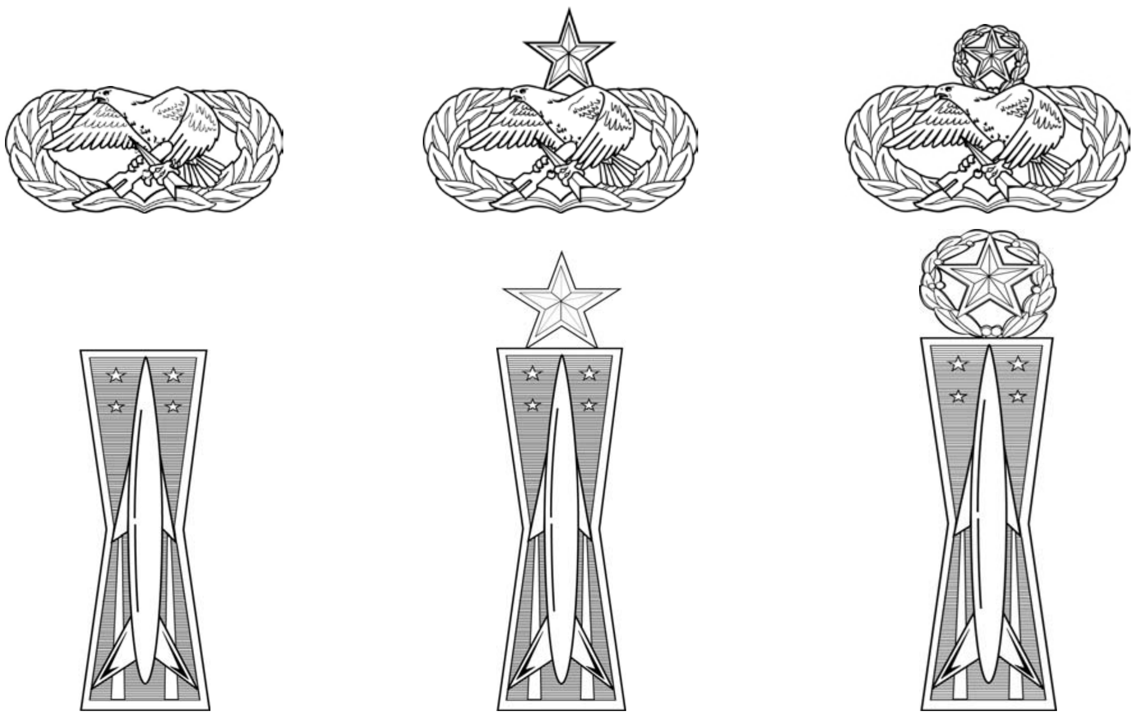
CDC 2M051A

Missile and Space Systems Electronic Maintenance Journeyman

Volume 3. Intercontinental Ballistic Missile Maintenance Familiarization



Air Force Career Development Academy

Air University

Air Education and Training Command

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

Unit 1 provides information on materiel management and supply discipline. The unit will cover the Air Force supply system basics and how materiel and supply assets are managed. You will also learn about illustrated parts breakdowns, determining supply priorities, and standard reporting designators. Finally, we will cover common supply forms.

Unit 2 begins with a brief overview of the power systems at the missile alert facility (MAF) and launch facility (LF). The unit will cover the three types of power systems that enable the weapon system to remain functional during normal and emergency operations as well as the equipment and components that generate, distribute, monitor, and refine the power. Then the unit will detail how the components in the launch control center (LCC) and LF are connected. Finally comes an in-depth look at how the command and control (C2) system is used to sustain day-to-day operations and how it is used to fulfill its primary function—launch missiles.

Unit 3 will cover the guidance and control (G&C) liquid cooling system, to include the two types of checkouts and troubleshooting. The unit will then cover powering up the operational ground support equipment and aerospace ground equipment as you prepare for a tape load startup. The coding lesson will discuss the different types of code components you will use and the process you follow to place the missile on strategic alert. The last lesson will give an overview on the LF security system.

Finally, unit 4 will discuss the different communications systems. You will read about the various equipment components used to send and receive messages, status, and enable phone calls. This unit will also give you a general understanding of how the communications systems in the missile field are linked with other agencies.

Code numbers on figures are for preparing agency identification only.

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

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

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For Guard and Reserve personnel, this volume is valued at 20 hours and 5 points.

NOTE:

In this volume, the subject matter is divided into self-contained units. A unit menu begins each unit, identifying the lesson headings, numbers, and page location. 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.

Unit 1. Materiel Management and Supply Discipline

As you progress in this course and your on-the-job training, many people will depend on you for the skills and knowledge that come with your new level of responsibility. You will be responsible for applying this knowledge to your work environment on a daily basis; therefore, you must remember that your success depends on how well you grasp the information presented here. It is vital to the success of your organization and the Air Force (AF) mission.

In this unit, you will study programs that manage replacement parts. You will learn which documentation is needed to get replacement parts required to keep the equipment you are responsible for in good repair and ready to use.

Whether you have been dispatching to the missile field as a technician or team chief, or working on base, you have no doubt seen that our mission requires many types of supplies to continue moving forward. The AF is constantly acquiring new items and systems, but there is a need to sustain systems that went online decades ago. In this section, you will gain knowledge of AF materiel management, how to order parts through the supply system, and how to complete common forms required for these processes. Note that throughout the following lessons, the terms *shop stock* and *bench stock* is used interchangeably.

301. Supply system description

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 AF organization, there 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.

Standard Base Supply System

The AF supply system, or the Standard Base Supply System (SBSS), is an extensive operation. The SBSS is the standard base level (retail) inventory accounting and ordering management system for the AF. 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 seem complex at first, 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, AF Instruction (AFI) 23–101, *Air Force Materiel Management*, AF Manual (AFMAN) 23–122, *Materiel Management Procedures*, and AF 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 accomplish 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 (NSN) (fig. 1–1) is a numeric code applied to each item currently used, bought, stocked, or distributed by the Department of Defense (DOD). When a 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:

1. Federal supply classification (FSC).
2. National item identification number (NIIN).

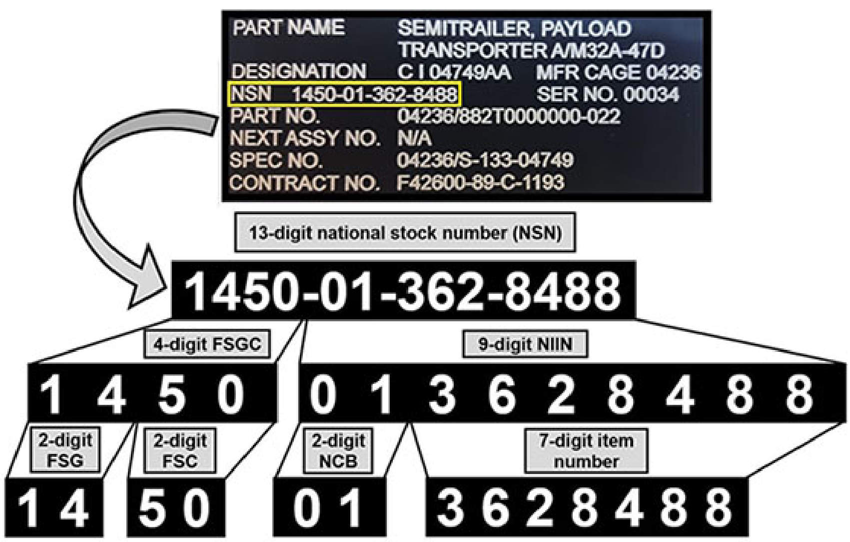


Figure 1–1. National stock number.

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 supply item. Presently, the structure of the FSC consists of 78 groups, which are 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 (e.g., 10 – weapons, 11– nuclear ordinance, 18 – space vehicles).

National item identification number

The NIIN consists of nine digits. The first two digits are the National Codification Bureau (NCB) code, which identifies the country assigning the identification number (e.g., United States (US) (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 AF, the NSN is designed for use by other federal agencies such as the Army and Navy.

Classes of supply

There are millions of items in the supply system identified under a supply classification system. This system allows all branches of the armed forces, as well as any United States government agency of a North Atlantic Treaty Organization (NATO) country, to order the same item of equipment under a common NSN. The materiel comes from a variety of sources to satisfy customer needs. The chart below provides 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 C – Combat rations S – Nonrefrigerated subsistence (less combat rations)
II	Clothing, individual equipment, tentage, organizational tool sets and tool kits, hand tools, and administrative housekeeping supplies and equipment.	B – Ground support materiel E – General supplies F – Clothing and textiles M – Weapons – Industrial supplies
III	Petroleum, oil, and lubricants (POL). Petroleum fuels, lubricants, hydraulic and insulating oils, preservatives, liquid and compressed gasses, 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 material to include installed equipment, and all fortification/barrier material.	
V	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 used 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. Usually, these numbers can be converted to NSNs by using the master cross-reference lists (MCRL) or the federal logistics data (FEDLOG) 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 that categorize AF 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 that requires the unit to do a one-for-one swap of a bad item for a good item so the bad item can be repaired. The ERRC designator is 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 (e.g., 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, 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 van. Place these good items back in stock so they can be used. 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 listed and described in the following table.

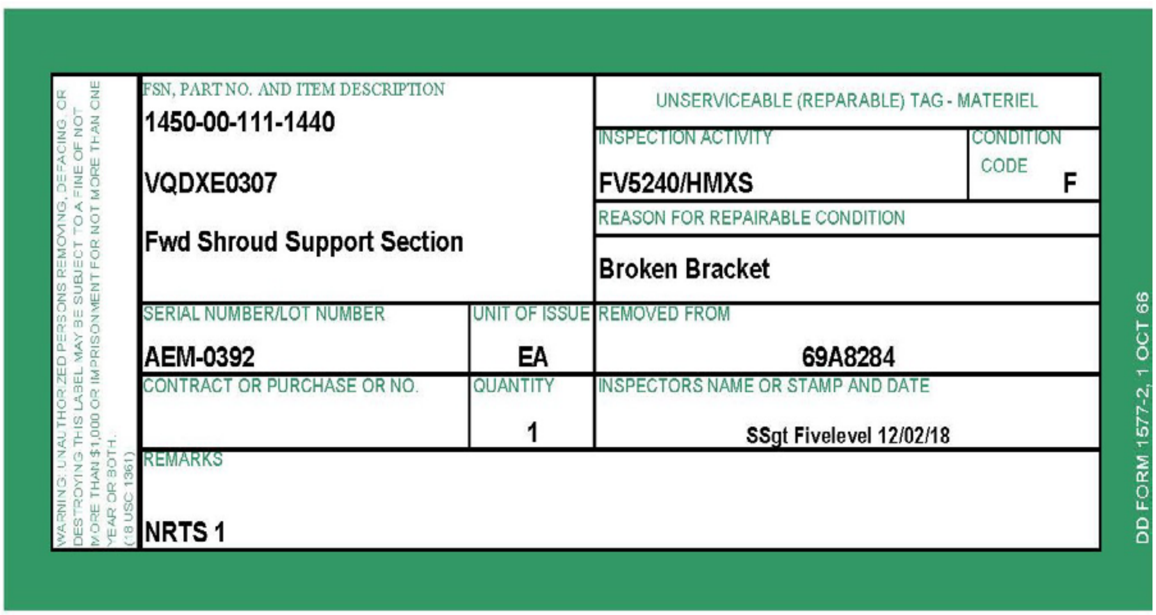
EERC Codes	
Position	**Description**
1st	Identifies the expendability of the item (X = expendable, N = nonexpendable).
2nd	Identifies the highest authorized repair level (B = base or user, F = field, D = depot).

EERC Codes	
Position	**Description**
3rd	Identifies the cost category in which an item belongs. Items are identified as investment or expense. 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, major command (MAJCOM), or AF. 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.”

Refer to figures 1–2, 1–3, and 1–4 for the following examples of the most common types of ERRC codes.

XD2

Unserviceable/Repairable items may be sent to a backshop or to the depot for possible repair. Notice that this code does have an expendable identifier (X) in the first position; however, 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. You will fill out a *green tag* and attach it to the unserviceable XD2 asset when an item is coded as not repairable 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 to ship the asset back to the applicable depot for repair. Use green tag Department of Defense (DD) Form 1577–2, Unserviceable (Reparable) Tag - Materiel.



WARNING: UNAUTHORIZED PERSONS REMOVING, DEFACING, OR DESTROYING THIS LABEL 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)

FSN, PART NO. AND ITEM DESCRIPTION
1450-00-111-1440
VQDXE0307
Fwd Shroud Support Section

UNSERVICEABLE (REPARABLE) TAG - MATERIEL

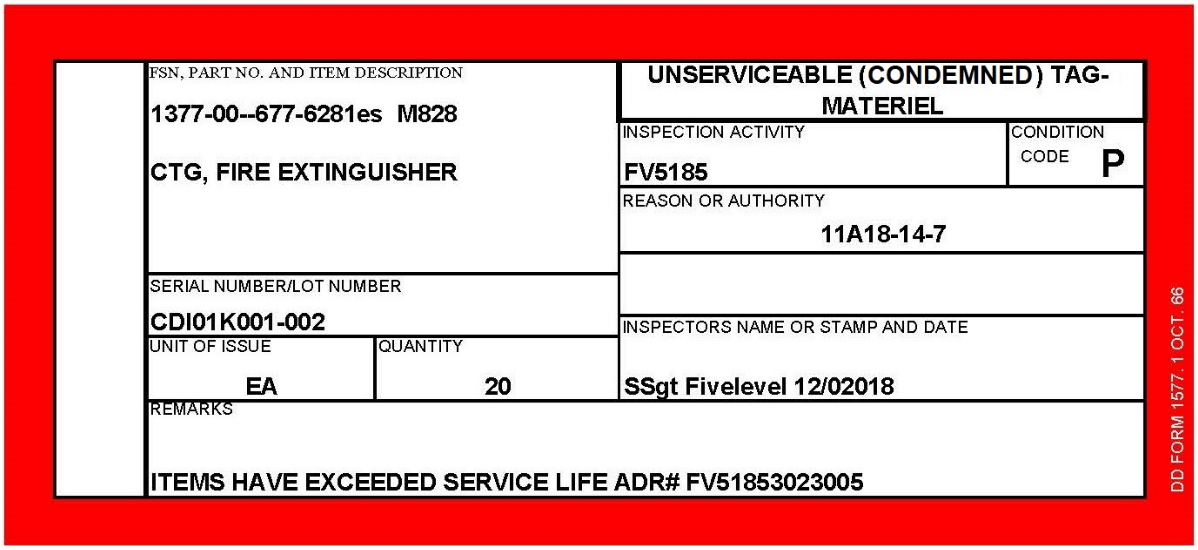
INSPECTION ACTIVITY: FV5240/HMXS
CONDITION CODE: F
REASON FOR REPAIRABLE CONDITION: Broken Bracket
SERIAL NUMBER/LOT NUMBER: AEM-0392
UNIT OF ISSUE: EA
REMOVED FROM: 69A8284
CONTRACT OR PURCHASE OR NO.:
QUANTITY: 1
INSPECTORS NAME OR STAMP AND DATE: SSgt Fivelevel 12/02/18
REMARKS: NRTS 1

DD FORM 1577-2, 1 OCT 66

Figure 1–2. DD Form 1577-2.

XF3

Unserviceable/Condemned items may be sent to the AF enhancement repair program (AFREP) for possible repair, but the majority of these items are sent to the Defense Reutilization and Marketing Service (DRMS) for scrap. Fill out the red tag and attach it to the unserviceable XF3 asset when it is not backshop repairable. These assets are not repairable by the AFREP or other back shops 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) to be properly disposed. XF3 assets are coded DIFM because of the cost and sensitivity of the asset. Use the red DD Form 1577, Unserviceable (Condemned) Tag – Materiel.

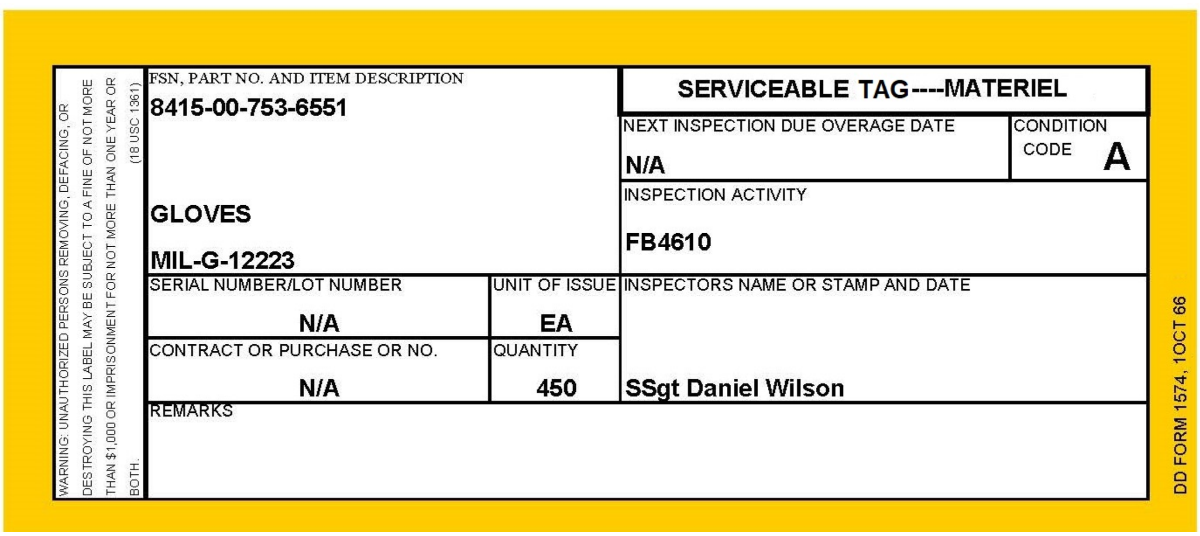


FSN, PART NO. AND ITEM DESCRIPTION
1377-00--677-6281es M828
CTG, FIRE EXTINGUISHER
UNSERVICEABLE (CONDEMNED) TAG-MATERIEL
INSPECTION ACTIVITY
FV5185
CONDITION CODE
P
REASON OR AUTHORITY
11A18-14-7
SERIAL NUMBER/LOT NUMBER
CDI01K001-002
UNIT OF ISSUE
EA
QUANTITY
20
INSPECTORS NAME OR STAMP AND DATE
SSgt Fivelevel 12/02018
REMARKS
ITEMS HAVE EXCEEDED SERVICE LIFE ADR# FV51853023005
DD FORM 1577. 1 OCT. 66

Figure 1–3. DD Form 1577.

