand receipts are forms used to acknowledge receipt and responsibility for property. By placing your signature on a hand receipt for an item, such as a hand-held radio, you are acknowledging receipt and responsibility for returning the item when you are done using it.

- Temporary hand receipts are used to account for property that is loaned out for 30 days or less. Again, your name on the document assigns accountability for loss.
- Equipment receipts are used to assign responsibility for property that is issued to the same person for brief recurring periods.

### **Canceling erroneous requests**

In this era of strict funding, it is essential that orders (due-outs) be canceled when it is determined they are no longer required. Funds are wasted when they are expended to purchase equipment and supplies that are not required. This practice can have a negative impact on unit readiness by depleting funds needed to purchase mission-essential supplies and equipment. Customers should exhaust all effort to ensure items that remain on due-outs are needed to satisfy valid requirements.

### **Turning in excess materiel**

The policy for disposing of government property is relatively simple. The only items that may be disposed of as trash are those items that meet the following criteria:

- Have no required demilitarization (DEMIL) actions. The DEMIL code dictates what must happen to an item when it is no longer being used by the military.
- Have no potential value to the government through future use or resale by the Defense Logistics Agency Disposition Services (DLADS) (formerly known as the Defense Reutilization Management Office (DRMO), either in its current configuration or for its basic materiel content (i.e., used gaskets, seals, broken plastic lenses, and used light bulbs).

All other materiel, serviceable or unserviceable, must be turned in to supply or the DLADS for disposition. All items requiring demilitarization must be turned in to the DLADS on a separate Department of Defense (DD) Form 1348-1A, Issue Release/Receipt Document.

### **Due-in from maintenance process**

Due-in from maintenance (DIFM) inputs are critical to recording and getting monetary credit for proper repair cycle times. DIFM status codes are currently broken down into three categories—delayed maintenance time (sometimes called awaiting maintenance or AWM), repair time (sometimes called in-work or INW), and awaiting parts (AWP) time. Repair time is the only time recorded and used to determine the number of assets base supply can stock. Not using the proper codes when they change reduces the number of assets on base. Remember that DIFM is basically a one-for-one swap of a good item for a repairable item. If you have swapped out the item and the repairable part is sitting in your shop rather than at base supply, your unit won't get reimbursed for the turn-in and, more importantly, base supply will not be able to request additional units because they are limited to the supply they can stock. In the larger scope of supply think about it this way—if you are both hoarding good items for future AWM repairs and holding onto the bad items so they cannot make it back to the supplier for repair—it means the amount of good repaired inventory available to the Air Force will be reduced until you turn your bad items in or return some good items to the system for redistribution. The amount of DIFMs on hand in a shop should be reduced to as near zero as possible since credit is not given for delayed maintenance or AWP time.

### **Responsibility for public property**

The property you use in your duties, whether it is a desk, a toolbox, a truck, or an electronic test stand, is your responsibility. Good management dictates that the person who is using the property will be responsible for that property. The money used to buy government property comes from all of us in the form of taxes. Any one person does not hold the title to this property; instead, all Americans jointly own it. All people working for the Air Force (military and civilian workers alike) are responsible for government property. They must treat this property as if it were their own. When you

use a piece of government property, it is like borrowing a book from the library. Eventually, you must return it, and you are the one who is responsible for it. It is important that you clearly understand your responsibility for government property because a time may come when the Air Force will ask you to pay for a piece of equipment.

This lesson focused on understanding your individual responsibility in maintaining supply discipline. Knowing how to prevent fraud, waste, and abuse will aid in protecting and maintaining available government systems for operational requirements.

## 228. Illustrated Parts Breakdown

You may have heard the phrase, “If an item is not broke, then do not fix it”; however, if the item is broke, and you can fix it, then you must order a replacement part for that item. Some replacement items can look similar but fit very different, so it is critical that you research and order the correct parts every time. The illustrated parts breakdown (IPB) technical orders provide you with information on part numbers, nomenclature, and units per assembly for each component of a Minuteman Weapon System. It also provides you with a brief description of each part, identifies which series of the weapon system each part is used on, and lists the manufacturer of each part. In the following lesson, you will become familiar with the process for ordering replacement parts for the weapon system and other support systems.

### Purpose

The purpose of an IPB is to assist you in identifying and ordering the parts you need to complete your maintenance. Remember that the IPB is not intended to be used for assembly or disassembly of any part of the weapon system. An IPB may be a chapter of an equipment TO, or a separate TO altogether. The IPB consists of several illustrations of the various equipment and components each identified by a number that correlates to a number on a parts listing table. The IPB; therefore, breaks down the equipment into manageable sections and sub-sections for ease in ordering.

### Format

The 21M-LGM30F-4-1, *Minuteman Weapon System Introduction and Pictorial, Numerical, and Reference Designation* series technical order is the introduction to the complete 5-volume IPB for Wings 1, 3, and 5, and Vandenberg AFB weapon systems. For this lesson, we will be referencing TO 21M-LGM30F-4-1 for 21M-LGM30F-4 Series IPBs, and 21M-LGM30F-4-4, *IPB Minuteman Weapon System Maintenance Ground Equipment (Common)*. Instead of listing out the entire numerical designator every time a TO is mentioned, we will simply refer to the IPB as the 4-1 or 4-4 IPB. You will find that the format of the IPB series TO is divided into four sections which are listed and described below.

- *Introduction*—the introductory section of the IPB explains the system used in the TO for numbering components and sub-systems, identifying drawings, and outlines general information and instructions regarding use of the publication itself.
- *Numerical Index*—this is a single list of all part numbers appearing in the IPB arranged in part number sequence. It provides the part number, volume, figure, and index of the item along with other data such as the source code or repair code (fig. 4-2).
- *Reference Designation Index*—these references are listed on a schematic and identify the cabinet, shelf, drawer, diode, resistor, etc., for a particular unit. The reference designation index is a list of all reference designations used for electrical parts listed in the maintenance parts list (MPL). It provides a rapid means of cross-referencing between TO schematic wiring diagrams and the MPL. In this index, the reference designations are arranged in numerical sequence and cross-referenced to figure, index number, and part number.
- *Maintenance Parts List*—the MPL is a list that breaks down the equipment into its major assemblies, subassemblies, detail parts, and attaching parts. The MPL provides information on (1) figure and index number, (2) part number, (3) Commercial and Government Entity

(CAGE) code, (4) description, (5) units per assembly, (6) usable on code, and (7) source, maintenance, and recoverability (SMR) codes. The table below shows a MPL with its accompanying illustration (fig. 4-4)—refer to it as you read the following table.