XB3

Expendable at base level (unserviceable assets are sent to DRMS). Every new asset comes with a yellow serviceable tag. The tag identifies or turns in (TIN) any serviceable assets. Once turned in, the asset will go back into stock or go to lateral support (other AF organizations). A unit will recoup the money for serviceable TIN's. Make sure to annotate if an item has been used or repaired in the remarks section. Use the yellow DD Form 1574, Serviceable Tag – Materiel, for these type assets.



WARNING: UNAUTHORIZED PERSONS REMOVING, DEFACING, OR DESTROYING THIS LABEL 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)
FSN, PART NO. AND ITEM DESCRIPTION
8415-00-753-6551
GLOVES
MIL-G-12223
SERVICEABLE TAG----MATERIEL
NEXT INSPECTION DUE OVERAGE DATE
N/A
CONDITION CODE
A
INSPECTION ACTIVITY
FB4610
SERIAL NUMBER/LOT NUMBER
N/A
UNIT OF ISSUE
EA
INSPECTORS NAME OR STAMP AND DATE
CONTRACT OR PURCHASE OR NO.
N/A
QUANTITY
450
SSgt Daniel Wilson
REMARKS
DD FORM 1574, 1OCT 66

Figure 1–4. DD Form 1574.

302. Materiel and stock management

As a supervisor, you play a critical role in materiel management and supply discipline because you oversee others who may be ordering parts and equipment through the supply system. You may also be in a position where you directly or indirectly oversee a shop that maintains its own stock of items. In this lesson, we will cover the basic steps of ensuring the correct items and quantities are ordered. We will also cover the basic guidelines for maintaining a stock of parts and equipment.

Ordering parts and equipment

What causes the need to order a part through the supply system? It is inevitable that you will need to order parts or equipment as a team chief working in the missile field or in a shop on the missile support base (MSB). As a 2M0X1, your need to order parts will typically start with one of two types of maintenance—periodic and troubleshooting.

Periodic maintenance

Ordering parts during a periodic maintenance inspection (PMI) is a common occurrence on the air-launched cruise missile due to the age requirements on the various missile components. Once a part with age requirements is installed, it starts its lifespan and depending on its requirements, it will need to be changed regardless of any abnormal indications. Since this lesson is focused on the procurement of items that are not already in stock, we will assume that a defective piece of equipment must be ordered through the supply system.

Troubleshooting

This is the most common way that parts are ordered for the weapon system. While troubleshooting, your technical order directs you to remove and replace a faulty part, however, you do not have a spare.

Depending on the circumstance, the defective part will be removed when it is first discovered, or removed just prior to installing the replacement part once it has arrived through the supply system.

Parts and equipment research

Now that a need to order a part has been established through a PMI or by troubleshooting, the next step is to ensure that the proper replacement part is ordered. Research the needed part in the applicable illustrated parts breakdown (IPB). Always follow the IPB to the lowest component level that you can to procure the part you need. If the part you need only comes as a part of another larger component, then you will need to order the larger component.

Ordering parts and equipment

You have established the need for a part and have gathered all the necessary information from the IPB. The next step is to place a demand on the supply system by entering a work order into the Integrated Maintenance Data System (IMDS)—if you discovered the faulty part while completing a PMI, or by modifying an existing job control number (JCN) if the faulty part was discovered while you were troubleshooting.

Work centers may order parts and modify work orders differently. In some cases, the team chief is tasked with ordering his or her own parts; in other cases, there may be a sole individual in the work center whose job is to modify work orders or the data in IMDS, and/or order parts. Regardless of the method used to place the demand on the supply system, the order for the replacement part or equipment is not complete until materiel control has acknowledged it. When ordering items through IMDS, be sure to correct any errors as soon as possible, and always get positive verification that the item was actually placed on order.

Removal and replacement of the faulty part or equipment

Once the new part is on base and available, IMDS will reflect it and the work order will be scheduled. The next step in the process is to replace the defective part with the new one. As mentioned before, the defective part may have been removed when it was discovered, or it may still be installed. Without installing the replacement part, there is no way to know if the proper part was ordered, or if the proper part was ordered but received a substitute.

Perform a functional checkout

While this step is more functional in nature, it is still important to the procurement process. A defective part may have been received, which must be documented, and a deficiency report may need to be accomplished.

Another reason for the functional checkout is to verify that the replacement part actually fixed the issue. You may have replaced the part only to find that another component in the system was also defective. If this happens, another replacement part will need to be ordered using the same process that we just covered.

No job is complete until the defective system is repaired and a full functional checkout is passed. In fact, until this occurs, the work order will remain in IMDS. This may begin with a simple work order to complete a PMI or to troubleshoot a known fault, but the basic steps are still the same. Another team chief or technician may have ordered the part that you have been tasked with installing. At times, you will find at some sites multiple faults have been investigated by multiple teams.

Building and maintaining a bench stock

A bench stock consists of supplies and parts that are 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. This reduces the base supply workload by consolidating small frequent issues 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 these items being 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 bench stock should not exceed a 30-day supply unless you receive authorization from base supply.

Users of the bench stock sign-out items from the bench stock monitor as they need them. Because of the usage, bench stock items must be replenished periodically. The bench stock monitor physically inventories 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, it 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.

303. Using the illustrated parts breakdown

Your 5-level CDC provided a very basic, step-by-step lesson that showed you how to order a part. This lesson will give you a better understanding of an IPB with the intent of giving you a greater understanding of this powerful research tool.

An IPB shows exploded views of weapon system and support equipment components that will help in narrowing your search down to the exact part that you need to order. For this lesson, we will again be referencing technical orders (TO) 21M-LGM30F-4-1, *Minuteman Weapon System Introduction and Pictorial, Numerical, and Reference Designation Indices for 21M-LGM30F-4 Series IPBs*, and 21M-LGM30F-4-2, *IPB Minuteman Weapon System Operational Ground Equipment (Unique)*. Instead of listing the entire numerical designator every time a technical order is mentioned, we will simply refer to the IPBs as the 4–1 or 4–2 IPBs. You will find the format of the IPB series technical order is divided into four sections, which are listed and described in the following table.

Four Sections of an IPB Technical Order	
Section	**Description**
Introduction	Explains the system used in the technical order for numbering components and sub-systems, identifies drawings, and outlines general information and instructions regarding use of the publication itself.

Four Sections of an IPB Technical Order	
Section	**Description**
Numerical index	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.
Reference designation Index	These references are listed on a schematic and identify the cabinet, shelf, drawer, diode, resistor, and so forth 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 technical order 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	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.

T.O. 21M-LGM30F-4-2

FIGURE & INDEX/ SHEET NO.	PART NUMBER	CAGE	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USABLE ON CODE	SMR CODE
2-1 96/6	25-66509-6	81205	. . CABLE ASSEMBLY, EMP ANTENNA, COAXIAL (USED ON 25-66508-5 AND -7) LF PERSONNEL ACCESS SYSTEM EQUIPMENT W4508	1		XA
97/4	25-61853-	81205	. DOOR, LAUNCHER PERSONNEL ACCESS, PRIMARY (SEE Figure 2-53 FOR BRKDN) [1]	1		
98/4	3037-1050-	81205	. DOOR, LAUNCHER PERSONNEL ACCESS, SECONDARY (SEE T.O. 21M-LGM30F-4-7 FOR BRKDN) [1]	1		
99			. (DELETED)			
100/4	BA23461	088K1	. **HCI** ACTUATOR ASSEMBLY, EMA (AFTER TCTO 21M-LGM3G-1040) (SEE T.O. 21M-LGM30F-4-7 FOR BRKDN)	1		PAODD
101/4	BA22800	088K1	. **HCI** ACTUATOR ASSEMBLY, EMA (SEE T.O. 21M-LGM30F-4-7 FOR BRKDN)	1		PAODD
102			. (DELETED)			

Figure 1–5. Figure sheet and index in the 4–2.

The following table lists the breakdown and description of an MPL (fig. 1–5). Refer to figure 1–5 as you read the following table.

Maintenance Parts List Categories	
Category	**Description**
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	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. Usually, manufacturer's part numbers are assigned in numerical order. Standard part numbers normally have an alphabetical prefix. These parts are used throughout the AF for various kinds of equipment.

Maintenance Parts List Categories	
Category	**Description**
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	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	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	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 code	This last column contains joint military services uniform SMR codes only. These codes provide 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, *AF Technical Order System Source, Maintenance, and Recoverability Coding of Air Force Weapons, Systems, and Equipment.*

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.

The IPB’s purpose is to assist you in identifying and providing you the part number needed to order a part. Remember, the IPB is not intended to be used for assembly or disassembly of any part of the weapon system.

Your search to find a replacement upper telescoping ladder section will take two different paths– one path if you know the part number, and the other path if you do not.

If the part number is known

Knowing the part number is the fastest way to find the part you need to order. First, to turn to Chapter 2, *Numerical Index*, in the 4–1 IPB. (**NOTE:** This method will only work if the part you are researching is in the 4–2, 4–4, 4–5, or 4–7 IPBs.)

Table 2–1, Numerical Index, makes up the entirety of Chapter 2. The index is in alphabetical/numerical order, and the part number for the telescoping upper ladder section at the time that this career development course (CDC) was written is *25-93936-3*. The index would show the technical order as 4–2, figure as 2–149 and the Index/Sheet Number is 1/1 for the upper ladder section.

The part numbers are listed in alphabetical order, so all you need to do is flip through the pages until you find the one you are looking for. After you locate the part number in the 4–1’s numerical index, the next step is to proceed to the IPB listed in the T.O. column. Once there, reference figure 2–149, then turn to sheet 1, and locate index number 1.

The following paragraphs will detail the steps of using the figure, sheet number, and index number. You can write these numbers down, or keep the 4–1 IPB open for reference.

The figure number of the part you are looking for is located in the FIGURE column of the Numerical Index in the 4–1 IPB. All the figures in the 4–2 IPB are preceded by the number 2, which is assumed since the figures are in chapter 2, so the 4–1 IPB does not include this number. In other words, the reference figure 161 will equate to figure 2–149 in the 4–2 IPB. Then, turn to figure 2–149 in the 4–2 IPB.

Understanding the sheet & index numbers

The sheet and index numbers for the part you are looking for are located in the INDEX & SHEET NO column of the Numerical Index in 4–1 IPB. Once at the figure, locate the correct sheet number. The reason for this is that some figures are broken down into multiple sheets. You will know this because it is mentioned by the name of the figure (sheet 1 of 3). If you are using the correct figure, but are on the wrong sheet, you may not be able to find the index number that you are looking for.

Once you have located the correct sheet within the figure, the next step is to locate the index number that points to the visual representation of the part you are looking for. Some figures are complex, so this may take a bit of searching.

Once you have located the index number within a figure in the 4–2, you are almost done. The final step is to locate your index number in the data table found immediately after the figure(s). This is where the information resides for ordering the part through the supply system (fig. 1–6).

T.O. 21M-LGM30F-4-2

FIGURE & INDEX/ SHEET NO.	PART NUMBER	CAGE	DESCRIPTION 1 2 3 4 5 6 7	UNITS PER ASSY	USABLE ON CODE	SMR CODE
2-149	25-93767-7	81205	LADDER, TELESCOPING (SEE Figure 2-1 FOR LOCATION)	REF		XB
1/1	25-93936-3	81205	. LADDER ASSEMBLY, AM SYSTEM	1		
2/1,2	25-93930-3	81205	. . UPPER LADDER SECTION, AM SYSTEM . . .	1		PAOZZ

Figure 1–6. Figure sheet and index in the 4–2.

The data tables are always located *after* the figure to which they correspond, and 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 SMR code. It is wise to record all this information since you will need it to order the part using IMDS or an AF Form 2005, Issue/Turn-In Request. Let's look at some other headings in the data table.

CAGE Code column

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.

Units Per Assembly column

The quantity specified is the required quantity for each detail part in an assembly and the quantity required for each assembly in the next higher assembly. The quantity listed for each attaching part is the quantity required to attach one unit or one assembly.

Abbreviation	Definition	Description
AR	As Required	Reflects oversized or undersized parts and parts that have indefinite quantities
PR	Pair	Reflects a part that is ordered as a pair.
REF	For reference purposes	Such items show a quantity where the item is first listed, assembled, or in detail, and then shown REF in other listings.

Useable On Code column

This column contains the code or codes that differentiate between similar assemblies and their components where one figure number has been assigned. A letter, or letters, in the Usable On Code column indicates the item is part of the assembly or assemblies to which it is indented and lists a corresponding letter. When a listing in this column is not shown, it indicates the parts are usable as replacements on all assemblies covered by the figure.

SMR Code column

The SMR code states whose responsibility it is to repair the part, if the part is procured or manufactured, and how to dispose of the part once it is no longer useful. As of the time that this CDC was written, a detailed breakdown of SMR codes can be located in the 309th Maintenance Wing Instruction (309MXWI) 23-106, *Non-Stock Listed Requests*.

If the part number is unknown

If you do not know the part number, there are additional steps involved. We will the use 4–2 IPB as our example. Use the title of the 4- series to help locate what book to use.

The first step is to reference Chapter 2, *Maintenance Parts List* in the 4–2 IPB’s table of contents to find the area of the launch facility (LF) or missile alert facility (MAF) where the part you are looking for is located. The LF telescoping ladder section is listed explicitly in the table of contents (fig. 1–7), and a page number is given.

T.O. 21M-LGM30F-4-2

TABLE OF CONTENTS – Continued

Chapter Page

Figure 1–7. Table of contents in the 4–2 IPB.

To take this a step further, say you are looking for a relay located in the motor generator. The table of contents is not going to list a relay, but it will show a higher assembly (motor generator). From there go to the figure listed for the motor generator and start drilling down until you find your replacement relay. The IPBs are very versatile; as long as you know what you are looking for, you can take multiple paths to arrive at the same destination.

After you know which IPBs contain what types of parts, you will more than likely find yourself going straight to that reference instead of beginning your search in the 4–1 IPB.

304. Determining supply system priorities

Fast-forward your career; you are part of the maintenance group (MXG) leadership team. Over the years, your focus has shifted from fixing the weapon system to the oversight of the weapon system and those who repair it. You have a LF that is down for a relay panel in the distribution box (D-box) or a cruise missile that has been on the stand for two weeks because it has a bad air cycle machine. You would like to get the write up cleared, but you cannot because the part you need has not arrived through materiel control. The reason that the part is still not in your hands, is the wrong priority was placed on it. This lesson will focus on the proper determination of supply system priorities, which will aid you in preventing this scenario from happening in the future.

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*, each of them depend on the other. Always ensure that you and the technicians you oversee place the correct priority on orders. Abuse of the system hurts everyone who uses it. Note this priority system is not the same as the priority system used to determine how quickly a team must respond to a fault in the missile field or getting a cruise missile in for maintenance. However, you will take maintenance and scheduling priorities into account when determining how quickly the part needs to arrive.

Priorities for parts and equipment located on base

Let's say that the relay panel 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 determining how soon you need the part or equipment and then selecting the corresponding two-digit priority code. A list of the numbers and their meanings is included in the following table.

Priority	Usage
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

Let's say 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. 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 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 UND is covered in the following table.

UND	Usage
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 expressed in roman numerals I, II, III, IV, or V. The second step to determining the UMMIPS designator is selecting the FAD under which your request falls. The FAD indicates the level of combat readiness each activity must maintain, and expresses the relative importance of the unit placing the order. An explanation of each FAD is in the following table.

FAD	Usage
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 United States 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 assigned to other military service programs and projects that 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 United States forces being maintained in a state of combat readiness.
V	Is assigned to all other United States 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*; and the request originated from a combat force maintained in a constant state of readiness that 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.

	FAD				
UND	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				

305. Determining the standard reporting designator

A standard reporting designator (SRD) is a three-character code 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 identifies 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 also communicate how well the supply chain is supporting various weapon systems.

Think of an SRD as a tool that allows several individuals that speak different languages to communicate with each other. Typically, SRDs are assigned during the acquisition of the item, which happens long before you will encounter it. However, in certain circumstances, an SRD may need to be added, changed, or removed. The master location for all SRD data is the Reliability and Maintainability Information System (REMIS), and this data is transmitted periodically to other maintenance information systems (MIS).

306. Preparing supply forms

In this unit, we will cover some additional details involved when using and completing three common types of supply and materiel management documents: AF Form 2005, Issue/Turn-In Request; DD Form 1348–1A, Issue Release/Receipt Document; and DD Form 1348–6, DOD, Single Line Item Requisition System Document (Manual-Long Form).

Preparing the AF Form 2005

Once you need to order a part through the supply system, and have found the information for that part in the IPB, then initiate the request. Normally, the part is ordered through IMDS, which then alerts your local materiel control. In the event you need to use a digital or paper copy of the AF Form 2005, there are certain parts of the form that need to be filled out in order for it to process properly. Use the digital version of the form whenever possible (fig. 1–8*)*. Detailed instructions are available in AFH 23-123, Volume 2, Part 1, *ILS-S, Materiel Management Operations*.

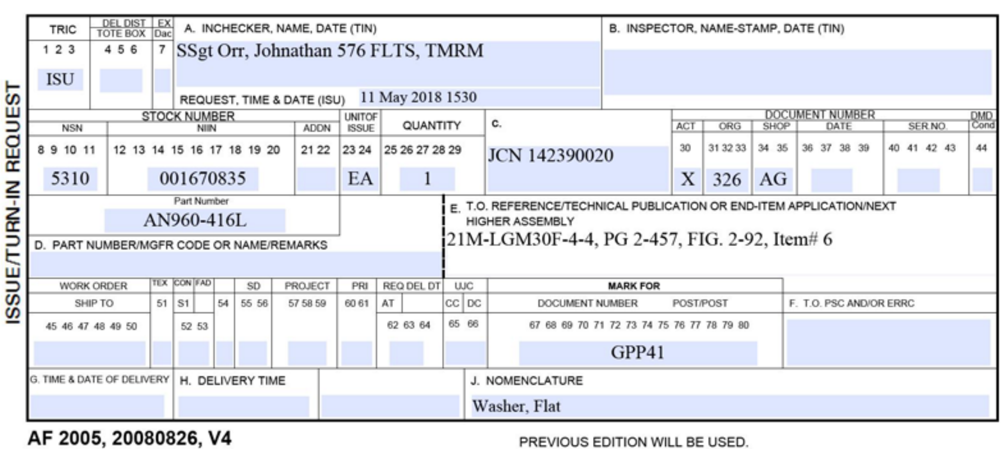


Figure 1–8. AF Form 2005.

The requestor (you) will complete portions of the form, and materiel control personnel will complete other parts. The following description lists only the fields that need to be completed by the requestor. Note that 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.

TRIC block (1-3)

In this block, enter “ISU,” which indicates the parts or equipment need to be issued.

Block A: Inchecker, name, date

In this block, put your full name and rank, your shop’s phone number, the date, and the time. It is important to put all the necessary information in this block so that materiel control can contact you or someone from your shop if they have any questions about the part you are ordering.

Stock number block (8-22)

This block is where the NSN is populated. A manufacturer part number can be cross-referenced with its NSN through FEDLOG or Web Federal Logistics Information System (WebFLIS), which are both web-based programs. If the manufacturer part number cannot be cross-referenced with a NSN, then a separate DD Form 1348-6 will need to be submitted along with the AF Form 2005. Instructions for preparing the DD Form 1348-6 are covered in your 7-level CDC.

Unit of issue block (23-24)

This block contains the unit of issue (e.g., “EA” = each, “SE” = set, “HD” = hundred.) You will find this information in FEDLOG or WebFLIS.

Quantity block

This block is where you enter the quantity of the item you are ordering needed to complete the job. It is important to pay attention when filling out this block, or you could end up with too many or too few of the item you need When too many items are ordered the unused go into “work residue” at materiel control, and can be used for another job. However, ordering too few means the job cannot be completed until additional parts are ordered.

Consider the following scenario: Five of the 25 bolts that secure a panel door at the LF need to replacing. FEDLOG says that each kit contains all 25 bolts; meaning one unit of issue contains an entire set of panel bolts, *not* just one bolt. You overlook this and order five units. You would receive five orders of 25 bolts, which is far more than what you need to complete the job.

Block C

Although this block is not labeled, this is where the work unit code (WUC) is populated. If the specific piece of equipment does not have its own WUC, then use the WUC of the next highest assembly.

Block D: Part number/manufacturer code or name/remarks

In Block D, use the information you found in the IPB. This might be a part number, NSN, or manufacturer code. It is important to provide as much information as possible here so that materiel control can reference the data and order the correct part.

Block E: T.O. reference

In Block E enter the technical order or civil engineering manual (CEM) reference for the part you are trying to order. Add as much detail as you possibly can so that materiel control can reference it if there is any confusion. The following table, using data from the IPB lesson, provides a deeper explanation.

Information	Example
TO or CEM number	TO 21M-LGM30F-2-4.
Page number	Page 2-830.
Figure number	Figure 2-161 (Sheet 2)
Index number	Item number 23 (bottom-left of figure)
Data page– List the page after the figure that contains all of the data.	Example: Page 2-833.

Block F: T.O., PSC, and/or ERRC

This block's heading is misleading; however, this is where the JCN is populated. If you discover the need to order parts while completing another scheduled job, use that JCN. If a new work order was created in IMDS, be sure to use that JCN.

Block J: Nomenclature

In Block J, list the name of the part. It is best to list it exactly as the IBP lists it. It is a good idea to spell out any acronyms. Remember, the individual who is processing your AF Form 2005 is not likely a 2M0.

Example: SENSOR, DIFFERENTIAL PRESSURE (PSR-4) (90598 SPEC EAS81230-6).

Include as much information as possible. You can scan the applicable technical manual or CEM pages and staple them to the back of the AF Form 2005. It is likely that your shop already has templates for parts that are commonly ordered, so be sure to check with the shop supervisor on duty.

Remember, on a day-to-day basis, parts will be ordered through IMDS; however, it is essential as a team chief or supervisor that you are aware of how to prepare AF Form 2005 form correctly. This will ensure you and the technicians you oversee submit the form properly, and the correct parts arrive in a timely manner.

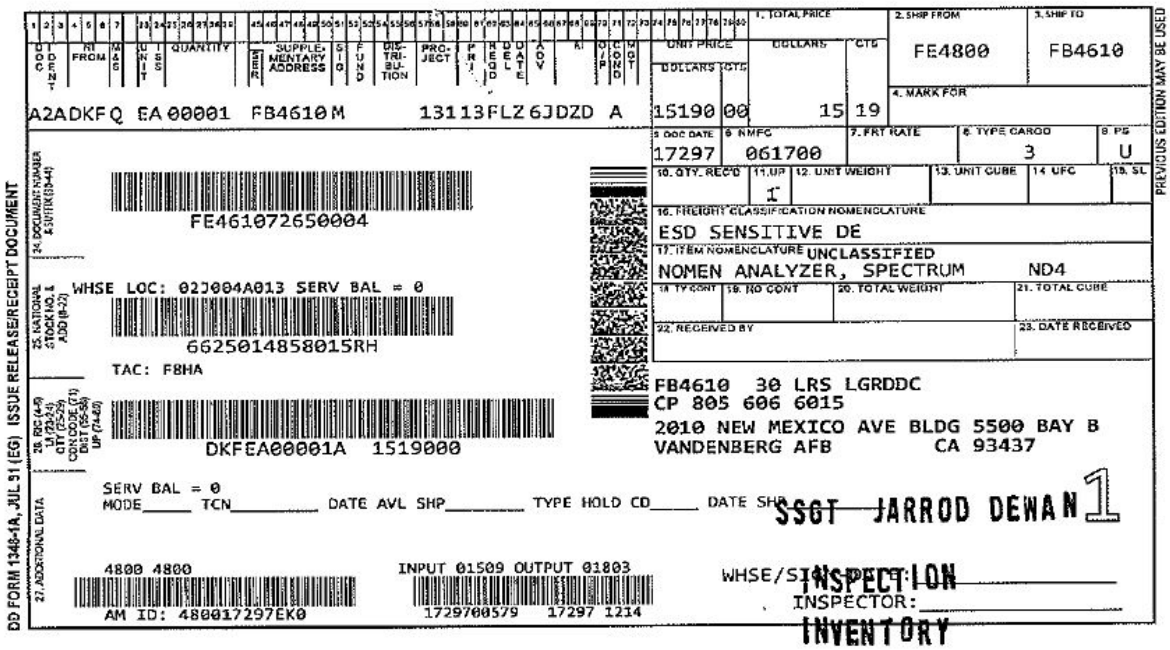
Preparing the DD Form 1348-1A

Use DD Form 1348-1A when an item changes hands. The DD Form 1348-1A has two purposes.

1. Document the issue release of an item from supply to a customer.
2. Turn items into DLADS.

If you have ever signed for a part or piece of equipment at materiel control, you signed this document. In addition, if you have ever turned equipment into DLA disposition services, you used the form to relinquish the items to them. The DD Form 1348-1A (fig. 1–9) is considered a receipt, and there are three copies:

1. 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.
2. Copy 2 is kept by the receiving organization to be stored for their record.
3. Copy 3 is returned to the flight service center upon turn-in of an unserviceable asset for processing.



A2ADKFQ EA 00001 FB4610 M 13113FLZ6JDZD A
15190 00 15 19

1. TOTAL PRICE
2. SHIP FROM FE4800
3. SHIP TO FB4610
4. MARK FOR
5. DOC DATE 17297
6. NMFC 061700
7. FRT RATE
8. TYPE CARGO 3
9. PS U
10. QTY. REC'D
11. UP 1
12. UNIT WEIGHT
13. UNIT CUBE
14. UFC
15. SL
16. FREIGHT CLASSIFICATION NOMENCLATURE
ESD SENSITIVE DE
17. ITEM NOMENCLATURE UNCLASSIFIED
NOMEN ANALYZER, SPECTRUM ND4
18. TY CONT
19. NO CONT
20. TOTAL WEIGHT
21. TOTAL CUBE
22. RECEIVED BY
23. DATE RECEIVED

24. DOCUMENT NUMBER & SUFFIX (30-44)
FE461072650004
WHSE LOC: 02J004A013 SERV BAL = 0
25. NATIONAL STOCK NO. & ADD (8-22)
6625014858015RH
TAC: F8HA
26. RIC (4-6) UI (23-24) QTY (25-29) CON CODE (71) DIST (55-56) UP (74-80)
DKFEA00001A 1519000

FB4610 30 LRS LGRDDC
CP 805 606 6015
2010 NEW MEXICO AVE BLDG 5500 BAY B
VANDENBERG AFB CA 93437

27. ADDITIONAL DATA
SERV BAL = 0
MODE_____ TCN________ DATE AVL SHP_______ TYPE HOLD CD____ DATE SHP SSGT JARROD DEWAN 1
4800 4800
AM ID: 480017297EK0
INPUT 01509 OUTPUT 01803
1729700579 17297 1214
WHSE/SIGNATURE: INSPECTION
INSPECTOR:
INVENTORY

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT
PREVIOUS EDITION MAY BE USED

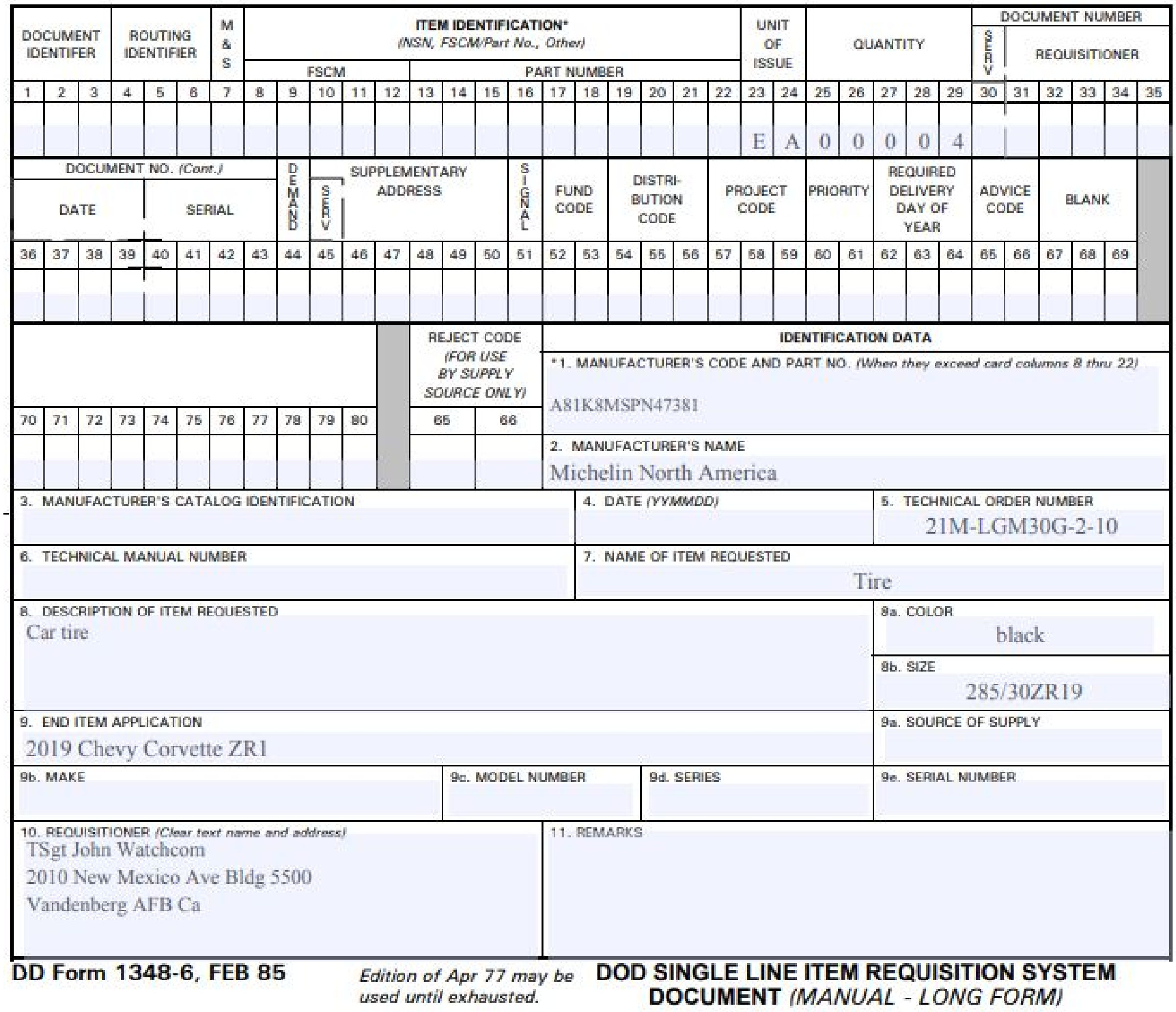
Figure 1–9. DD Form 1348-1A.

See the following table for the descriptions for each block on the 1348-1A.

DD Form 1348-1A	
Block	**Action or Description**
1-3	Document identifier, (e.g., ISU- issue request.)
8	Type Cargo (e.g., Z-General, 3-ESD, etc.)
9	Control Inventory Items Code (CIIC) (e.g., 7-sensitive, 9-crypto.)
23-24	Unit of issue
25-29	Quantity
60-61	Priority
71	Condition
74-80	Unit price
Box 1	Total price
Box 2	Ship from Stock Record Account Number (SRAN)
Box 3	Ship to SRAN
Box 5	Document date
Box 16	Freight Classification and Special Packaging Instructions
Box 17	Item Nomenclature
Box 24	Document Number
Box 25	National stock number

Preparing the DD Form 1348-6

A DD Form 1348-6 is used for local purchases when you do not have a NSN, and is submitted along with an AF Form 2005. A DD Form 1348-6 allows the customer 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. DD Form 1348-6 (fig. 1–10) is depicted with instructions for completing the form.



DOCUMENT IDENTIFER | ROUTING IDENTIFIER | M & S | ITEM IDENTIFICATION* (NSN, FSCM/Part No., Other) FSCM PART NUMBER | UNIT OF ISSUE | QUANTITY | DOCUMENT NUMBER SERV REQUISITIONER

1 2 3 4 5 6 7 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

E A 0 0 0 0 4

DOCUMENT NO. (Cont.) DATE SERIAL | DEMAND | SERV SUPPLEMENTARY ADDRESS | SIGNAL | FUND CODE | DISTRI-BUTION CODE | PROJECT CODE | PRIORITY | REQUIRED DELIVERY DAY OF YEAR | ADVICE CODE | BLANK

36 37 38 39 40 41 42 43 44 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 | REJECT CODE (FOR USE BY SUPPLY SOURCE ONLY) 65 66 | IDENTIFICATION DATA

*1. MANUFACTURER'S CODE AND PART NO. (When they exceed card columns 8 thru 22)
A81K8MSPN47381

2. MANUFACTURER'S NAME
Michelin North America

3. MANUFACTURER'S CATALOG IDENTIFICATION

4. DATE (YYMMDD)

5. TECHNICAL ORDER NUMBER
21M-LGM30G-2-10

6. TECHNICAL MANUAL NUMBER

7. NAME OF ITEM REQUESTED
Tire

8. DESCRIPTION OF ITEM REQUESTED
Car tire

8a. COLOR
black

8b. SIZE
285/30ZR19

9. END ITEM APPLICATION
2019 Chevy Corvette ZR1

9a. SOURCE OF SUPPLY

9b. MAKE

9c. MODEL NUMBER

9d. SERIES

9e. SERIAL NUMBER

10. REQUISITIONER (Clear text name and address)
TSgt John Watchcom
2010 New Mexico Ave Bldg 5500
Vandenberg AFB Ca

11. REMARKS

DD Form 1348-6, FEB 85 | Edition of Apr 77 may be used until exhausted. | DOD SINGLE LINE ITEM REQUISITION SYSTEM DOCUMENT (MANUAL - LONG FORM)

Figure 1–10. DD Form 1348–6.

Instructions For Completing DD Form 1348-6		
Field Legend	**Block Number**	**Entry And Instructions**
Manufacturer's Code and Part Number	1	Enter the item CAGE code when available, first, followed by the complete part number when the part number exceeds 10 digits.
Manufacturer's Name	2	Enter the manufacturer's name and address (including zip code, if known) when the CAGE is not available.
Manufacturer's Catalog Identification	3	Enter the manufacturer's catalog identification number when available.

Instructions For Completing DD Form 1348-6		
Field Legend	**Block Number**	**Entry And Instructions**
Date	4	Enter the date of the publication in calendar date format (YYMMDD).
Technical Order Number	5	Enter the applicable order number in which the requested item may be defined.
Technical Manual Number	6	Enter the applicable technical manual number in which the requested item may be defined.
Name of Item Requested	7	Enter the appropriate name of item requested.
Description of Item Requested	8	Enter the description of item requested and, if necessary, attach exhibits or pictures.
Color	8a	Enter the color of item requested, if applicable.
Size	8b	Enter the size of item requested, if applicable.
End Item Applicable	9	Enter the name of the applicable end item for which the requested item applies. Entry should cite NSN and/or nomenclature. If application is unknown, enter unknown.
Supply Source	9a	Enter the supply source of the applicable end item, if known.
Make	9b	Enter the manufacturer's make of the applicable end item, if known.
Model Number	9c	Enter the manufacturer's model number of the applicable end item, if known.
Series	9d	Enter the manufacturer's series number of the applicable end item, if known.
Serial Number	9e	Enter the serial number of the end item, if known. **NOTE:** If a unique item identifier (UII) is available, enter in Block 11 (prefixed with "UII").
Requisitioner	10	Enter the requisitioner's name, commercial or DSN number, and address including ZIP code.
Remarks	11	Enter any additional information that will assist the supply source to obtain the correct item.

Self-Test Questions

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

301. Supply system description

1. What is the SBSS?

2. What AF document provides direction for determining and stocking materiel requirements, cataloging, ordering, sourcing, receiving, delivering, and return/disposal of items?

3. What is a NSN?

4. Describe a FSC code.

5. What is a combination of numbers, letters, and symbols assigned by a designer, a manufacturer, or vendor to identify a specific part or item of materiel known as?