<b>Maintenance Parts List Categories</b>	
<b>Category</b>	<b>Descriptio</b>
Figure, Index, and Sheet Number	The first column in the IBP MPL contains the figure, index, and sheet numbers. The figure numbers in the MPL correspond to the number on an accompanying illustration. The index numbers (1, 2, 3, etc.) are arranged in numerical order to reflect the sequence of disassembly, except where drawing order prevents the disassembly sequence from being maintained.
Part Number	This column provides the part number for each part in the listing. This number can be a manufacturer's part number or a government standard part number. Manufacturer's part numbers are usually assigned in numerical order. Standard part numbers normally have an alphabetical prefix. These parts are used throughout the Air Force for various kinds of equipment.
CAGE (Commercial and Government Entity) code	The CAGE code identifies the design activity or government agency whose number appears in the part number column. When a CAGE code for the appropriate design activity or government agency is not published in the current issues of the H4/H8 Cataloging Handbooks, the word "none" is inserted in the CAGE column directly opposite the part, model, or type number listed in the part number column.
Description	The description column provides a breakdown of the equipment into its assemblies, subassemblies, detail parts, and attaching parts. The column entries are indented to show relationship of parts to their next higher assemblies.
Units Per Assembly	This column reflects the quantity of parts required on the next higher assembly. You may find the abbreviation AR, which denotes—as required, in this column. This indicates no specific number can be given. Simply use as many as required. The abbreviation REF indicates that the units per assembly will be found on another figure, or are listed for reference only.
Usable on Code	This column indicates the usage of a part. If a part is common to all configurations of the assembly, there will be no code. If the part is limited to a specific model of the equipment, an alpha or alphanumeric code is shown. These codes are defined at the end of the parts list for the applicable figure.
SMR (Source, Maintenance, and Recoverability) code	This is the last column. It contains joint military services uniform source, maintenance, and recoverability codes only. These codes provide you with information concerning the source of the part, where the part will be repaired, and if the part is repairable. Definitions of these codes are available in TO 00-25-195, <i>AF Technical Order System Source, Maintenance, and Recoverability Coding of Air Force Weapons, Systems, and Equipment</i> .

Now that you have a basic understanding of the purpose and the format of an IPB, we will now transition to the process of ordering a replacement part. Your search will take two different paths depending on whether you know the part number or not.

### **Part number is known**

Knowing the part number is the fastest way to find the part you need to order. For this example, we will use the sling bracket of the work cage sling assembly used on the Guided Missile Maintenance

Platform. The known part number for this part is 33307-40186-1. Refer to figures 1-1, 1-2, and 1-3, to follow along as you read and study each of the following steps.

1. The first step is to turn straight to the *Numerical Index* section in the 4-1 IPB. Note that this method will only work if the part you are researching is in the 4-2, 4-4, 4-5, or 4-7 IPB. The Guided Missile Maintenance Platform components are found in the 4-4 IPB, so this method will work for finding the sling bracket. Next, locate the part number and note the assigned figure and index numbers. Figure 4-2 below highlights our example using part number is 33307-40186-1. The figure number is 79 and the index number is 5.

T.O. 21M-LGM30F-4-1

PART NUMBER	T.O.	FIGURE	INDEX & SHEET NO.
33307-40164-1	4-4	78	1
33307-40175-10	4-4	65	9
33307-40185-10	4-4	65	21
33307-40185-10	4-4	79	
33307-40186-1	4-4	79	5
33307-40187-1	4-4	79	1
33307-40197-1	4-4	80	13/2
33307-40200-10	4-4	65	14

PART NUMBER	T.O.	FIGURE	INDEX & SHEET NO.
33307-40238-10	4-4	74	14/1
33307-40240-10	4-4	80	7/2
33307-40240-10	4-4	81	
33307-40243-1	4-4	80	28/3
33307-40244-1	4-4	80	3/1
33307-40247-1	4-4	80	27/3
33307-40251-10	4-4	80	22/3
33307-40251-10	4-4	80	48/4

Figure 4-2. IPB Numerical Index in the 4-1.

2. After you locate the part in the 4-1, the next step is to proceed to the IPB listed in the “TO” column, which is the 4-4 IPB (fig. 4-2). Once you are there, you will need to reference *figure 79*, and finally, locate index number 5 in the accompanying maintenance parts list.

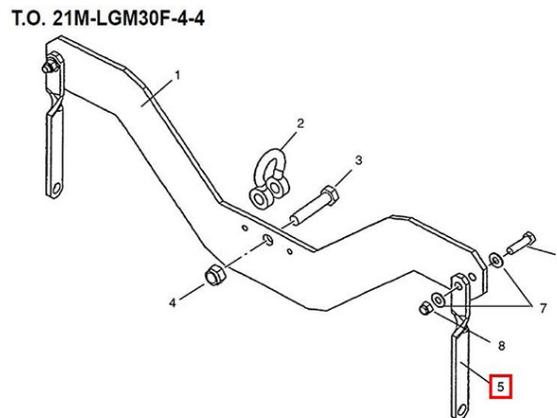


Figure 2-79. Work Cage Sling Assembly.

Figure 4-3. Index number in the 4-4 IPB.

3. Once you have located the index number within “figure 2-79” (fig. 4-3), you are almost done. The final step is to locate your index number in the data table that is found immediately after the figure(s). This is where the information resides for ordering the part through the supply system (fig. 4-4). When you need a pictorial representation of the part or its location, refer to the same index number on the illustration.

T.O. 21M-LGM30F-4-4										
FIGURE & INDEX/ SHEET NO.	PART NUMBER	CAGE	DESCRIPTION					UNITS PER ASSY REF	USABLE ON CODE	SMR CODE
			1	2	3	4	5			
2-79	33307-40185-10	97384	SLING ASSEMBLY, WORK CAGE (SEE Figure 2-65 FOR NHA)							
1	33307-40187-1	97384	PLATE, SLING					1		PAFFF
2	1018115	76257	SHACKLE (97384 SPEC 33307-90027-1)					1		PAFZZ
3	B1821BH075C350N	80204	CAPSCREW, HEX HD (AP)					1		PAFZZ
4	MS51922-57	96906	NUT, SLF-LKG (AP)					1		PAFZZ
5	33307-40186-1	97384	BRACKET, SLING					2		PAFZZ
6	B1821BH050C175N	80204	CAPSCREW, HEX HD (AP) (80204 SPEC ANSI B18.2.1)					1		PAFZZ
7	MS15795-818	96906	WASHER, FLAT (AP)					2		PAFZZ
8	MS51922-33	96906	NUT, SLF-LKG (AP)					1		PAFZZ

Figure 4-4. Work Cage Sling Assemble data table in the 4-4 IPB.

The data tables are always located *after* the figure that they correspond to and will show the figure number at the top-left of the table. As you can see, next to the index number are columns that contain the part number, the CAGE code, the description, the units per assembly, the usable on code, and the source, maintenance and recoverability (SMR) code. It is a wise idea to record all of this information since you will need it to order the part using IMDS or an AF Form 2005, Issue/Turn-In Request.

### Part number is not known

If you do *not* know the part number of the sling bracket for the work cage assembly, the process of finding the information includes some additional steps. For this part of the lesson, we will assume that you are aware that all Guided Missile Maintenance Platform parts are contained in the 4-4 IPB.

1. The first step is to determine what unit the part is associated with. Since you already know that the sling bracket is a component of the Guided Missile Maintenance Platform, which is contained in the 4-4 IPB, we can continue. Next, turn to the table of contents, select the most appropriate title (Guided Missile Maintenance Platform), and make a note of the page number. In the example below, figure 4-5, the page number is 2-375.

T.O. 21M-LGM30F-4-4	
TABLE OF CONTENTS – Continued	
Chapter	Page
Frame and Miscellaneous Braces.....	2-228
Fresh Air Filter Group .....	2-201
Front Outside Panels .....	2-1052
Front, Top, Bottom, and Left Side Outside Panels .....	2-194
Fuel Tank and Base .....	2-1099
Ground Handling Equipment .....	2-2
GSU-101/E Missile Base Support Level Set .....	2-571
GSU-104/E Lift Hand Truck.....	2-548
GSU-122/E Lift Hand Truck.....	2-516
GSU-123/E Leveling Jack Set.....	2-494
GSU-125/E Missile Base Adapter Ring Extension Assembly .....	2-614
GSU-157/E Missile Transfer Bridge Set .....	2-557
GSU-171/E Hydraulic Pusher Dolly.....	2-550
GSU-184/E 2nd Stage Rocket Motor Carriage.....	2-365
GSU-189/E Air Conditioning-Heat Set Pipe.....	2-559
GSU-235/E 3rd Stage Rocket Motor Carriage .....	2-367
GSU-95/E 1st Stage Rocket Motor Carriage.....	2-360
GSU-99/E Lift Hand Truck.....	2-1101
Guidance Section Cooler Test-Repair Set.....	2-989
Guidance Section Liquid Cooler Test Set.....	2-976
Guidance Section Liquid Cooler Test Set Tester .....	2-849
<b>Guided Missile Maintenance Platform .....</b>	<b>2-375</b>

Figure 4-5. Table of contents in the 4-4 IPB.