6. The ERRC designator is a three-position code that designates what two things?

7. What is an item labeled that has a low and/or no PBR?

302. Materiel and stock management

1. What are two reasons to perform a functional check out on a received item?

2. Decreasing maintenance time by reducing the time workcenter personnel spend waiting for spare parts is the goal of what program?

303. Using the illustrated parts breakdown

1. What is a single list of all part numbers appearing in the IPB arranged in part number sequence known as?

2. The maintenance parts list breaks down the equipment into what?

3. What is the purpose of an IPB?

4. When you already have the part number, what is the first place you will start you search when ordering a part?

304. Determining supply system priorities

1. What is the purpose of the supply priority system?

2. What is the priority code that represents the most damage to the mission?

3. What are the urgency of need designators and their meanings?

4. What FAD code is assigned to United States forces being maintained in a state of combat readiness?

305. Determining the standard reporting designator

1. The SRD is used by the supply system has what two purposes?

2. Where is the master location for all SRD data?

306. Preparing supply forms

1. When filling out the quantity block, what do you verify in WebFLIS/FEDLOG?

2. What does Block F of an AF Form 2005 contain?

3. What two purposes does the DD Form 1348-1A serve?

4. What are the two uses of a DD Form 1348-6?

Answers to Self-Test Questions

301

1. The standard base level (retail) inventory accounting and ordering management system for the AF.
2. AFI 23-101.
3. A numeric code applied to each item currently used, bought, stocked, or distributed by the DOD.
4. A series of four digits at the beginning of the NSN that designates the general commodity grouping of the item of supply.
5. Part number.
6. (1) Whether an item is expendable or not (can be thrown away or must be recycled) and (2) which level in the supply system (depot, intermediate, or base) repairs and/or condemns the item.
7. NRTS-1.

302

1. It ensures that the new part is not faulty and it verifies the part actually repaired the problem.
2. Bench stock.

303

1. Numerical index
2. Its major assemblies, subassemblies, detail parts, and attaching parts.
3. Assist in identifying and providing the part number needed to order a part.
4. Chapter 2, *Numerical Index*, in the 4-1.

304

1. Ensure available parts are delivered at a speed that meets the user and the mission's needs.
2. 02.
3. A–Mission essential; unable to perform the assigned operational mission, B–Mission is impaired, and C–Mission not affected. Use this for routine requirements.
4. FAD IV.

305

1. Collect materiel usage data that ranges across different weapon systems or end-items of equipment and communicate how well the supply chain is supporting various weapon systems.
2. REMIS.

306

1. The amount of items in a unit of issue.
2. The JCN from the job in progress.
3. Document the issue release of an item from supply to the customer and to turn items into DLADS.
4. Local purchases, and when you do not have a NSN, with an AF Form 2005.

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 Air Force Career Development Academy (AFCDA).

1. (301) The National Coding Bureau code of identification numbers identifies
   a. country of origin.
   b. date of manufacture.
   c. manufacturer's identification code.
   d. country assigning the identification number.

2. (302) To ensure a correct replacement part is ordered, research the
   a. illustrated parts breakdown.
   b. system flow diagram.
   c. system parts manual.
   d. technical order.

3. (302) At which percent of items on hand should a bench stock be replenished?
   a. 79.
   b. 69.
   c. 59.
   d. 49.

4. (303) Identify the first section used in an illustrated parts breakdown, if the part number is known when ordering parts.
   a. Introduction.
   b. Numerical index.
   c. Maintenance parts list.
   d. Reference designation index.

5. (304) Which system uses both on- and off-base priority systems to ensure mission needs are met when ordering parts?
   a. Standard Base Supply System.
   b. Defense Logistics Supply System.
   c. Integrated Maintenance Data System.
   d. Reliability and Maintainability Supply System.

6. (304) Identify the code used when ordering parts that expresses the mission importance.
   a. Job control number.
   b. National stock number.
   c. Urgency of need designator.
   d. Federal supply classification.

7. (305) The standard reporting designator is used for
   a. identifying the design activity or government agency.
   b. expressing the relative importance of the unit placing the order.
   c. categorizing Air Force inventory into various management groupings.
   d. collecting materiel usage data that ranges across different weapon systems.

8. (305) The *master* location for all standard reporting designator data is the
   a. Reliability and Maintainability Information System.
   b. Maintenance Information System.
   c. standard reporting master file.
   d. maintenance data master file.

9. (306) An AF Form 2005 is used to
   a. correct an item's part number.
   b. correct a national stock number error.
   c. annotate a serviceable equipment item.
   d. request a part through the supply system.

10. (306) Identify the form used when an item is released from supply.
   a. AF Form 457.
   b. DD Form 1574.
   c. DD Form 1577.
   d. DD Form 1348-1A.

Please read the unit menu for unit 2 and continue ➔

Student Notes

Unit 2. Launch Control Center and Launch Facility Systems

POWER CABLING, AND COMMAND AND CONTROL (C2) are key factors in the intercontinental ballistic missile (ICBM) weapon system. Commercial, standby, and emergency power ensure both the MAF and LF remain operational and on alert at all times. Cabling allows power and message signal interface within and between the LCC and LFs, and the C2 equipment provides the means to execute the mission.

2–1. Power Systems Description

The LFs and MAFs are critical components of the ICBM leg of the strategic nuclear triad. The facilities provide the infrastructure needed to sustain the missile in the underground LF, communicate with it, and launch it. The missile and all the equipment needed to launch the missile must have electrical power from a commercial power source; however, in the event of a nuclear attack, commercial power will likely not be available. This is where the power generation and distribution systems are important. This section will discuss the LF and MAF power systems to ensure you understand its operation, power sources, and major components that make up the systems.

307. Missile alert facility power system

This lesson will walk you through the power system for both Wing 1 and Wings 3 and 5 configurations so you have an understanding of the entire system, not just the piece of the puzzle you touch on a normal dispatch. Let’s start our discussion with Wings 3 and 5 MAF power systems.

Wings 3 and 5 missile alert facility power systems

The power systems at Wings 3 and 5 have few differences, so these systems are combined in most lessons. The purpose of the MAF power system is to perform the following:

- Distribute commercial alternating current (AC) power to the launch control equipment building (LCEB), tunnel junction, and launch control center (LCC).
- Automatically generate and distribute standby AC power when commercial power fails.

There are several components in the system that makes this power changeover happen. We will look at the two major areas where there is power generation and distribution equipment—the LCEB and LCC. Refer to figure 2–1 for a block diagram of the entire MAF power system.

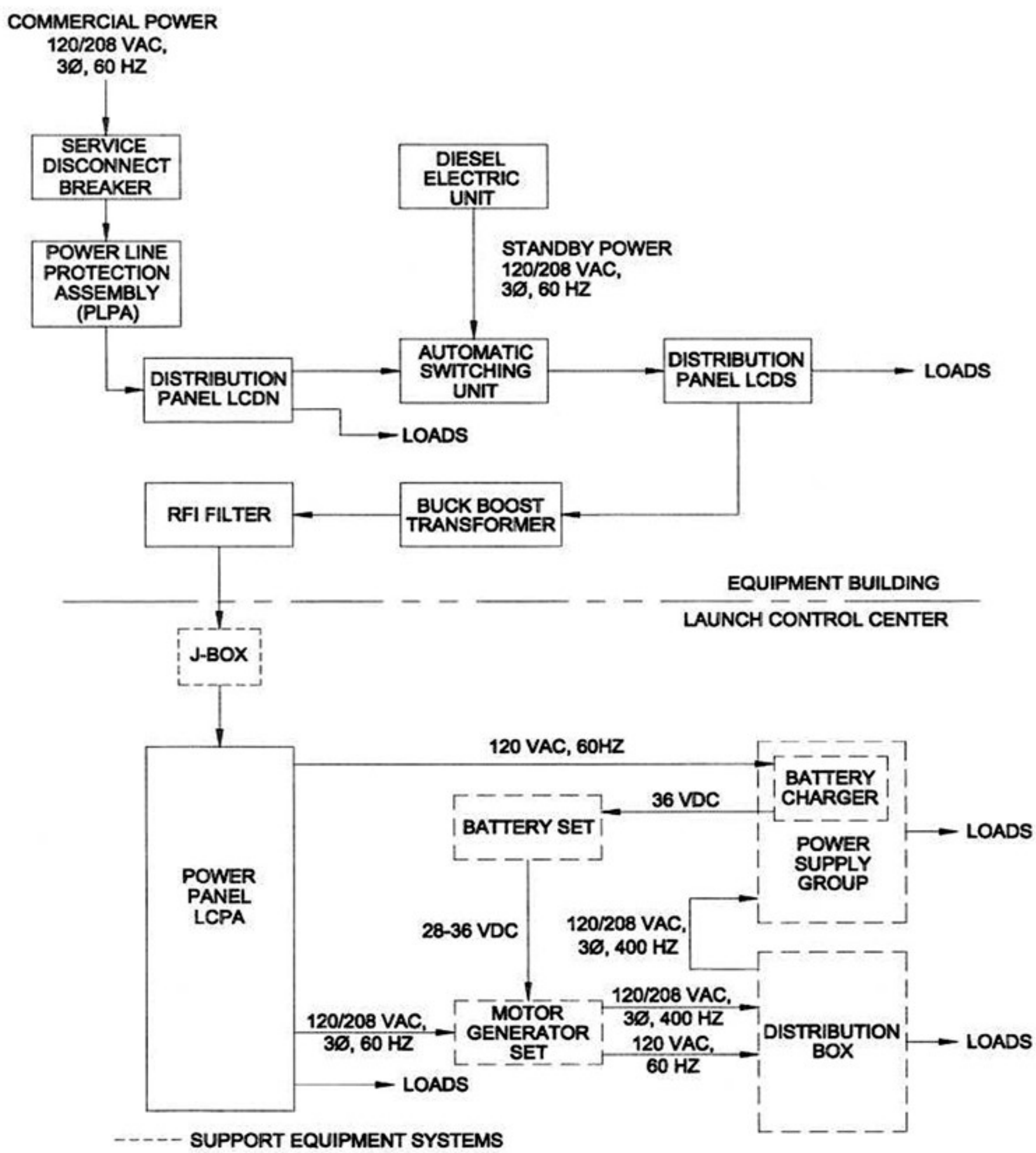


Figure 2–1. Wings 3 and 5 MAF power system.

Wings 3 and 5 missile alert facility launch control equipment building

At Wings 3 and 5, the LCEB is an underground, hardened structure that contains support equipment needed to provide power and environmental support for the launch-critical equipment in the LCC. The LCEB power system components (fig. 2–2) consist of the following:

- Buck boost transformer.
- Diesel electric unit (DEU).
- Service disconnect breaker.
- Automatic switching unit (ASU).
- Launch control distribution-normal bus (LCDN) panel.
- Launch control distribution-standby bus (LCDS) panel.

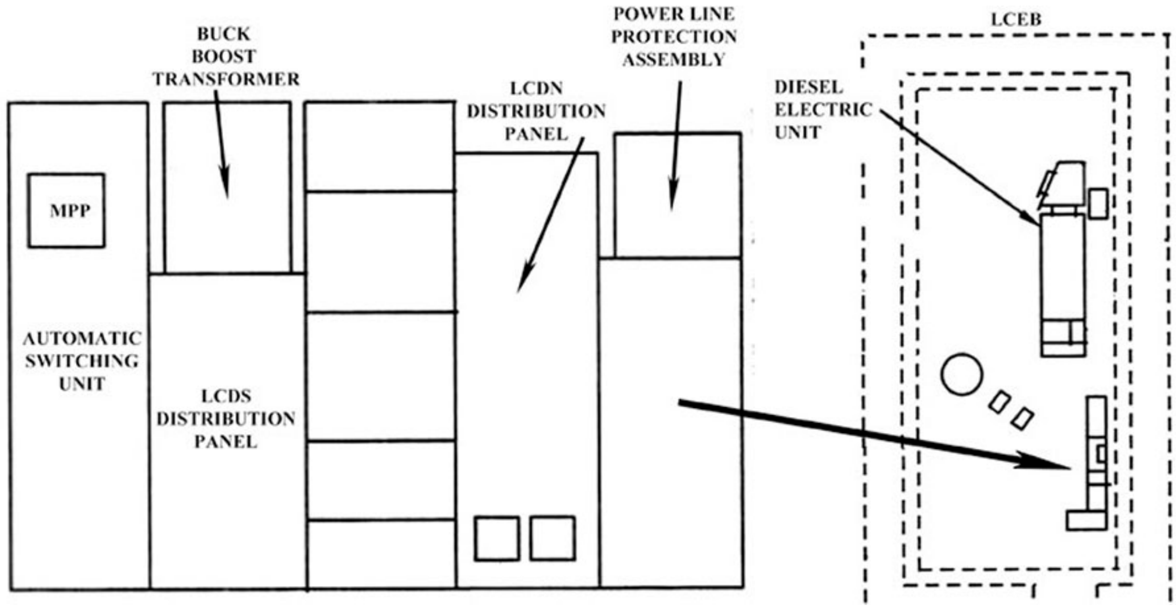


Figure 2–2. Launch control equipment building power system components.

Service disconnect breaker

Commercial power enters the MAF power system and comes into the 350 amperage (amp) service disconnect breaker which serves to isolate commercial power from the power line protection assembly (PLPA) for maintenance. It can also protect site equipment loads if the current is excessive; however, there is a commercial power main circuit breaker further down the line that is in place for the primary reason of protecting site equipment loads if the current is too high.

Diesel electric unit

Consisting of the diesel engine and generator unit, the DEU delivers 75 kilowatts of 120/208 volt AC (VAC), three-phase, 60-hertz (Hz) power to the ASU. The diesel engine is a liquid-cooled, turbocharged, in-line six-cylinder, four-stroke engine that operates at 1,800 revolutions per minute (RPM) to provide standby power in the event of a commercial power failure.

Automatic switching unit

The ASU contains the equipment necessary to monitor primary power (commercial and standby) and distribute it to site loads. In the event of a commercial power failure or commercial power that is out of tolerance, the Minuteman power processor (MPP) in the ASU automatically starts the DEU as backup power. The MPP will control the automatic transfer switches and distribute standby power to site loads if commercial power is lost or if it is out of tolerance.

Wings 3 and 5 missile alert facility launch control center

Now that we have covered the main components of the LCEB power system, let's discuss some of the LCC power system components.

Launch control power-A power panel

The launch control power-A (LCPA) power panel is the main distribution panel for AC loads in the LCC. It receives power from the LCDS panel in the LCEB through the buck boost transformer. The LCPA panel primarily provides power to and contains the circuit breakers for the power supply group's (PSG) battery charger and the motor generator (MG) set.

Motor generator

The MG contains an AC motor that runs as long as primary power is available from the LCPA panel. The MG's motor drives two AC generators, a 400-Hz generator, and a 60-Hz generator, which distribute power to the remaining components in the LCC. In the event of a primary power failure, the storage batteries power a direct current (DC) motor in the MG that drives those same two AC generators. Both motors (AC and DC) will cause the AC generators to produce the same power and provides an uninterrupted source of power for loads in the LCC needed to monitor the LFs and launch their missiles.

The MG is suspended under the LCC shock-isolated floor. A simplified drawing (fig. 2–3) shows you the MG's main components.

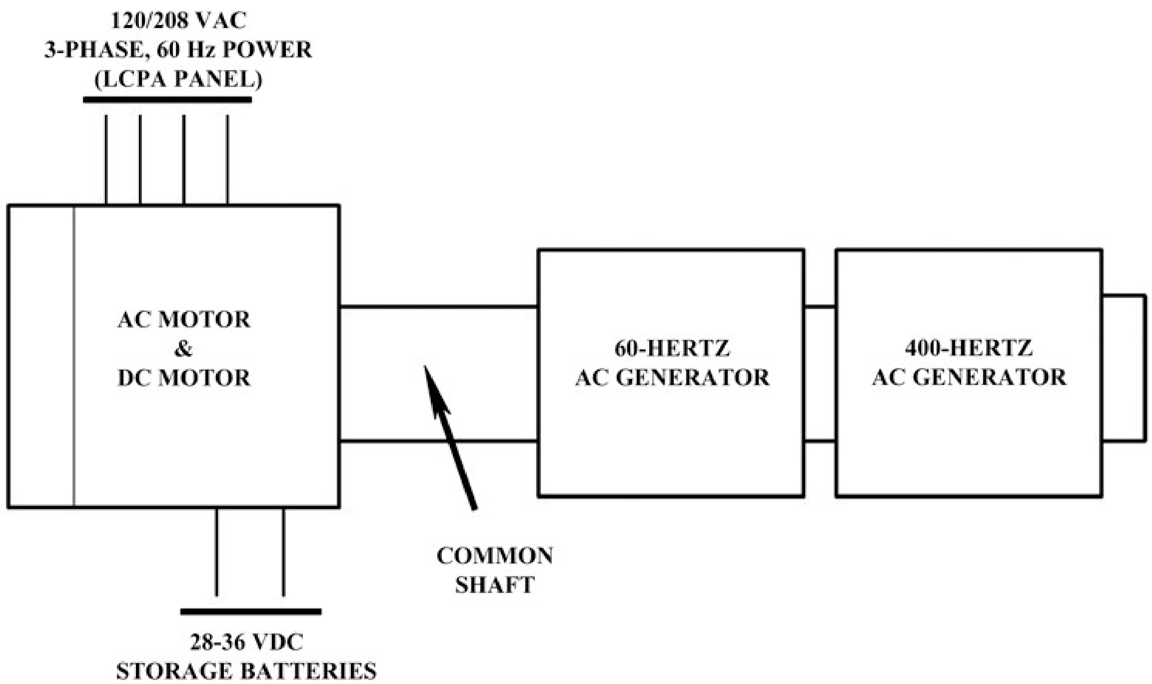


Figure 2–3. Motor generator components.

Storage battery set

The storage battery set, suspended under the LCC floor, provides emergency power for the LCC when primary power is not available. The storage batteries provide power to the MG's DC motor, the emergency environmental control system (ECS) components, and survival lights.

At Wings 3 and 5, you will find 10 storage batteries at the primary LCC and 12 storage batteries at the squadron command post and alternate command post LCCs. Each battery produces 16 volts DC (VDC) and connects in a series-parallel configuration (fig. 2–4). This produces 28–36 VDC; however, the more battery pairs you have, the more amps per hour the entire set can produce. The squadron command post and alternate command post LCCs need more amps per hour to operate the additional communication equipment they contain.