2. Next, you will need to turn to the page number indicated in the table of contents and locate the required part index number on the illustration. Figure 4-6, below, shows the illustration with all the components of the Guided Missile Maintenance Platform. In our case, we need to reference the part index number 21 representing the work cage sling assembly.

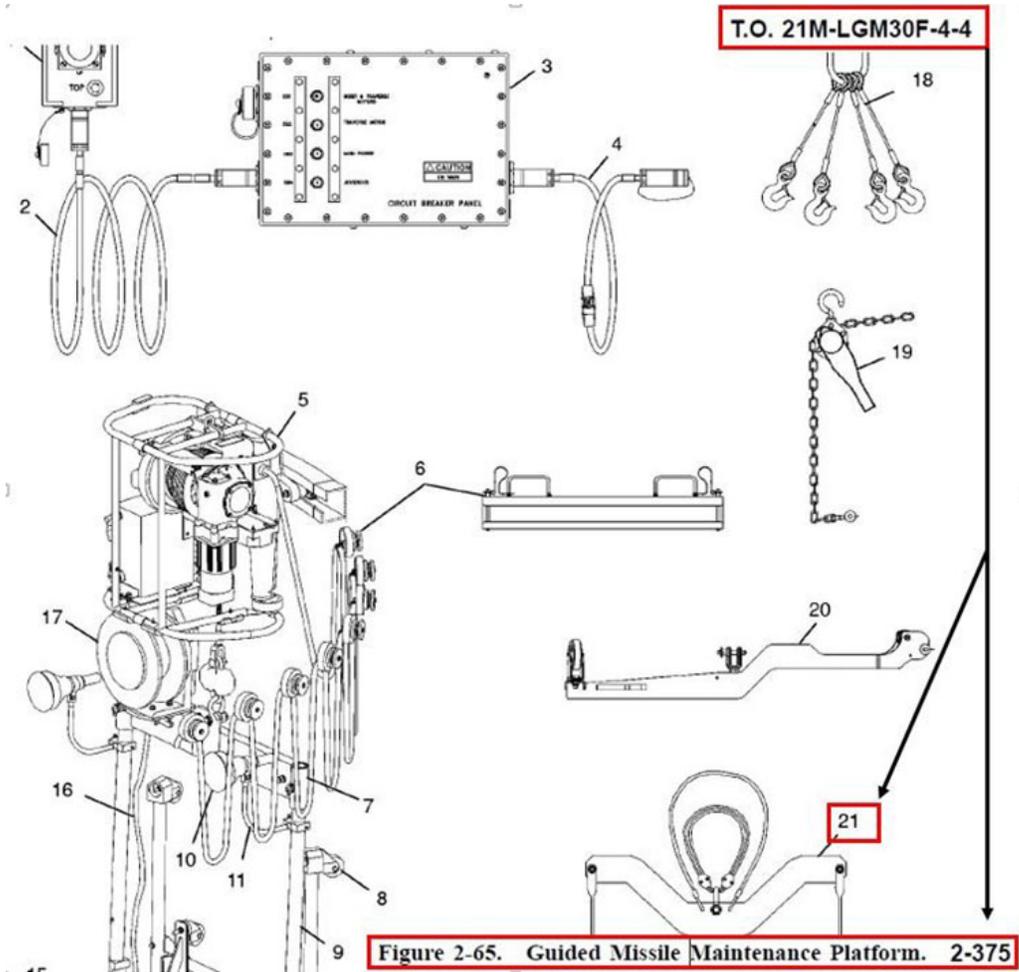


Figure 4-6. Guided Missile Maintenance Platform.

3. After you locate the correct index number from the illustration, you will need to refer to the data table, (fig. 4-7). Notice the Description column for index number 21 refers you to figure 2-79 for further breakdown (BRKDN). Recall earlier in the lesson that figure 2-79 (refer back to fig. 4-3) is the same illustration you used to find the work cage sling bracket when the part number was known.

FIGURE & INDEX/ SHEET NO.	PART NUMBER	CAGE	DESCRIPTION							UNITS PER ASSY	USABLE ON CODE	SMR CODE
			1	2	3	4	5	6	7			
2-65	33307-40000-10	97384	MAINTENANCE PLATFORM, GUIDED MISSILE . . .							REF		XB
1	33307-40350-10	97384	PENDANT ASSEMBLY, LER . . . . . (SEE Figure 2-84 FOR BRKDN)							1		PAFFF
2	33307-40020-10	97384	CABLE ASSEMBLY, (W2) . . . . . (SEE Figure 2-70 FOR BRKDN)							1		PAFFF
3	33307-40300-10	97384	POWER DISTRIBUTION BOX ASSEMBLY . . . . . (SEE Figure 2-82 FOR BRKDN)							1		PAFFF
4	33307-40015-10	97384	CABLE ASSEMBLY, (W1) . . . . . (SEE Figure 2-69 FOR BRKDN)							1		PAFFF
	201610016	= 98747	CABLE ASSEMBLY, (W1) . . . . .							1		PAFFF
5	33307-40050-10	97384	SUPPORT STRUCTURE ASSEMBLY . . . . . (SEE Figure 2-73 FOR BRKDN)							1		PFFFF
6	33307-40400-10	97384	TRAVERSE CABLE PACKAGE . . . . . (SEE Figure 2-87 FOR BRKDN)							1		PAFFF
7	33307-40150-10	97384	YOKE ASSEMBLY . . . . . (SEE Figure 2-78 FOR BRKDN)							1		PAFFF
8	33307-40360-10	97384	EXTENSION ARM ASSEMBLY, UPPER . . . . . RADIAL (SEE Figure 2-85 FOR BRKDN)							1		PAFFF
9	33307-40175-10	97384	SUPPORT ASSEMBLY, VERTICAL . . . . .							2		PAFFF
	L-56-5-36-SS	99862	BUSHING (97384 SPEC 33307-90118-1) . . . . .							1		PAFZF
	P-72-12-7812-SS	99862	BUSHING (97384 SPEC 33307-90046-1) . . . . .							1		PAFZF
10	33307-40036-10	97384	CABLE ASSEMBLY, LIGHT, (W13) . . . . . (SEE Figure 2-72 FOR BRKDN)							2		PAFFF
11	33307-40035-10	97384	LIGHT BRACKET ASSEMBLY . . . . . (SEE Figure 2-72 FOR BRKDN)							2		PAFFF
12	33307-40425-10	97384	RADIAL ACTUATOR ASSEMBLY . . . . . (SEE Figure 2-88 FOR BRKDN)							1		PAFFF
13	33307-40370-10	97384	EXTENSION ARM ASSEMBLY, LOWER . . . . . RADIAL (SEE Figure 2-85 FOR BRKDN)							1		PAFFF
14	33307-40200-10	97384	WORK PLATFORM ASSEMBLY . . . . . (SEE Figure 2-80 FOR BRKDN)							1		PFFFF
15	33307-40010-10	97384	SAFETY NET ASSEMBLY . . . . . (SEE Figure 2-68 FOR BRKDN)							1		PAFFF
16	33307-40025-10	97384	CABLE ASSEMBLY, (W12) . . . . . (SEE Figure 2-71 FOR BRKDN)							1		PAFFF
17	33307-40005-10	97384	CABLE REEL ASSEMBLY . . . . . (SEE Figure 2-66 FOR BRKDN)							1		PAFFF
18	404D-1/4"X36"	97924	SLING (97384 SPEC 33307-90057-1) . . . . .							1		PAFFF
19	33307-40325-10	97384	HOIST ASSEMBLY, LER . . . . . (SEE Figure 2-83 FOR BRKDN)							1		PAFFF
20	33307-40450-10	97384	ARM ASSEMBLY . . . . . (SEE Figure 2-86 FOR BRKDN)							1		PAFFF
21	33307-40185-10	97384	SLING ASSEMBLY, WORK CAGE . . . . . (SEE Figure 2-79 FOR BRKDN)							1		PAFFF