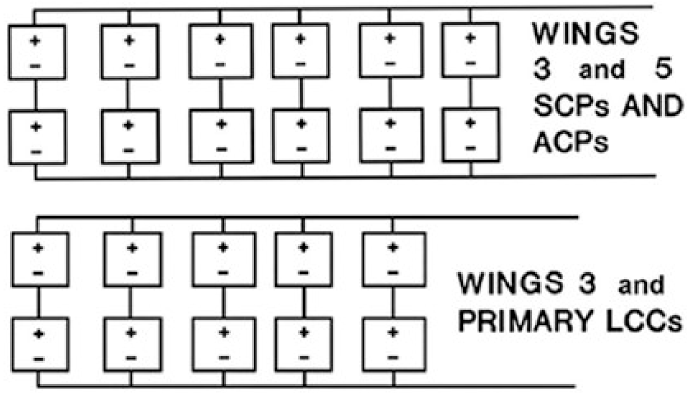


Figure 2–4. Launch control center storage battery configurations.

Power supply group

The PSG is a floor-mounted rack that contains power conversion and distribution equipment. It serves to convert the motor generator's AC voltage output into 28 VDC for use by the communications and rapid execution and combat targeting (REACT) console equipment in the LCC. Additionally, the PSG contains the storage battery charger. This 60-amp charger receives power from the LCPA panel and charges the storage batteries when primary power is available.

Distribution box

The D-box is mounted on the wall next to the PSG. It receives power from both AC generators in the MG, distributes it to the PSG and critical communications and monitoring equipment within the LCC, and the REACT console.

308. Launch facility power system

This lesson breaks down the power systems in both the Wings 3 and 5 configuration and the Wing 1 configuration. There are many similarities between the LF and MAF systems, so only the differences will be highlighted.

Figure 2–5 shows a block diagram of the LF power system at Wings 3 and 5. Wing 1 is very similar; therefore, it will not need to be illustrated. The flow of power through this diagram will be explained as we discuss the two areas of the system—the launch facility support building (LFSB) and launcher.

Launch facility support building power system

Remember at Wings 3 and 5, this room is called the LFSB. At Wing 1, it is launch support building (LSB).

Wings 3 and 5 support building

The physical location of Wings 3 and 5 LFSB power system components are illustrated in figure 2–6.

Commercial power enters the facility at the service disconnect breaker (upper left corner). The service disconnect breaker, the PLPA and DEU are identical to those installed on the MAF. The DEU produces 120/208 VAC, three-phase, 60-Hz, 75 kW. In the event of a commercial power failure or if commercial power is out of tolerance the DEU starts and provides power to the loads. Commercial power, or standby power if commercial power fails, enters the ASU then the MPP provides automatic switching between the two power sources.

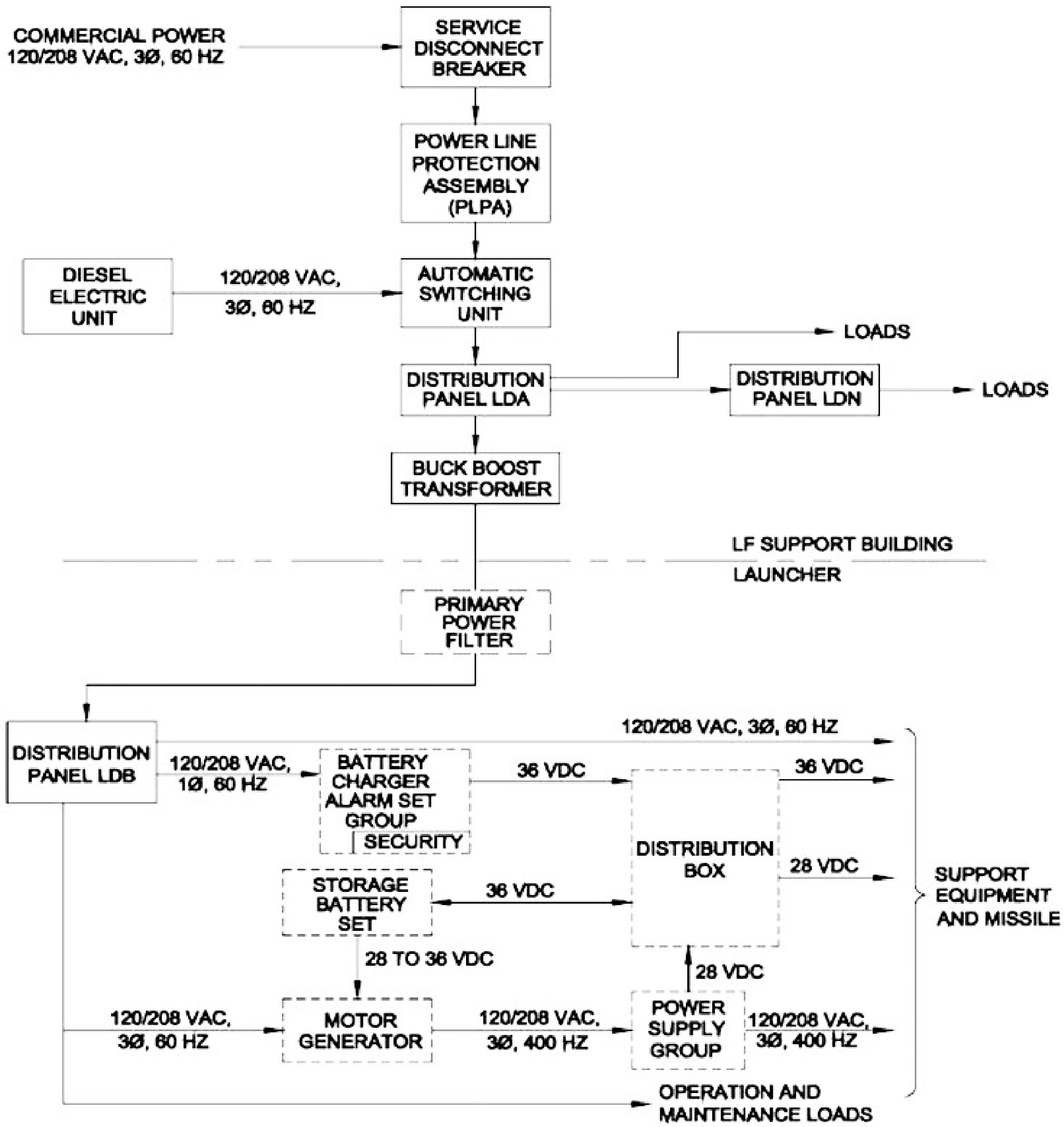


Figure 2–5. Wings 3 and 5 launch facility power system.

After leaving the ASU, power enters the LDA distribution panel. Before leaving the LFSB, power is adjusted by the buck boost transformer, which compensates for voltage drops across filters and line filters. The main difference between the LF and MAF buck boost transformers is which phases are boosted; the LF buck boost transformer boosts A-phase 9 VAC and C-phase 3 VAC. From the buck boost transformer, power passes through a primary power filter that prevents stray radio frequency interference (RFI) from interfering with electronics in the launcher. Power then enters the launcher distribution-B (LDB) panel in the launcher power system.

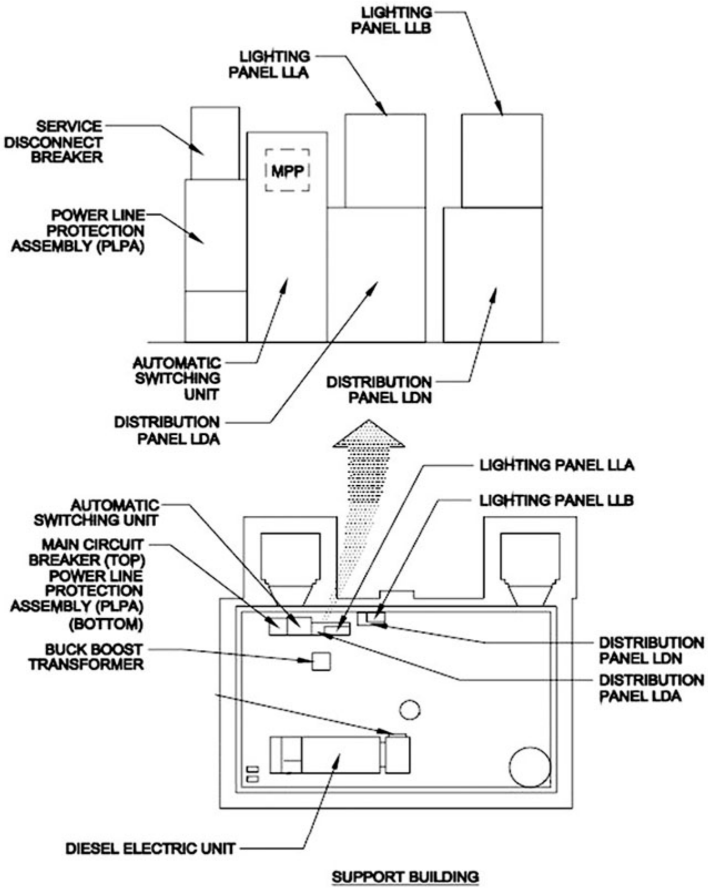


Figure 2–6. Wings 3 and 5 launch facility support building power system components.

Wing 1 support building

The physical location of the Wing 1 LSB power system components are shown on figure 2–7.

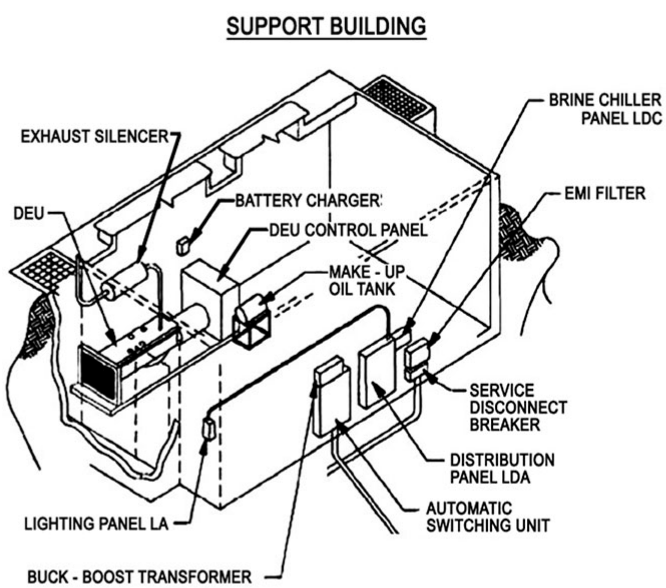


Figure 2–7. Wing 1 launch facility support building power system components.

Commercial power enters the facility and passes through the service disconnect breaker to an electromagnetic interference (EMI) filter assembly. The EMI filter assembly serves the same purpose as the PLPA on the Wings 3 and 5 systems. From the EMI filters, commercial power enters the [1] launch support building distribution-A (LDA) panel and passes through a commercial power main circuit breaker before entering the ASU.

The DEU is a four-cycle, liquid-cooled, 75 kW engine that produces 120/208 VAC, three-phase, 60-Hz power in the event of a commercial power failure or commercial power that is out of tolerance. Commercial power enters the ASU (or standby power when it is needed), which provides automatic switching between the two power sources.

Whichever power is applied, commercial or standby, it travels to the LDA panel to be distributed to the LSB and launcher. In the LSB, the LDA panel powers the LSB brine chiller panel and LSB lighting panel. The launcher distribution-C (LDC) panel contains the circuit breakers for the brine chiller; lighting panel A (LA) contains many of the circuit breakers for miscellaneous items in the LSB. From the LDA panel, power travels to the LDB panel in the launcher.

Launcher power system

The launcher power system in both Wing 1 and Wings 3 and 5 configurations are the same, so they will not be discussed separately.

Power enters the launcher from the LDA panel in the LFSB/LSB. After passing through the primary power filter to remove any stray RFI, power enters the LDB panel where it is distributed to loads in the launcher. There are some major differences between the launcher and LCC power systems, so we will go into more detail in this section.

Battery charger alarm set group

The battery charger alarm set group (fig. 2–8) is located in the upper level launcher equipment room (LER) on the shock-isolated floor. This electronic rack provides charging current to the storage battery set in the lower LER and power to the D-box. The battery charger is powered by primary power (commercial or standby power). The 60-amp charger provides 36 VDC.

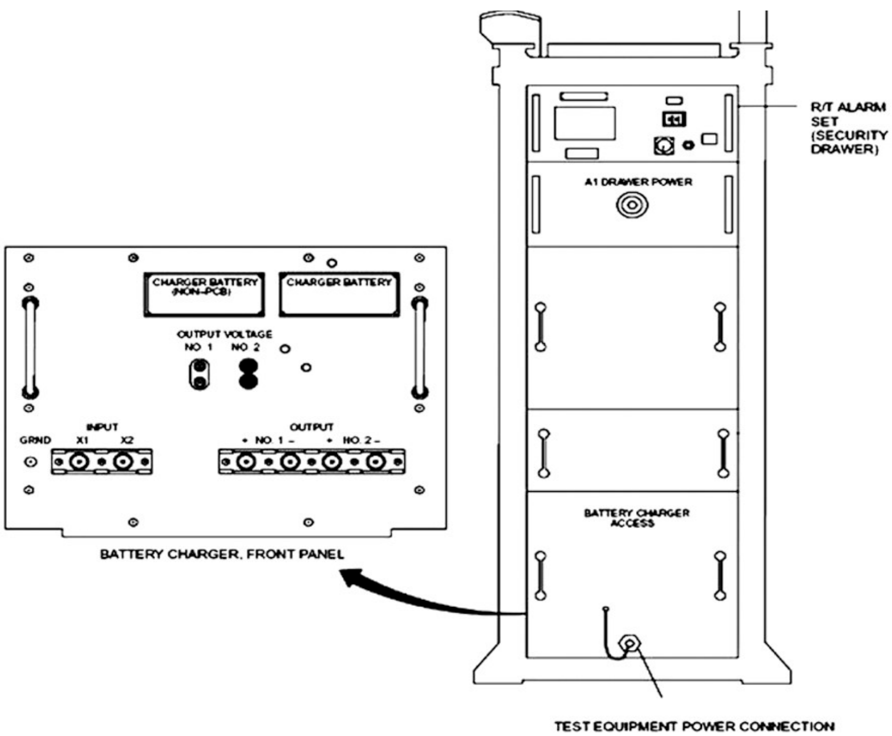


Figure 2–8. Battery charger alarm set group.

Storage battery set

The storage battery set is located in the lower LER, suspended from the upper level's shock-isolated floor. When primary power is available, the batteries are charged by the battery charger alarm set group. When primary power fails, the storage batteries provide power to the emergency ECS and the DC motor on the MG. The battery set consists of 12 batteries, connected in series-parallel; so there are six pairs of batteries connected in parallel.

Motor generator

The MG (fig. 2–9) is located in the lower LER; like the storage batteries, it is suspended from the shock-isolated floor above. The MG provides uninterrupted power to the PSG, which in turn distributes power to the D-box, operational ground equipment (OGE), and the missile.

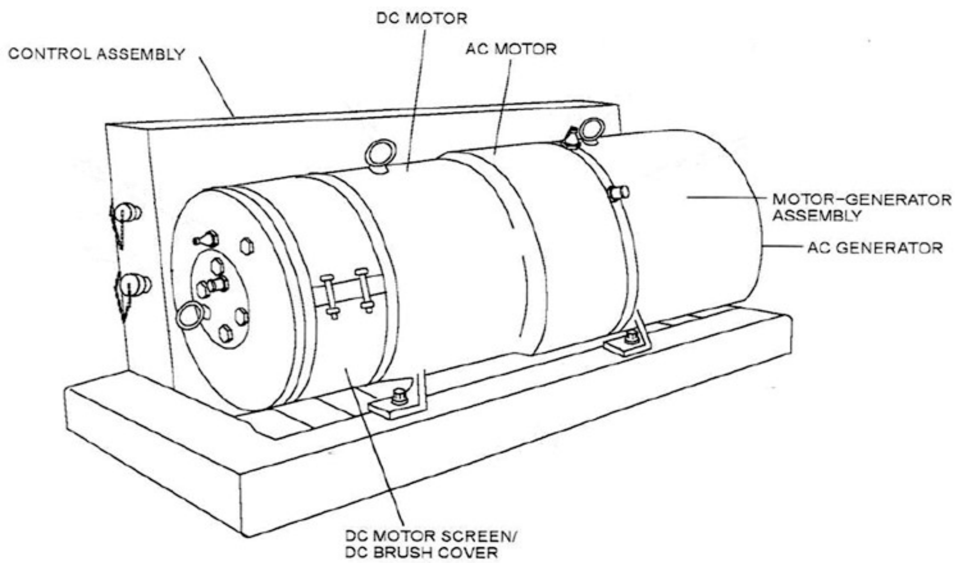


Figure 2–9. Motor generator.

Like the MAF MG, this MG contains an AC motor that operates as long as primary power is supplied from the LDB panel. The AC motor is on a common shaft with a single AC generator that produces 120/208 VAC, three-phase, 400-Hz power to the PSG. The MAF has an additional 60-Hz generator, whereas the LF only has the one 400-Hz generator. In the event of a primary power failure, the AC motor stops and the DC motor starts. The input for the DC motor comes from the storage battery set. This ensures uninterrupted power for the PSG and other critical loads in the launcher.

Power supply group

The PSG is another electronic rack located on the shock-isolated floor. Its power input comes from the MG and serves as the main power source for the OGE and the missile. The PSG takes some of the AC output from the MG and converts it to 28 VDC for use by the D-box.

Distribution box

The D-box (fig. 2–10) is located on the upper level LER on the shock-isolated floor, next to the guidance section liquid cooler. The D-box distributes signals and DC power to the missile downstage electronics, relays, and the safe and arm motors. The safety control switch (SCS) is installed on the D-box to allow a technician to manually safe the missile during maintenance. The SCS is a motor-driven, multi-contact switch with an override mechanism. When the SCS key is not installed, the ordnance devices of the missile are connected to the D-box and are ready for launch signals. When the SCS key is installed, it overrides the multi-contact switch connecting the ordnance devices in order to test loads.