Figure 4-7. Guided Missile Maintenance Platform data table.

Regardless of whether you started at the Guided Missile Maintenance Platform level, or went directly to the work cage bracket sling assembly, you would arrive at the same figure as you did when you knew the part number. The rest of the process is the same; you would reference figure 2-79, where you will find the sling bracket, whose index number is 5.

After you know which IPB contains the parts you are looking for, you will more than likely find yourself going straight to that reference instead of beginning your search in the 4-1 IPB.

This lesson focused on the steps necessary to locate a part in 4-series IPB. You covered how to locate a part if you already know the part number, and then covered the procedures for locating a part with an unknown part number. Efficiently navigating the IPB will save you hours of headache when performing parts research and ensure that you order the correct part for the job.

## 229. Determining supply system priorities

The primary mission of the Air Force supply system is to furnish the right supplies, at the right place, at the right time, in the right amount, and at the least possible cost. Completing this mission requires a priority system to prevent a work stoppage or other mission degradation situations. This lesson details the process for determining the proper designator of the supply priority system.

The purpose of the supply priority system is to ensure that the available parts are delivered at a speed that meets the user and the mission's needs. The SBSS uses two priority systems; *on-base* and *off-base*, and each of them depends on the other. As with any program that gives priority or preferential treatment to individual requirements, the possibility exists that what should be processed as "routine" is requested to be processed as "immediately." It is a law of nature that when everything becomes a priority, nothing is priority. Thus, if we abuse a priority-based system we not only hurt ourselves, but every other user of the system. Most priority system abuse is more of a matter of poor education than of intentional abuse.

### Priorities for parts and equipment located on base

Let's say that a part you need is in stock at the base supply point. The on-base priority system is used when the item is in stock on the base, and priority is determined by time needed to deliver the part to the ordering work center. Think of it as how soon the item should arrive at your work center. The only step in the process is to determine how soon you need the part or equipment and then select the corresponding two-digit priority code. A list of the numbers and their meanings are included in the following table.

Priority	Description
02	Needed within 30 minutes; mission impacted.
03	Needed within 1 hour; mission impacted.
04	Needed within 4 hours.
05	Needed within 8 hours.
06	Can wait until the next workday.

### Priorities for parts and equipment located off base

For off-base priority, let's say that the part you need is not available at the base supply point or your local Materiel Control. The off-base priority system is called the Uniform Materiel Movement and Issue Priority System (UMMIPS). It provides a basis for expressing the relative importance of the movement and receipt of the part by assigning a two-digit priority designator. The priority designator ranges from 01 thru 15; 01 is the most important, 15 is the least important.

The UMMIPS uses a combination of the urgency of need designator (UND) and force activity designator (FAD) to determine the importance of receiving the part you need. This is expressed as a simple formula: **UND + FAD = UMMIPS designator**. We will go over UND and FAD in the following paragraphs, and then combine the two to determine the UMMIPS designator.

#### *Determining the UND*

The UND is a one-position alpha/numeric value used to express varying degrees of urgency when operational mission capability is jeopardized due to assets nonavailability. This value is expressed as A, B, and C. The first step is to determine the proper UND based on importance of the mission.

An explanation of each of the UND is in the following table.

UND	Description
A	Mission essential; unable to perform the assigned operational mission.
B	Mission is impaired.
C	Mission not affected. Use this for routine requirements.

### *Determining the FAD*

The FAD is a one-position numeric character that may be entered on customer issue requests. The authorized FAD codes are expressed in Roman Numerals I, II, III, IV, or V. The second step to determining the UMMIPS designator is selecting the FAD that your request falls under. The FAD indicates the level of combat readiness each unit must maintain, and expresses the relative importance of the unit placing the order. An explanation of each of the FAD is in the following table.

FAD	Description
I	The highest national priority designated by the President and the Secretary of Defense based on recommendations from the Joint Chiefs of Staff.
II	Is assigned to US combat, combat ready, and combat support forces deployed outside the continental United States (CONUS).
III	Is assigned to all other combat ready and direct combat support forces outside CONUS not included in FAD II. It is also assigned to other military service programs and projects, which are of comparable importance. For example, technology or resources that are broad or generic in scope and operational in nature but not directly combat related.
IV	Is assigned to US forces being maintained in a state of combat readiness.
V	Is assigned to all other US forces and programs including staff, administrative, and base supply type activities. Also, for foreign country forces not otherwise directed.

### **Off-base priority; putting it all together**

Now that you have determined the UND and the FAD, the third and final step is to put them together to determine the UMMIPS designator. Example: A routine request has a UND of C; a request that originates from a combat force maintained in a constant state of readiness has a FAD of IV. If you cross-reference the two designators, you will see that your UMMIPS designator is 14. Using priorities correctly ensures the customer request with a more important need is always prioritized over a customer with a less critical need. An easy reference for determining the UMMIPS is included in the following table.

UND	FAD				
	I	II	III	IV	V
A	01	02	03	04	05
B	06	07	08	09	10
C	11	12	13	14	15

UMMIPS Designator

This lesson on determining supply system priorities covered the steps required to determine priorities for parts located on base, and also parts that were located off base. You must realize that high priority

issue requests increase the overall costs of supply support by increasing transporting and handling costs. To minimize these costs, make sure the UND assigned is consistent with the actual urgency of need. Misuse of priority designators adversely affects the integrity of the system, waste resources, and degrades the overall supply support you receive.

### 230. Preparing Air Force supply forms

As a missile maintenance technician, you will routinely use various forms and documents used to process items through the standard base supply system. Three of the most commonly used maintenance supply forms are the AF Form 2005, Issue/Turn-In Request, DD Form 1348-1A, Issue Release/Receipt Document, and the DD Form 1348-6, DOD Single Line Item Requisition System Document (Manual-Long Form), for local purchase or any noncatalogued requests. A brief explanation of these forms is provided below, but your familiarity with these forms will grow over time as you use them on a daily basis.

#### Issue of supplies

The initial issue of supplies and equipment is based on proper justification. Some examples include authorization documents, established stock levels, special projects, special orders, and other publications. Organizations obtain supply items directly from base supply issue points such as the base service store or supply point. Depending on the urgency of need, supplies may be requested by radio, telephone, mail, through IMDS, or in person. It is important to exercise quality control when preparing and processing these requests. Inaccurate inputs can generate excessive levels, wrong transactions, unnecessary workloads, or delay receipt of parts.

#### Data elements and codes

While you are reading the description of the codes and data elements, refer to figure 4-8 on an AF Form 2005. The entries in blocks A through J of the AF Form 2005 are self-explanatory. As a Missile and Space Systems Maintenance Journeyman, your first step in the order process is to ensure the AF Form 2005 has the correct data elements and codes. You will not have to use all of the codes covered; however, you will need to be familiar with them. Portions of the form will be completed by the requestor (you), and other parts will be completed by materiel control personnel. The following description lists only the fields that need to be completed by the requestor. Additionally, this process might differ slightly between organizations. If you have never prepared an AF Form 2005, it is best to ask if there is local training or a template available.

AF Form 2005	
Blocks	Entry Descriptions
TRIC ( <i>Transaction identification codes</i> ) blocks 1 through 3	The TRIC is a three-position alphanumeric code you enter that materiel management personnel will refer to in order to properly process your transaction as either a turn-in (TIN), or issue (ISU). The TRIC ISU used in figure 4-8 tells the Materiel Management database to select the issue program for processing the input.
<i>Delivery destination code</i> , blocks 4, 5, 6	This is a three-digit code established locally to aid supply in delivering parts. You will most likely need to get this from your shop to complete this part.
<i>Issue exception code</i> , block 7	This is a one-position alphanumeric code assigned to the item record. It identifies issue conditions unique to an item. The purpose of an issue exception (IEX) code is to identify and control the issue of certain items. Some examples of IEX codes are D for Do not back order, B for Warranty, 5 for Time change item, etc. In our example below, there is no exception code to enter.
Block A	To order a part, you need the name of the requestor, time, and date.

<b>AF Form 2005</b>	
<b>Blocks</b>	<b>Entry Descriptions</b>
<i>Block B</i>	Completed by supply.
<i>National Stock Number</i> , blocks 8 through 22	OAs requestor, you identify your request to the logistics readiness squadron (LRS) using either an NSN or part number. Remember that a stock number is only 13 digits made up of the NSN and NIIN; however, we have two extra spaces (blocks 21–22) on the form. This is used for a special management identifier associated with a specific stock number. For example, some weapon components may use the code CM to identify nuclear ordnance commodity managed (NOCM) items. If the NSN is not available, place the part number in block D and the TO references in block E. The research section of base supply will use this information to convert the part number into an NSN.
<i>Unit of issue</i> , blocks 23 and 24	This is how the materiel is packaged. Examples: each (ea.), gallon (gal.), bag (bg.) and can generally be found on your IPB or using FED LOG.
<i>Quantity required</i> , blocks 25 through 29	In our case, we asked for one item. Notice that the other blocks are zeroed out.
<i>Block C</i>	Not used.
<i>Activity code</i> , block 30	Block 30 identifies priority-related information. Usually maintenance organizations use the code B for bench stock, R for routine maintenance, or X for expedite. Do not get in the habit of marking everything as expedited because it will make everything a priority and backlog the supply system.
<i>Organization and shop codes</i> , blocks 31 through 35	The organization code is locally determined and usually consists of three numbers. The shop code (blocks 34 and 35) of each organization assigns, controls, and uses this code to identify functions within that organization. Get with your shop for this information. It may be written down in a local user guide maintained by the shop.
<i>Date and serial number</i> , blocks 36 through 43	The Julian dating system is used in most all supply transactions. The first digit (in block 36) is the last digit of the year. The last three digits are the Julian day, starting with 001 for January 1st and ending with 365 for December 31st. The other four blocks (40 through 43) tell how many transactions were processed through Supply that day.
<i>Demand code</i> , block 44	The demand code is used by the materiel management system to determine stock levels and repair cycle item control. The requesting organization assigns the demand codes: R for recurring need, N for nonrecurring need, or I for an initial request.
<i>FAD (force activity designator)</i> , blocks 52 and 53	Normally left blank. Base supply automatically assigns the FAD to your issue request.
<i>Project code</i> , block 57, 58, and 59	Project codes are three-position alphanumeric codes used to identify special projects. These codes allow you to identify materiel management transactions associated with a particular project and allow Air Force and DOD personnel to track the cost data and service performance of items related to special projects, program, exercises, and maneuvers.
<i>Priority code</i> , blocks 60 and 61	This numeric code represents the maximum time that may elapse from the time the LRS receives the request until the materiel is delivered to the requester (assuming the part is on hand at supply). Priorities 01 and 02 are delivered within 30 minutes, 03 within 1 hour, and 04 within 4 hours. Lower priorities (higher numbers) are issued on a routine basis.

AF Form 2005	
Blocks	Entry Descriptions
UJC (urgency justification code), blocks 65 and 66	Identified by two elements, the urgency of need designator (UND), and type of requirement. These two codes combined make up what is known as the UJC.
Mark for, blocks 67 through 80	The "Mark For" field identifies the end item of equipment on which the request item will be used. Base supply will assist in completing this data.
Nomenclature, block J	Enter the name of the asset.

Blocks 45–51, 54–56, 62–64, and F–H are filled out by Supply. They will not be discussed in this CDC.

ISSUE/TURN-IN REQUEST	TRIC			DEL DST			EX			A. INCHECKER, NAME, DATE (TIN)										B. INSPECTOR, NAME-STAMP, DATE (TIN)																														
	1 2 3			4 5 6			7			SMITH, TED, MSgt, 0830/25032018																																								
	ISU			B16						REQUEST, TIME & DATE (ISU)																																								
	NSN			STOCK NUMBER										ADDN			LIMIT OF ISSUE			QUANTITY			C.										ACT			ORG			SHOP			DATE			SERNO			COND		
	8 9 10 11			12 13 14 15 16 17 18 19 20										21 22			23 24			25 26 27 28 29													30			31 32 33			34 35			36 37 38 39			40 41 42 43			44		
	1650			002345678													EA			00001													X			101			HS			3301			0005			R		
				Part Number																																														
				D. PART NUMBER/MGFR CODE OR NAME/REMARKS																			E. T.O. REFERENCE/TECHNICAL PUBLICATION OR END-ITEM APPLICATION/NEXT HIGHER ASSEMBLY																											
				PART NUMBER. MANUFACTURER'S CODE																			T.O. FIGURE INDEX																											
	WORK ORDER			TRK			SOO/AD			SD			PROJECT			PRB			REQ DEL DT			UJC			MARK FOR																									
SHIP TO			51			51			54			55 56			57 58 59			60 61			AT			CC			DC			DOCUMENT NUMBER			POSTA/POST			F. T.O. PSC AND/OR ERRC														
45 46 47 48 49 50			52 53															62 63 64			65 66			67 68 69 70 71 72 73 74 75 76 77 78 79 80																										
335014			4						01						02			AA			7033265CVC72																													
G. TIME & DATE OF DELIVERY																								J. NOMENCLATURE																										

AF 2005, 20080826, V4

PREVIOUS EDITION WILL BE USED.

Figure 4–8. Sample AF Form 2005.

Once you have determined the part you need to order through the supply system, and found the information for that part in one of your IPB, the next step is to initiate the request. Normally, the part is ordered through IMDS, which then alerts your local materiel control section. Base supply issues items on hand based on the priority used in blocks 60–61. If the item you need is not on hand at supply, your request will be backordered and supply will reorder the item from a depot or General Services Administration (GSA) source. When the item is received at base supply, it will be delivered to your shop using the same priority system discussed. Confirmation of your supply requests is shown on a computer listing called a D04, Daily Document Register. You should check this tool as soon after your request as possible to determine the status of the item you need. An assigned document number is your proof the item has been placed on order with supply. If you do not receive a supply document number, you should follow up with supply to check on the status. Further guidance on supply procedures may be found in AFH 23–123.