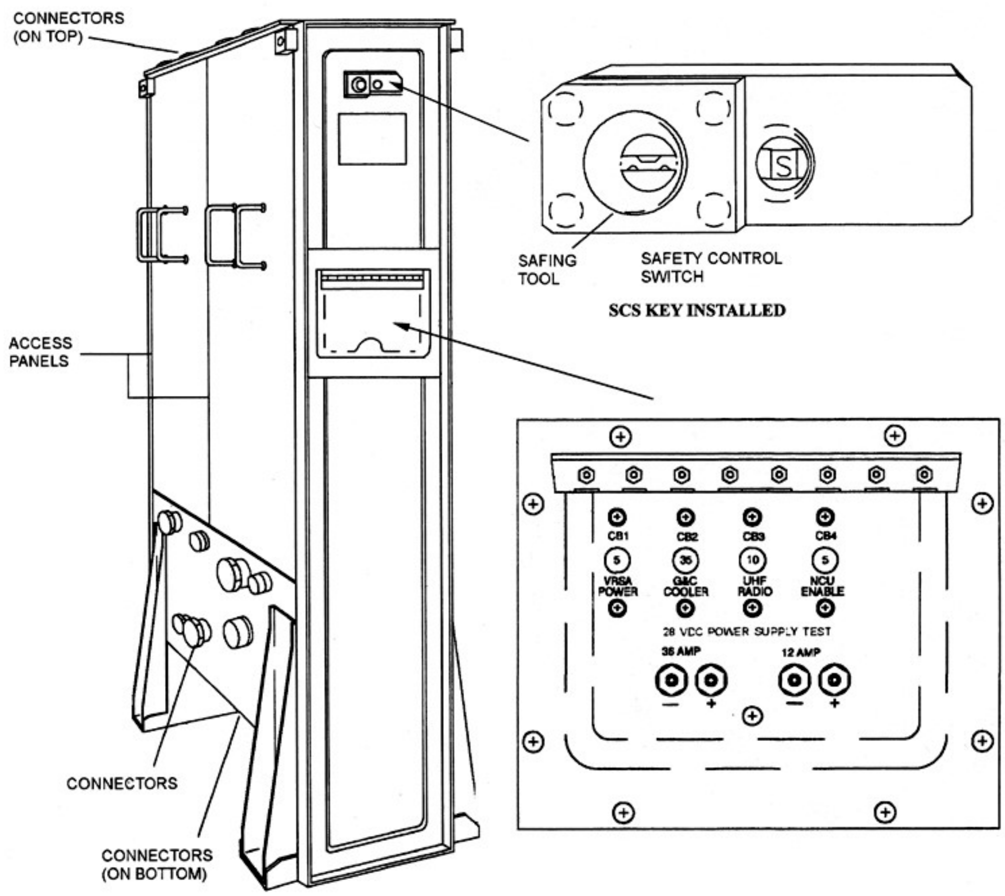


Figure 2–10. Distribution box.

Self-Test Questions

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

307. Missile alert facility power system

1. What is the purpose of the MAF power system?

2. What is the purpose of Wings 3 and 5 DEU?

3. What does the MPP do during a commercial power failure?

4. What Wing 3 and 5 power panel provides power to the MG set?

5. When does the AC motor on the MG operate?

6. What happens to the MG operation when primary power fails?

7. How are Wings 3 and 5 LCC storage batteries configured?

8. What purpose does the PSG’s power conversion equipment serve?

308. Launch facility power system

1. Which components at Wings 3 and 5 LFSB are the same as the ones at the MAF?

2. How many amps and volts does the battery charger provide to the storage batteries?

3. What components do the storage batteries provide power to when primary power fails?

4. What is the major difference between the LF and MAF MGs?

5. How is the D-box configured when the SCS key is not installed?

2–2. Intrasite Cabling Description

Just as power is required to sustain the ICBM weapon system mission, cabling is required to route that power and other signals to various equipment in the MAF and LF. This section is divided into two lessons. The first lesson covers the LCC cabling system components and the second lesson covers the LF cabling system components.

309. Launch control center intrasite cabling system

In this lesson, you will study the physical and functional characteristics of the intrasite cabling systems found at the LCC. This lesson begins with the description of the LCC cable assembly set.

Cable assembly set

The cable assembly set is composed of approximately 200 cables. These cables are routed in two overhead cable trays (fig. 2–11) or clamped to the walls and other structures inside the LCC. The cables are tied to the cable tray every 24 inches and at the entrance and exit of the cable tray.

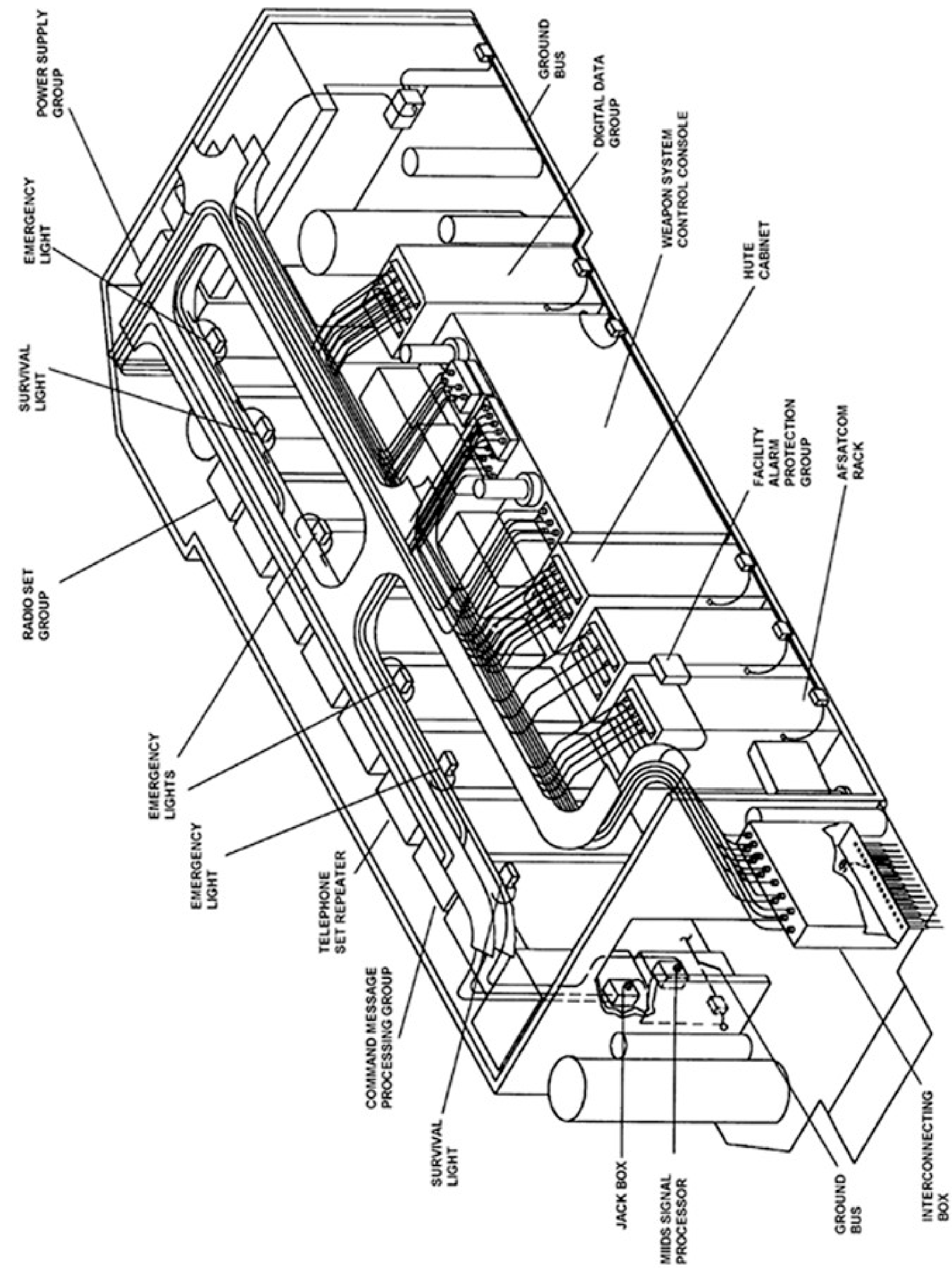


Figure 2–11. Typical LCC cable trays (partial view).

At Wings 1, 3, and 5, the high frequency (HF) and ultra-high frequency (UHF) antenna cables are routed through a hole in the shock-mounted acoustical enclosure above the rack, along the ceiling, back down into the electrical surge arrester vault, and then out to the antennas through conduit (fig. 2–12).

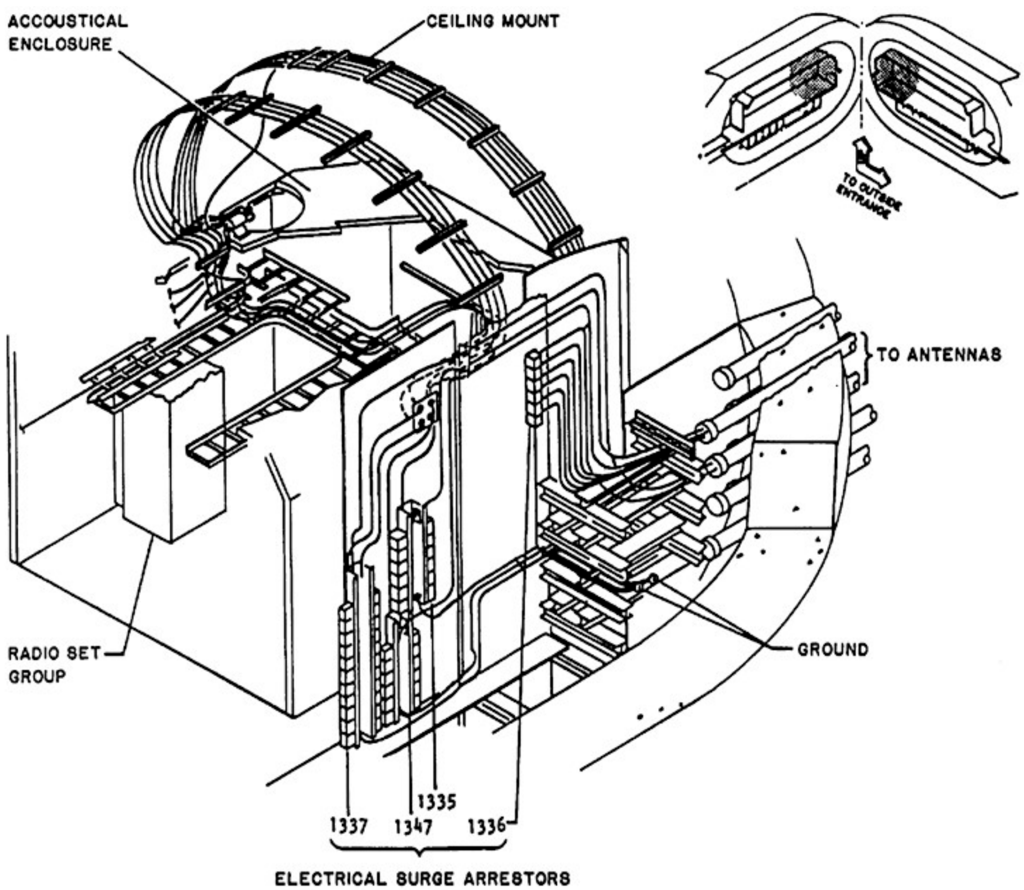


Figure 2–12. Typical UHF antenna cables.

Cables between the LCC and the topside support building are routed through a conduit. Cables in the support building going from one room to another are usually routed through the ceiling and along a catwalk in the attic. Cabling between the hardened equipment building (except Wing 1) and the LCC runs in a tunnel connecting the two areas.

There are several types of cables in the LCC, weighing from as little as one pound to in excess of 100 pounds. Some cables are single conductor cables, such as battery and ground cables. The majority are multi-conductor cables that have at least one connector potted and molded to the cable. These cables are not reparable at the organizational level, but are replaced when a faulty one is found. Cables in which the individual wires terminate with terminal lugs are reparable at the organizational level, to the extent that the lugs may be replaced if the wire length permits.

Under the LCC floor, cables interconnect the storage batteries with each other, the respective battery chargers, the MG, and other equipment (fig. 2–13). Many of these cables consist of simple conductors terminated in a single lug or in a group of wire terminals. A few of the cables have molded connectors that mate to other cables or equipment.

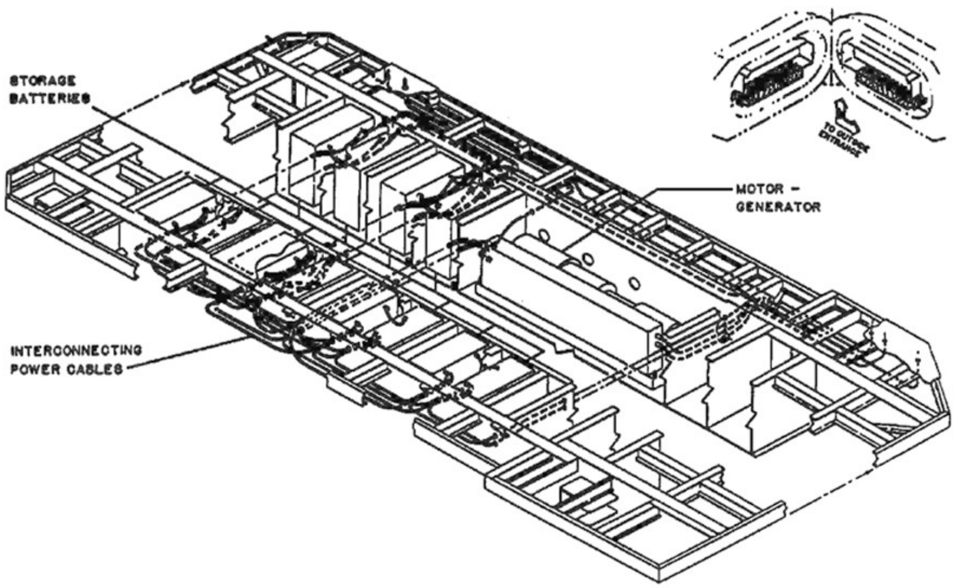


Figure 2–13. Typical battery cables.

The signal cables consist of several multi-conductor shielded cables that run from the LCC equipment to the electrical surge arrester (ESA) vault. Figure 2–14 shows a typical ESA vault with its ESA panels and cabling. The voltage before it enters the ESA and the voltage after the ESA are commonly called the high and low voltage sides, respectively. High voltage refers to the unprotected side of the ESAs, that is, the side the overvoltage or spike would enter. Low voltage refers to the protected side of the ESAs.

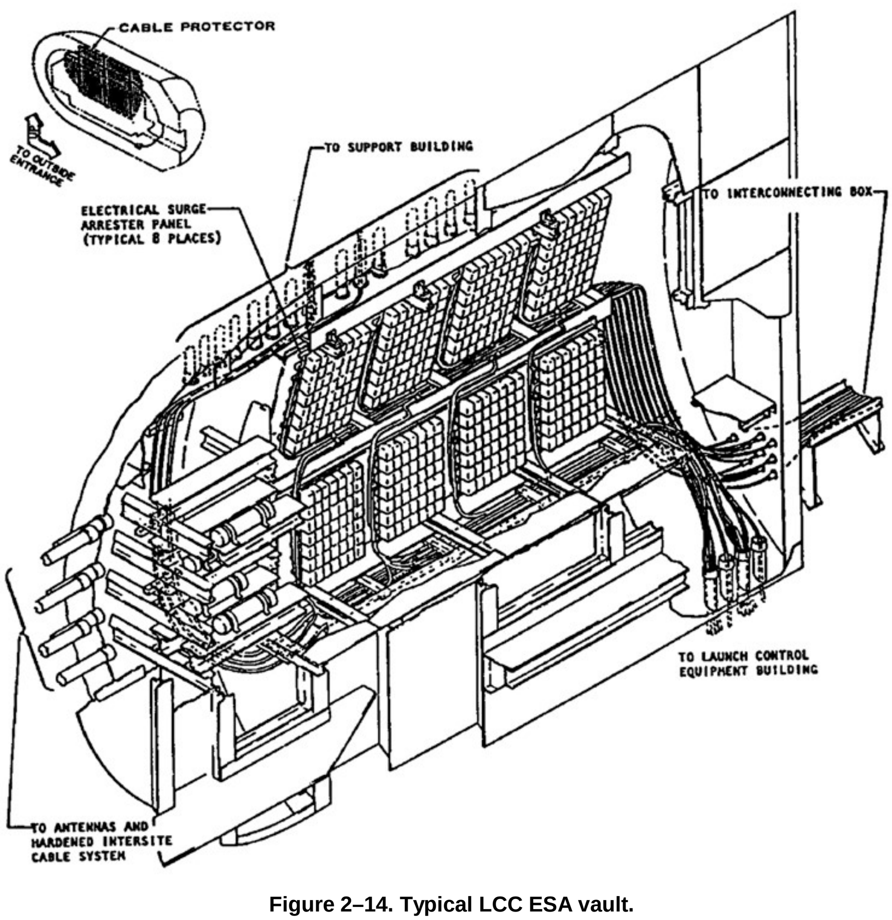


Figure 2–14. Typical LCC ESA vault.

Interconnecting box

Each LCC has an interconnecting box (I-box) that provides an interface between the ESAs and electronic equipment. Each LCC I-box is wired differently due to the different number and functions of wire pairs entering and leaving the LCC. Figure 2–15 shows a typical I-box with its top connectors, terminal boards, internal wire bundles, and bottom connectors. Cables connected to the top connectors interface with the LCC electronic equipment, while those connected to the bottom interface with the ESAs.