### Preparing the DD Form 1348–1A

Now we will focus on the DD Form 1348–1A, Issue Release/Receipt Document. The DD Form 1348–1A (fig. 4–9) is produced to reflect the status of an item that was requested through the Supply system. As the name implies, this form is primarily used as the receiving document, but it is also used to turn-in items, (turn-in of property means putting it back into the supply channels). Procedures for disposal depend on the property involved. If the property is *not* serviceable, it is transferred to the Defense Logistics Agency Disposition Services (DLADS) (formerly known as the Defense Reutilization Management Office [DRMO]). If it *is* serviceable, it is turned-in for reissue.

If you have ever signed for a part or piece of equipment at materiel control, this is the document you signed. In addition, if you have ever turned equipment into DLADS, you used this form to relinquish the items to them.

While the choice to use each numbered block on the form may vary from one unit to another, the blocks in the following two lists are the most important. There are two separate sections of this form, each having its own set of numbered blocks. The first section of blocks in this first list runs along the top of the form, from left to right:

- Blocks 1–3, *Document identification*: contains the three-digit document identification code, (example ISU-issue request).
- Blocks 23–29, *Unit of issue and quantity*: self-explanatory.
- Blocks 45–50, *Supplementary address*: lists an address that may be different from the unit making the requisition.
- Block 71, *Condition code*: shows the current condition of the item being requisitioned or turned in.
- Blocks 74–80, *Unit price*: contains the price per unit.

1	2	3	4	5	6	7	23	24	25	26	27	28	29	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	1. TOTAL PRICE	2. SHIP FROM	3. SHIP TO
OOI	-TZ	RI	M	S	UN	IT	QUANTITY	SUPPL.	S	F	DIS-	PRO-	P	R	E	L	D	A	D	V	R	I	C	M	O	G	T	P	R	I	N	D	UNIT PRICE	DOLLARS	CTS	4. MARK FOR																
24. DOCUMENT NUMBER & SUFFIX (99-44)	25. NATIONAL STOCK NO. & ADD (8-22)	26. RIC (4-6) LIJ (23-24) CON CODE (7) (7-8-9) UP (74-80)	5. DOC DATE	6. NMFC	7. FRT RATE	8. TYPE CARGO	9. PS	10. QTY. REC'D	11. UP	12. UNIT WEIGHT	13. UNIT CUBE	14. UFC	15. SL	16. FREIGHT CLASSIFICATION NOMENCLATURE	17. ITEM NOMENCLATURE	18. TY CONT	19. NO CONT	20. TOTAL WEIGHT	21. TOTAL CUBE	22. RECEIVED BY	23. DATE RECEIVED																															

Figure 4–9. DD Form 1348–1A.

The second section of blocks on the form (presented in this second list) begins in the upper-right corner of the form and runs from top to bottom:

- Block 1, *Total Price*: lists the cumulative price of items requisitioned/turned-in.
- Block 2, *Ship From*: lists the organization where the item originated.
- Block 3, *Ship To*: lists the organization where the item is destined.
- Block 8, *Type Cargo*: lists the type of cargo in terms of national stock class (NSC).
- Block 16, *Freight Classification Nomenclature*: lists the type of freight for shipping purposes.
- Block 24, *Document Number*: lists the supply document number.
- Block 25, *National Stock Number*: self-explanatory.

The DD Form 1348-1A is considered a receipt, and there are three copies as follows:

- Copy 1 is returned to supply to be turned in to document control after being signed by the receiving organization in receipt of the asset.
- Copy 2 is kept by the receiving organization to be stored for their record.
- Copy 3 is returned to the Flight Service Center upon turn-in of an unserviceable asset for processing.

### Preparing the DD Form 1348-6

There are times when you need to get items but you may not have some pieces of information like a national stock number (NSN) or part number (P/N). Sometimes you may also need to purchase items locally for the office. In this lesson, you will learn the basics of preparing the DD Form 1348-6.

A DD Form 1348-6 is used for local purchases, items that are not stock listed or are no longer available, but they are still required, or when you do not have a NSN. Typically, the form is submitted with an AF Form 2005. A DD Form 1348-6 allows the customer (you) to provide additional information necessary to facilitate item procurement from a vendor. The more information you provide as the customer, the quicker the item can be procured (see the following DD Form 1348-6 instructions).

<b>DD Form 1348-6 Instructions</b>	
<b>Top Blocks</b>	<b>Entry Descriptions</b>
<i>Document Identifier Code</i> , blocks 1 through 3	Enter "ISU" for Issue.
<i>Routing Identifier Code</i> , blocks 4 through 6	Enter your Delivery Destination code.
<i>Block 7</i>	Left Blank
<i>Federal Stock Class</i> , blocks 8 through 22	Enter the NSN or Part number (Leave blank if you do not have a stock number.)
<i>Unit of Issue</i> , blocks 23 and 24	Enter Unit of Issue.
<i>Quantity</i> , blocks 25 through 29	Enter the quantity requested, also enter zeros or lineout unused spaces.
<i>Activity Code</i> , block 30	Enter the Activity Code, "X" for expedite or "R" for routine issues.
<i>Organization Code and Shop Code</i> , blocks 31 through 35	Enter your Organization Account Code and Shop Code.
<i>Blocks 36 through 43</i>	Left blank.
<i>Demand Code</i> , block 44	Enter the Demand Code, "I" for initial issue (must be supported by a letter for DIFM assets) "R" for recurring or "N" for nonrecurring issues.
<i>Blocks 45 through 66</i>	Left blank.
<i>Blocks 67 through 80</i>	This field is used to identify the end item of equipment on which the request item will be used. Base supply will assist in completing this data.
<b>Bottom Blocks</b>	<b>Entry Descriptions</b>
<i>Manufacturer's Code and Part Number</i> , block 1	Enter the manufacturer code (if you have it) and Part Number of item.
<i>Manufacturer</i> , block 2	Enter the manufacturer's name and address. If more than one, enter on the reverse side of the form.
<i>Manufacturer's Catalog</i>	If applicable, enter the commercial catalog number.

<i>Identification, block 3</i>	
<i>Manufacturer's Catalog Date, block 4</i>	If applicable, enter commercial catalog date, which identifies the requested item.
<i>Technical Order Number, block 5</i>	Enter technical order number, figure, and index.
<i>Technical Manual Number, block 6</i>	Enter technical manual number, figure, and index.
<i>Name of Item Requested, block 7</i>	Self-explanatory.
<i>Description, block 8</i>	Enter a complete description of the item. The first 19 characters are the most important for Stock Number Directory purposes. Use common commercial terms for realistic and identifiable descriptions of the requested item. If the description is too long for both block 8 and block 11 (Remarks), use a separate sheet and attach it.
<i>Color, block 8a</i>	Self-explanatory.
<i>Size, block 8b</i>	Self-explanatory.
<i>End Item, block 9</i>	Data applicable to the end item, information regarding the source of supply.
<i>Source of Supply, block 9a</i>	Enter LP for local purchase.
<i>Make, block 9b through 9e</i>	Enter information about the end item this part goes on.
<i>Requisitioner, block 10</i>	Name of the requesting individual and telephone number. (Not applicable to DD Forms 1348-6 going to local procurement)
<i>Remarks, block 11</i>	Enter the suggested source of supply information and cost.

In this lesson, you learned how to prepare the Air Force Form 2005, Issue/Turn-In Request, DD Form 1348-1A, Issue Release/Receipt Document, and the DD Form 1348-6. It is imperative that you fill out each form correctly and review it for accuracy before submitting to avoid any delays in the process.

### **Standard reporting designator**

A standard reporting designator (SRD) is a three-character code that is used in the supply system to collect materiel usage data that ranges across different weapon systems or items of equipment. The first character of the SRD is used to identify the general equipment type. For example, "A" is for aircraft, "T" is for training equipment, and "M" is for ground-launched missiles. The remaining two digits are what identify the specific equipment, but have no specific meaning. Combinations of A through Z and 0 through 9 offer many different items to fall under the same first character of the SRD without the need to repeat. They are also used to communicate how well the supply chain is supporting various weapon systems. Think of an SRD as a tool that allows several individuals that speak completely different languages to communicate with each other. SRDs are typically assigned during the acquisition of the item, which happens long before you will come into contact with it. However, in certain circumstances, an SRD may need to be added, changed, or removed altogether. The master location for all SRD data is the REMIS, and this data is periodically transmitted to other maintenance information systems (MIS).

### Self-Test Questions

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

#### **226. Basic principles of materiel management**

1. What is the standard base level inventory accounting and ordering management system for the Air Force?
2. Which Air Force instruction provides direction for determining materiel requirements, ordering, receiving, and the disposal of items?
3. What numeric code is applied to each item currently used, bought, stocked, or distributed by the Department of Defense?
4. What two-digits identify the Country of a national item identification number?
5. Which supply class represents repair parts and components for missiles?
6. How do manufacturers identify a specific part or item of materiel?
7. Which *three-position* code designates whether an item is expendable or not and at which level in the supply system repairs and/or condemns the item?
8. Why are XF3 assets are coded DIFM?
9. What is the main objective of a bench stock?

#### **227. Supply discipline**

1. List one factor of how you exercise supply discipline.
2. What is one of the most critical aspects of maintaining good supply discipline?

3. What inputs are critical to recording and getting monetary credit for proper repair cycle times?
4. What are all people working for the Air Force (military and civilian workers alike) responsible for?

### **228. Illustrated parts breakdown**

1. What is the purpose of an illustrated parts breakdown?
2. Which section of the illustrated parts breakdown consists of a single list of *all* part numbers appearing?
3. Which section of the illustrated parts breakdown breaks down the equipment into its major assemblies, subassemblies, detail parts, and attaching parts?
4. List the seven columns contained in the maintenance parts listing.

*(For questions 5 and 6, refer to figure 4-2.)*

5. What is the first step for locating a replacement part when the part number is known?
6. What is the next step after you have located the part in the 4-1 illustrated parts breakdown?
7. What is the first step if you are looking for a replacement part when the part number *is not* known, but you do know which IPB the part is in?

### **229. Determining supply system priorities**

1. What two priority systems does the Standard Base Supply System use?
2. Which priority system is used when a part or equipment item is in stock on base?
3. What two-digit priority designator is the most important?

4. What is the first step to determine the proper alpha/numeric designator based on the importance of receiving the part you need?
5. Which urgency of need designator would you use to order a part that does not affect the mission?
6. What is the second step to determine the UMMIPS designator?
7. Using the UMMIPS designator chart, a routine request has a UND of *B*; with a FAD of *V*, if you cross-reference the two designators, what is the Uniform Materiel Movement Issue Supply designator?

### **230. Preparing AF supply forms**

1. What is the initial issue of supplies and equipment based on?
2. What is the first step in the order process when preparing AF Form 2005?
3. Using figure 4-8, sample AF Form 2005, and the description table, which code is used by the materiel management system to determine stock levels?
4. What form is primarily used as a receiving document, but it is also used to turn-in items?
5. How many DD Form 1348-6 copies are produced when you receive or turn-in an item?
6. What is the purpose of DD Form 1348-6?
7. Why is DD Form 1348-6 typically submitted with an AF Form 2005?
8. When are the standard reporting designators typically assigned?

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## Answers to Self-Test Questions

**226**

1. The Standard Base Supply System.
2. Air Force Instruction 23-101.
3. National stock number.
4. The first two digits.
5. Supply Class IX.
6. Part number.
7. Expendability, recoverability, reparability, category codes.
8. Because of the cost and sensitivity of the asset.
9. To decrease maintenance time by reducing the time workcenter personnel spend waiting for spare parts.

**227**

1. Promptly repair or turn in unserviceable (reparable) items and unserviceable items that cannot be locally repaired.
2. Assigning responsibility for equipment users.
3. Due-in from maintenance (DIFM) inputs.
4. Government property.

**228**

1. To assist you in identifying and ordering the parts you need to complete your maintenance.
2. The Numerical Index.
3. The Maintenance Parts List.
4. (1) figure and index number, (2) part number, (3) CAGE code, (4) description, (5) units per assembly, (6) usable on code, and (7) source, maintenance, and recoverability (SMR) codes.
5. The first step for locating a known part number is to search the Numerical Index 4-1 IPB, for the figure and index number assigned to the part number.
6. The next step is to proceed to the IPB listed in the "TO" column, which is the 4-4 IPB.
7. The first step for locating an *unknown* part when the IPB *is known*, start at the table of contents.

**229**

1. The *on-base* and *off-base* priority system.
2. The *on-base* priority system.
3. 01.
4. The urgency of need designator.
5. C.
6. The Force Activity Designator.
7. The Uniform Materiel Movement Issue Supply designator is 10.

**230**

1. Proper justification.
2. To ensure the AF Form 2005 has the correct data elements and codes.
3. The demand code.
4. DD Form 1348-1A.
5. 3 copies.
6. To use for local purchase items that are no longer available but still required.

7. To provide additional information necessary to facilitate item procurement from a vendor.
8. The standard reporting designators are typically assigned during the acquisition of the item.

**Complete the unit review exercises.**

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## 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.**

90. (226) What numeric code does the Federal Supply Classification and the national item identification number represent?
- Part number.
  - National Codification Bureau code.
  - National stock number.
  - Central supply classification.
91. (226) At what percentage should bench stock supplies be replenished when the authorized quantity on-hand drops below that which is authorized?
- 50.
  - 60.
  - 70.
  - 80.
92. (227) Which is an example of supply discipline?
- De-prioritize repair or turn in serviceable items.
  - Delaying the return of needed items to supply.
  - Promptly repair or turn in unserviceable (reparable) items.
  - Increase the hoarding of any supplies or equipment.
93. (228) What is the purpose of an illustrated parts breakdown?
- To assist in technical order changes.
  - To assist in identifying and ordering parts.
  - Shows relationships between figures and sequence numbers.
  - Shows relationships between appendixes and sequence numbers.
94. (228) Which section of the illustrated parts breakdown provides the part number, volume, figure, and index of an item?
- Introduction.
  - Numerical Index.
  - Maintenance Parts List.
  - Reference Designation Index.
95. (229) The purpose of the supply priority system is to
- assist in parts that are not mission affected.
  - assist in the three basic repair cycle categories.
  - identify deficiencies in parts received from the manufacturer.
  - ensure available parts are delivered at a speed that meets the mission's needs.
96. (229) If a part is needed within 1 hour, which two-digit priority code is selected?
- 01.
  - 03.
  - 05.
  - 15.