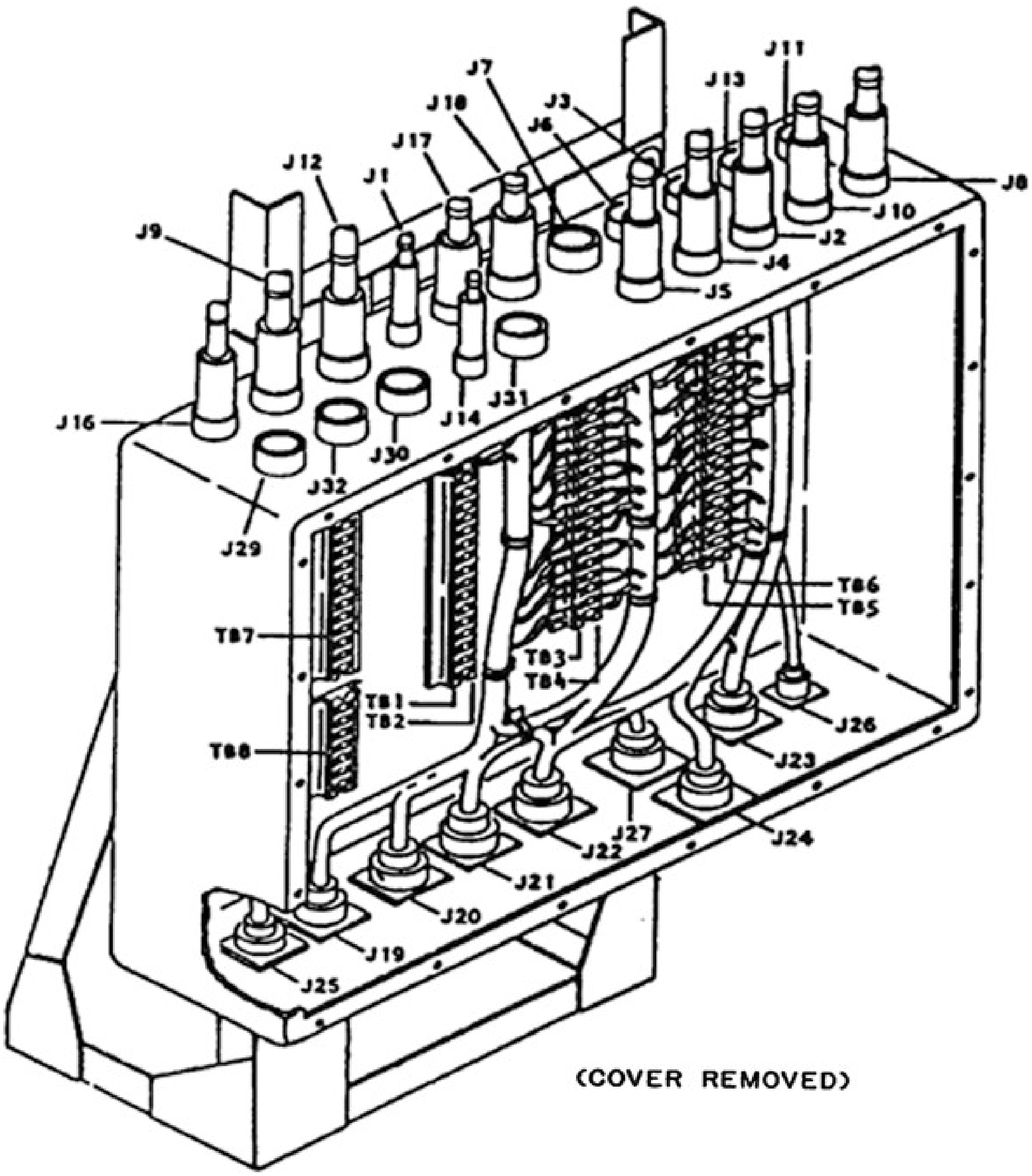


Figure 2–15. Typical LCC interconnecting box.

Launch control center electrical surge arrester set

At the LCC, the ESA set consists of eight ESA panels (fig. 2–16) and four high-energy spark gaps (HESG) located in the ESA vault.

Electrical surge arrester

Each ESA panel has seven or eight channels hinged at the left. When opened, the terminals in the rear of each of the seven modules on the channel are exposed. Figure 2–16 shows one channel of a panel swung open, the numbered arrangement of modules, a module schematic, and the rear view of a module.

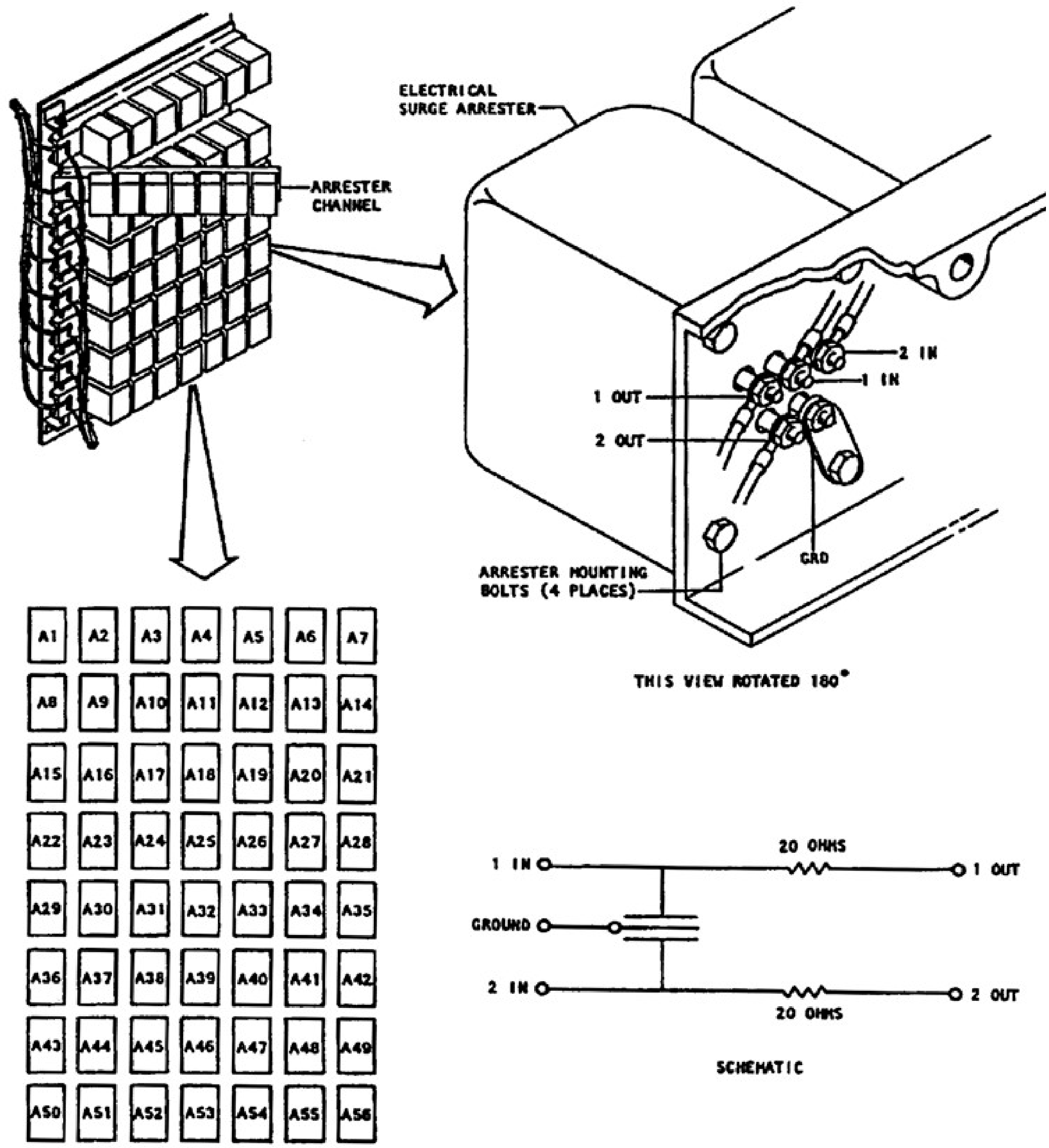


Figure 2–16. Typical ESA module.

Each panel has 49 or 56 ESA modules and a varying number of ESA circuit cards depending on LCC capability. Four of the panels are associated with signals passing through the hardened intrasite cable system (HICS) and four with other signals entering or leaving the facility. All HICS active and selected spare circuit pairs are connected to individual spark gaps terminals on the HESG panel. From the HESG panel, circuit pairs connect to an ESA module.

The ESA modules protect wire pairs entering the LCC from excessive voltage and current surges due to lighting or other electromagnetic pulses. Each module weighs three pounds and has two 20-ohm resistors and three carbon blocks. One carbon block connects to each of the signal wires entering the module, and the third carbon block is connected to ground. The carbon blocks have small gaps between them known as “spark gap.” High voltages (starting between 1,000 and 2,500 VDC) arc across the gap and short to ground (“clamping” the voltage); thus, the carbon blocks protect equipment by clamping the voltage and shunting excessive current to ground. The 20-ohm resistors, one in each signal line, limit the current entering the system during a surge condition.

High-energy spark gap

The function of the HESG is to protect electronic circuits, equipment, and personnel from voltage or current surges induced by lightning or other electromagnetic pulses in circuits entering the LCC via cables or conduit. The HESG provide spark gap protection for pulses of 50 to 600 volts.

Circuit cards

The ESA circuit cards provide circuit protection for high-level energy surges of 100 to 160 volts and low-level residual voltages above 15 volts. Non-HICS circuits use the carbon block spark gap in the ESA module along with ESA circuit cards on telephone circuits. Other circuits entering the LCC are connected to ESA modules for spark gap protection.

LCC radio and television ESA

The LCC radio and television (TV) ESA is mounted on the inside surface of the ESA vault wall. This ESA provides feed through connections for the radio and TV coaxial signal cable (fig. 2–17). The ESA assembly is a metal box with a 50-ohm N-type connector installed on the cable in the ESA vault.

The center conductor of the ESA connector is connected to the trigger terminal of a tri-gap 90-volt ESA by a number 22 wire, which acts as a fuse for a high-energy pulse. The wire is routed to ensure grounding of the fusing arc. The 90-volt ESA is grounded to the ESA case. A four-inch length of wire acting as a delay line, connected between the trigger terminal and the second terminal of the spark gap to limit output in the event of a very fast rise pulse of 2,000 volts or less. The signal is then passed to the output 50-ohm connector that mates with a new or existing 50-ohm connector installed on the capsule end of the cable. The use of 50-ohm connector has no effect on signal performance.

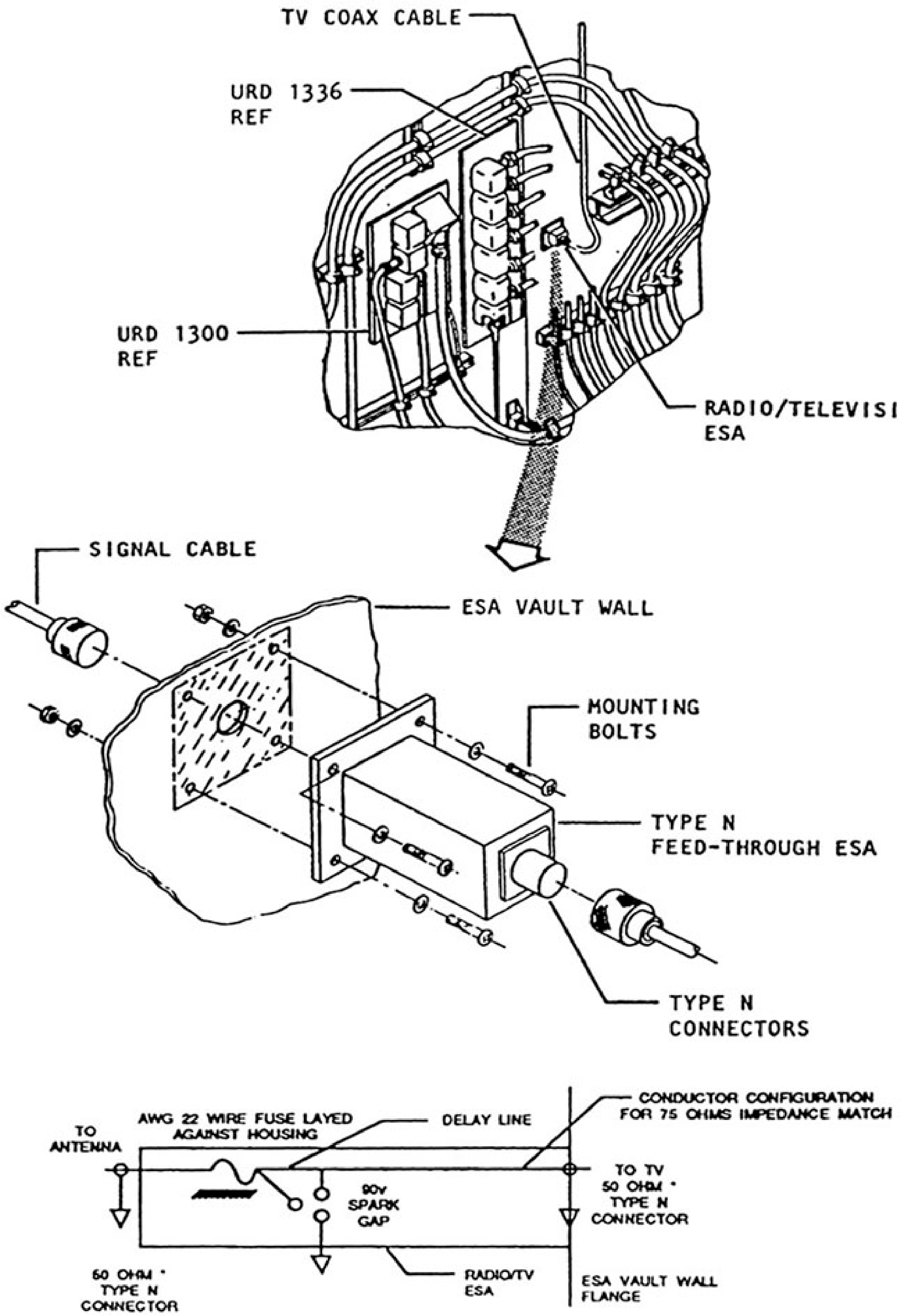


Figure 2–17. LCC radio and television ESA.

Security and monitor junction box

The LCC security monitor control panel is located on the capsule liner behind the I-box. It protects status lines from the LCEB equipment monitor panel; the control circuit for electrical door lock between the security control room and elevator access room; the three-phase power monitor lines from the LCPA panel; and control circuits for various water valves (fig. 2–18).

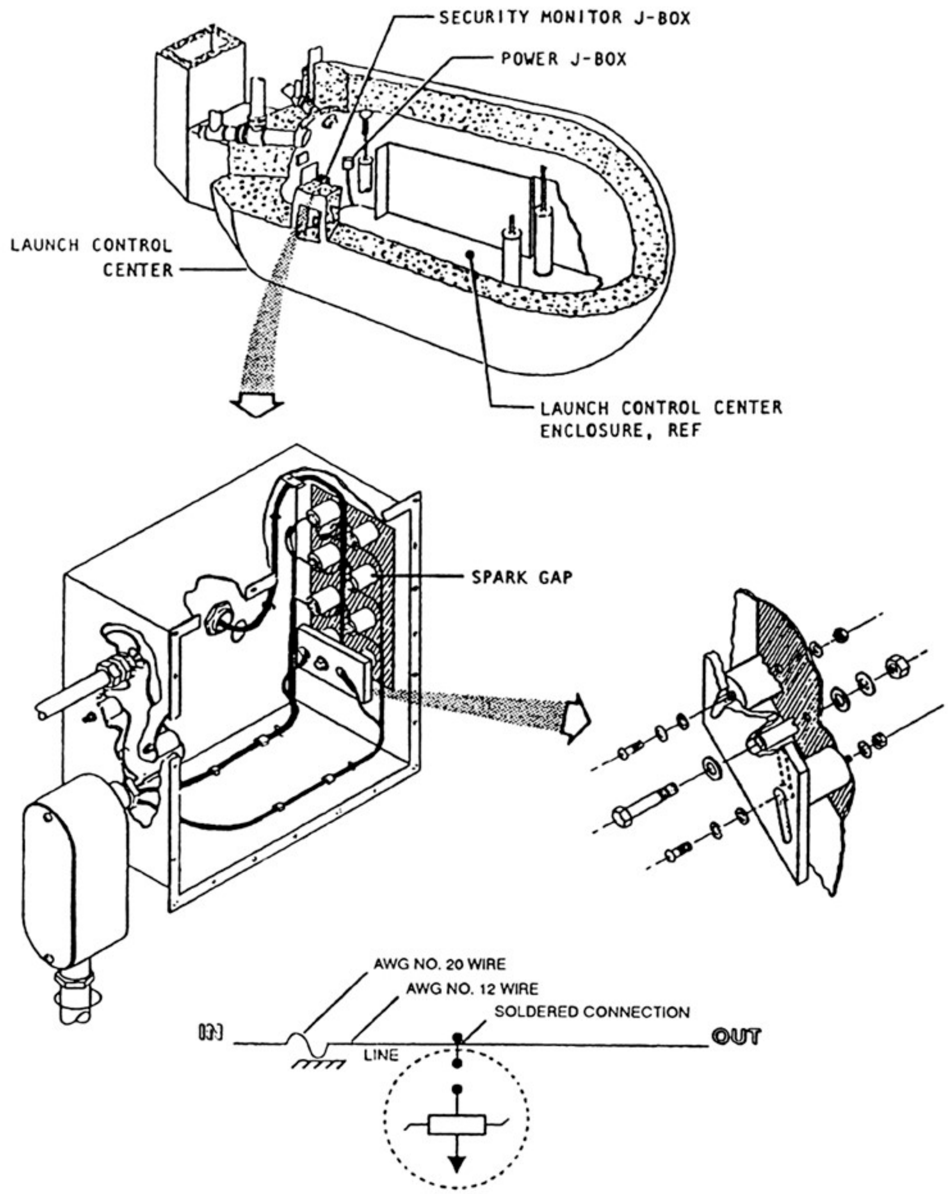


Figure 2–18. Security and monitor junction box.

Power junction box

Power cables from the LCEB are separated in the junction box mounted on the LCC liner from cables going to the LCC circuit breaker panel (fig. 2–19). Three metal oxide varistors (MOV) are bolted to the interior walls of the junction box, one for each of the three-phase input cables. The junction box insulates the “hot” top plate of the MOV assembly from the structure and provides terminal studs for connection of the power cables. At normal operating voltages, the MOVs provide a high resistance path to ground, in parallel with the power lines. When voltages increase above normal, the resistance decreases inversely to the rise in voltage to shunt high voltage to ground. The MOV size and rating is such that in the event of low-level pulses, the MOV will recover to normal resistance at the end of the pulse. A high-energy pulse will cause the MOV to short, by design, into a non-recoverable mode, grounding the input power cables to prevent subsequent pulses from entering the LCC via the power lines. Additional junction box fasteners are installed to ensure pulse effects do not escape the enclosure.