97. (229) What is the off-base priority system called?
- The Materiel Force Activity Designator.
  - The Materiel Urgency of Need Designator.
  - The Uniform Materiel Movement and Issue Priority System.
  - The Unchanging Measureable Materiel Issue Supply.
98. (229) What alpha urgency of need designator is used for mission-essential items?
- A.
  - B.
  - C.
  - D.
99. (229) If you already know the urgency of need designator, the next step to determine the Uniform Materiel Movement Issue Priority System designator is to select the
- force activity designator.
  - expedite activity designator.
  - priority assignment designator.
  - military standard requisitioning designator.
100. (230) Which document is considered a receipt?
- DD Form 1348-1A, Issue Release/Receipt Document.
  - DD Form 1348-6, DOD Single Line Item Requisition System Document (Manual-Long) Form.
  - DD Form 1348-5A, DOD Single Line Short Form.
  - AF Form 2005, Issue/Turn-In Request.

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## Glossary

### Abbreviations and Acronyms

$\Omega$	ohm
<b>AETCI</b>	Air Education and Training Command instruction
<b>AFGSC</b>	Air Force Global Strike Command
<b>AFH</b>	Air Force handbook
<b>AFI</b>	Air Force instruction
<b>AFMAN</b>	Air Force manual
<b>AFMC</b>	Air Force Materiel Command
<b>AFOSH</b>	Air Force Occupational Safety and Health
<b>AFOSI</b>	Air Force Office of Special Investigations
<b>AFPAM</b>	Air Force pamphlet
<b>AFPD</b>	Air Force policy directive
<b>AFPM</b>	Air Force policy memorandum
<b>AFREP</b>	Air Force enhancement program
<b>AFSC/SEW</b>	Air Force Safety Center Weapons Division
<b>AFTO</b>	Air Force technical order
<b>ALC</b>	air logistics complex
<b>APU</b>	auxiliary power unit
<b>AWM</b>	awaiting maintenance
<b>AWP</b>	awaiting parts
<b>B</b>	base or user
<b>bg.</b>	bag
<b>BRKDN</b>	breakdown
<b>CA/CRL</b>	custodian authorization/custody receipt listing
<b>CAGE</b>	Commercial and Government Entity
<b>CE</b>	civil engineering
<b>CEM</b>	civil engineering manual
<b>CEMIC</b>	civil engineering manual interim change
<b>CONUS</b>	continental United States
<b>D</b>	depot
<b>dc</b>	direct current
<b>DD</b>	Department of Defense
<b>DEMIL</b>	demilitarization
<b>DEU</b>	diesel electric unit

<b>DIFM</b>	due-in from maintenance
<b>DLADS</b>	Defense Logistics Agency Disposition Services
<b>DOD</b>	Department of Defense
<b>DR</b>	deficiency report
<b>DRMS</b>	Defense Reutilization and Marketing Service
<b>DRMO</b>	Defense Reutilization Management Office
<b>ea.</b>	each
<b>ECS</b>	environmental control system
<b>EMI</b>	electromagnetic interference
<b>EMP</b>	electromagnetic pulse
<b>EPA</b>	Environmental Protection Agency
<b>ERRC</b>	expendability, recoverability, reparability, category
<b>ESA</b>	electrical surge arrester
<b>ESD</b>	electrostatic discharge
<b>EXP</b>	expense
<b>F</b>	field
<b>FAD</b>	force activity designator
<b>FED LOG</b>	Federal Logistics
<b>FSC</b>	Federal Supply Classification
<b>FSG</b>	Federal Supply Group
<b>FWA</b>	fraud, waste, and abuse
<b>G&amp;C</b>	guidance and control
<b>gal.</b>	gallon
<b>GMMP</b>	guided-missile maintenance platform
<b>GSA</b>	General Services Administration
<b>HAB</b>	high-altitude burst
<b>HAZMAT</b>	hazardous material
<b>HC</b>	hardness critical
<b>HCP</b>	hardness critical procedures
<b>HICS</b>	Hardened Intersite Cable System
<b>HQ</b>	Headquarters
<b>ICBM</b>	intercontinental ballistic missile
<b>IEX</b>	issue exception
<b>IM</b>	item manager
<b>IMDS</b>	Integrated Maintenance Data System

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<b>in.</b>	inch
<b>INVEST</b>	investment
<b>INW</b>	in-work
<b>IPB</b>	illustrated parts breakdown
<b>ISU</b>	issue
<b>JDD</b>	job data documentation
<b>kt</b>	kiloton
<b>lb.</b>	pound
<b>LCC</b>	launch control center
<b>LCEB</b>	launch control equipment building
<b>LCSB</b>	launch control support building
<b>LER</b>	launcher equipment room
<b>LF</b>	launch facility
<b>LOAP</b>	list of applicable publications
<b>LRS</b>	logistics readiness squadron
<b>LSB</b>	launch support building
<b>MAF</b>	missile alert facility
<b>MAJCOM</b>	major command
<b>MC</b>	mission-critical
<b>MCL</b>	master change log
<b>MCRL</b>	master cross-reference list
<b>MDD</b>	maintenance data documentation
<b>MIS</b>	maintenance information system
<b>MMOC</b>	missile maintenance operations center
<b>MNCL</b>	master nuclear certification list
<b>Mph</b>	miles per hour
<b>MPL</b>	maintenance parts list
<b>MPP</b>	Minuteman Power Processor
<b>N</b>	nonexpendable
<b>NATO</b>	North Atlantic Treaty Organization
<b>NCB</b>	National Codification Bureau
<b>NIIN</b>	national item identification number
<b>NOCM</b>	nuclear ordnance commodity managed
<b>NRTS</b>	not reparable this station
<b>NSC</b>	national stock class
<b>NSN</b>	national stock number

<b>NWRM</b>	nuclear weapons related material
<b>O&amp;M</b>	operation and maintenance
<b>OI</b>	operating instruction
<b>OTI</b>	one-time inspection
<b>P/N</b>	part number
<b>PBR</b>	percentage of base repair
<b>PDM</b>	programmed depot maintenance
<b>POL</b>	petroleum, oils, and lubricants
<b>PPE</b>	personal protective equipment
<b>PRP</b>	personnel reliability program
<b>Psi</b>	pounds per square inch
<b>PSRE</b>	Propulsion System Rocket Engine
<b>PT</b>	payload transporter
<b>QA</b>	quality assurance
<b>QDR</b>	quality deficiency report
<b>QRP</b>	quick-release pin
<b>REMIS</b>	Reliability and Maintainability Information System
<b>RFI</b>	radio frequency interference
<b>RPIE</b>	real property installed equipment
<b>RV</b>	reentry vehicle
<b>SBSS</b>	Standard Base Supply System
<b>SCS</b>	safety control switch
<b>SECAF</b>	Secretary of the Air Force
<b>SIN</b>	support information network
<b>SMR</b>	source, maintenance, and recoverability
<b>sq.</b>	square
<b>SRD</b>	standard reporting designator
<b>TCM</b>	technical content manager
<b>TCTO</b>	time compliance technical order
<b>TIN</b>	turn-in
<b>TM</b>	technical manual
<b>TMCM</b>	technical manual change monitor
<b>TNT</b>	trinitrotoluene
<b>TO</b>	technical order
<b>TODO</b>	technical order distribution officer
<b>TRIC</b>	transaction identification code

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<b>UCMJ</b>	Uniform Code of Military Justice
<b>UHF</b>	ultrahigh frequency
<b>UJC</b>	urgency justification code
<b>UMMIPS</b>	Uniform Materiel Movement and Issue Priority System
<b>UND</b>	urgency of need designator
<b>USAF</b>	United States Air Force
<b>VAC</b>	volt alternating current
<b>VDC</b>	volt direct current
<b>WSSR</b>	weapon system safety rules
<b>WUC</b>	work unit code
<b>X</b>	expendable

## Student Notes

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