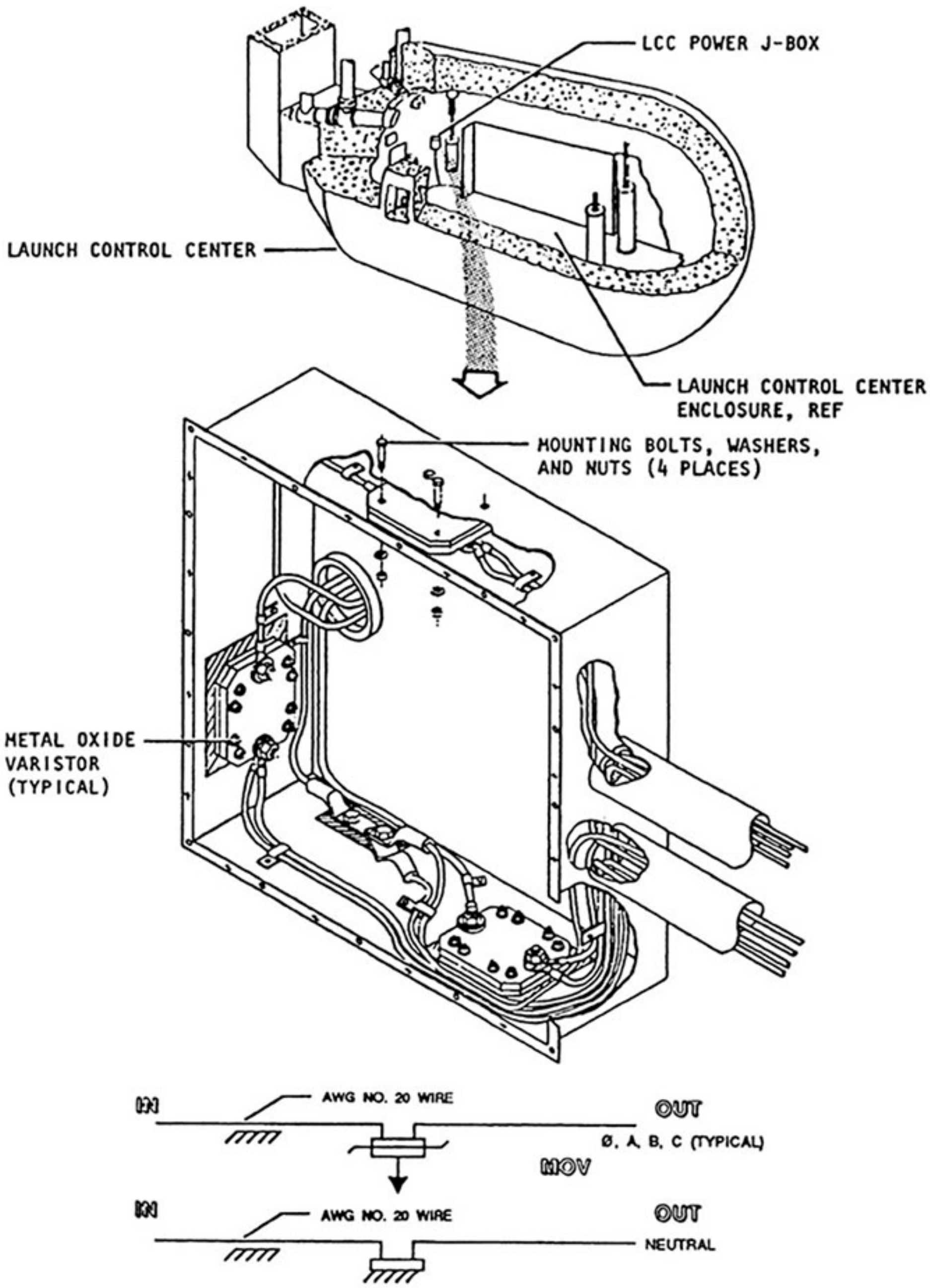


Figure 2–19. Power junction box.

Facility alarm protection assembly

The facility alarm protection assembly (FAPA) provides electromagnetic pulse (EMP) protection for the facility alarm and control lines from the LCEB to the LCC (fig. 2–20). The FAPA is designed to reduce EMP threat expected on the lines to an acceptable level prior to entering the auxiliary alarm panel (AAP) in the weapon system control console (WSCC). The FAPA is located on the outside of the acoustic enclosure bulkhead adjacent to the ESA vault. The FAPA provides EMP protection through fusible links, MOVs, and EMP filters.

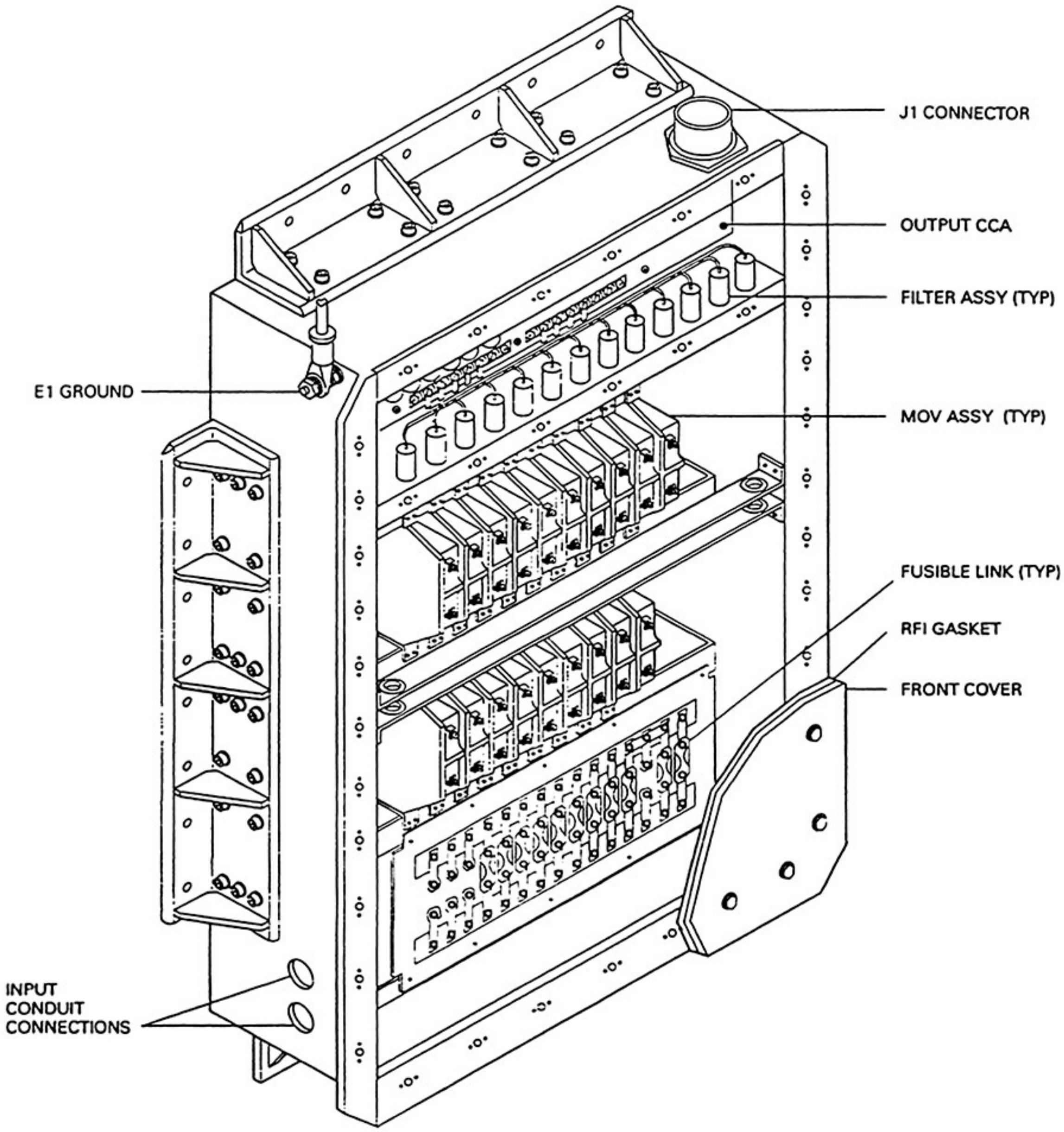


Figure 2–20. Facility alarm protection assembly.

310. Launch facility intrasite cabling system

In this lesson, we cover the physical and functional characteristics of the LF intrasite cabling systems. This lesson begins with the description of the LF cable assembly set.

Cable assembly set

The cable assembly set consists of approximately 140 LF cables. The cables leading to the equipment racks on the shock-mounted floor are routed in a double-decker cable tray above the air conditioning duct (fig. 2–21). Cables that go from the shock-mounted floor to a rigid structure have sufficient slack (shock loop) to prevent damage when the shock-mounted floor moves. A strap holds the shock loop near the personnel access entry out of the way of maintenance personnel. The strap is tied together with a nylon cord that will break if a shock of sufficient strength occurs. Cables to the batteries on the underside of the shock-mounted floor are clamped to the structure. Other cables are clamped to the walls of the launcher, the inside and outside of the launch tube liner, and the missile suspension and canister systems (as applicable).

Cabling runs in conduit between the launcher and the support or equipment building and between the launcher and the top side antennas. Cables in the support or equipment building run in an overhead cable tray that is clamped to the walls.

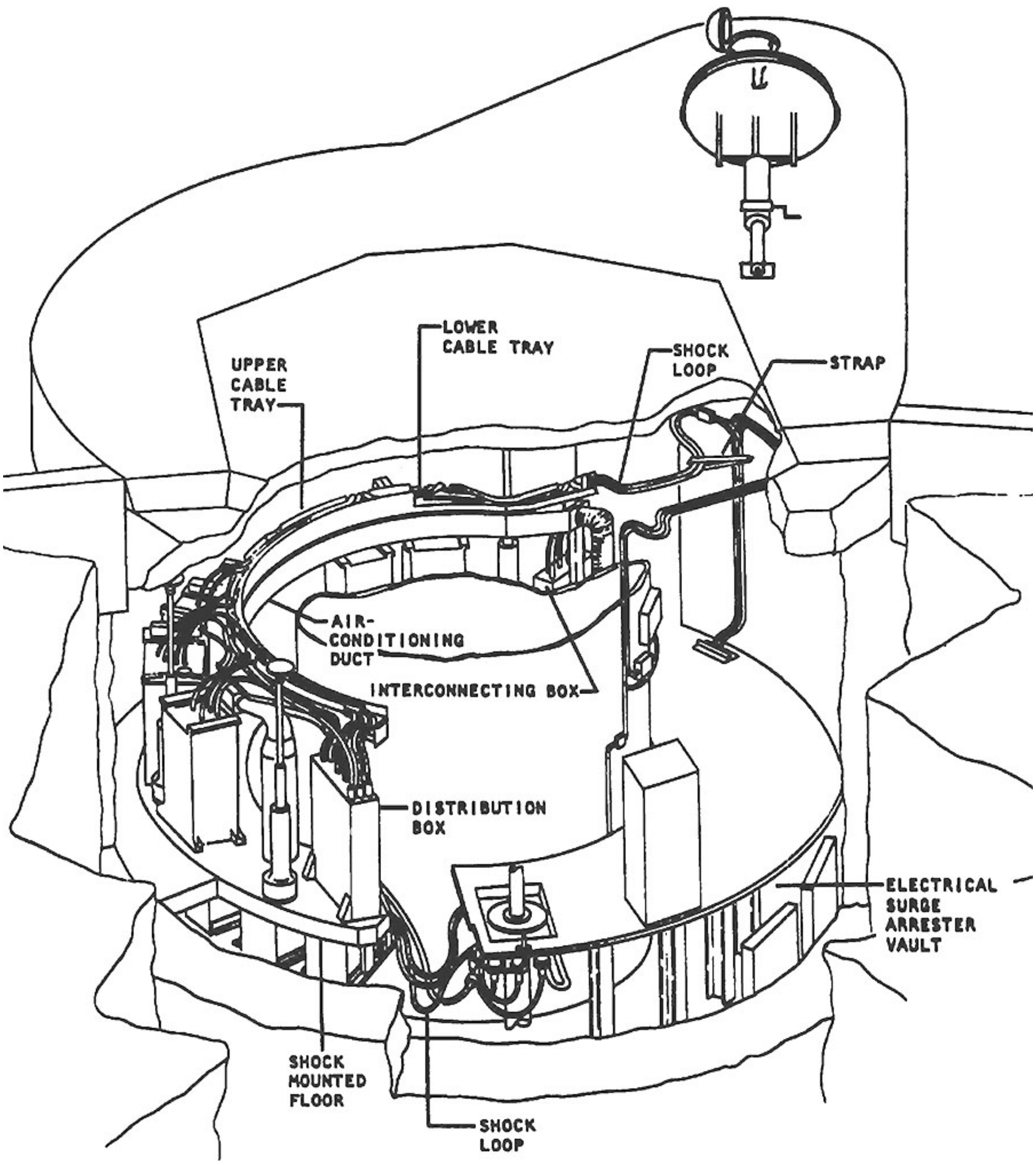


Figure 2–21. LF shock-mounted floor cable tray and cables.

As at the LCC, some of the cables at the LF are single conductor cables (battery and ground cables), while most are multi-conductor cables with at least one connector potted and molded or magneformed to the cable. These LF cables have the same maintenance and replacement requirements as the LCC cables.

Interconnecting box

Each LF has an I-box that contains a sorting plug to accomplish the signal distribution that is unique to each site. Figure 2–22 shows the location of the sorting plug. Each sorting plug is wired differently. The wing and site location engraved on the bottom of the plug identifies the particular LF. The LF I-box also contains a pulse suppressor assembly that suppresses undesirable signals that may have been picked up on the HICS cables. The two relays mounted inside the I-box are part of the standby power monitoring circuits. The K–1 relay monitors standby power failure and the K–2 relay monitors standby power on-line. The terminal boards have removable jumper bars for isolating command and support information network (SIN) lines.

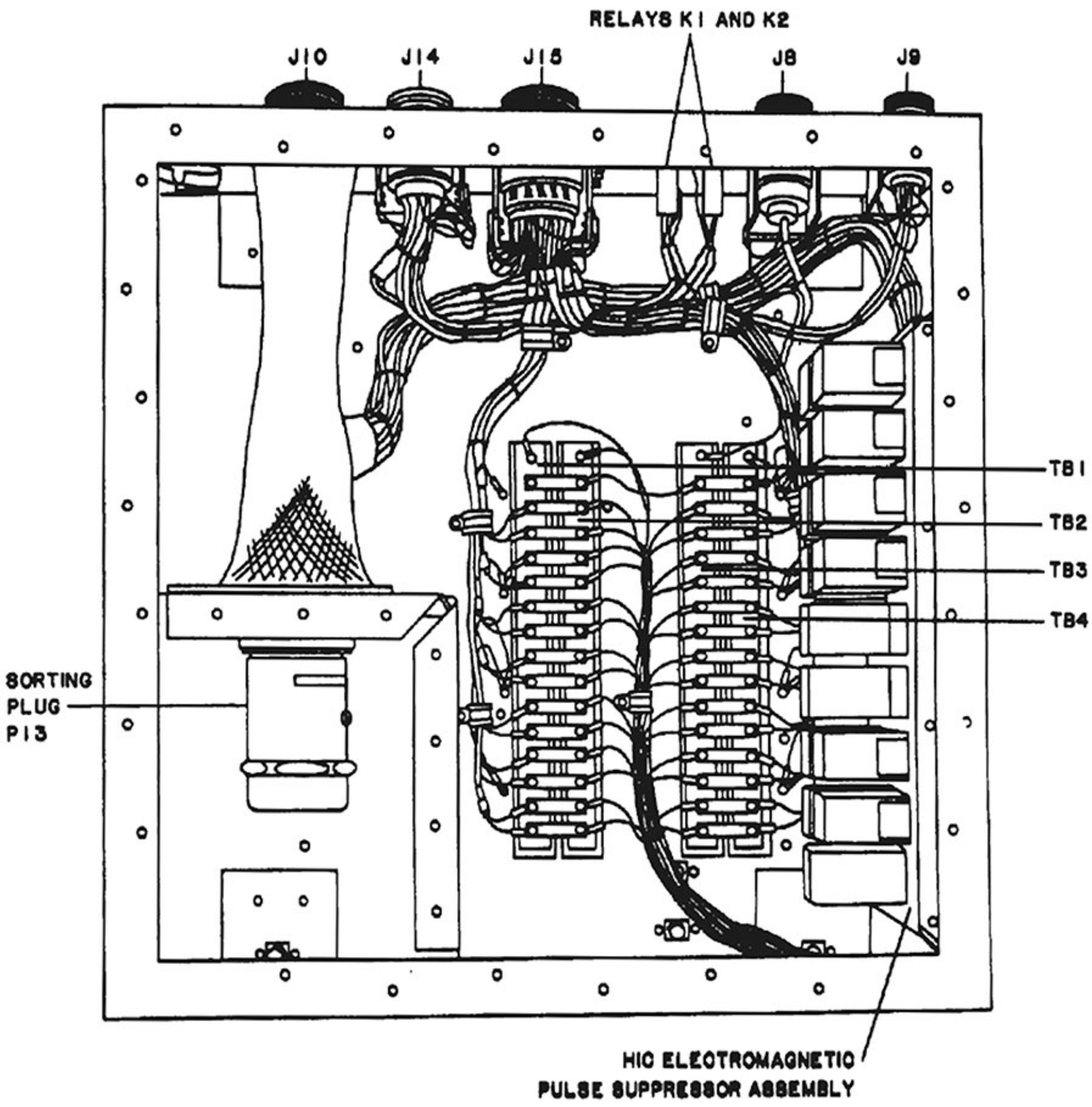


Figure 2–22. Typical launch facility I-box.

Electrical surge arrester set

The ESA set at an LF is similar to that at the LCC, except there are only two ESA panels (fig. 2–23). One panel, unit reference designator (URD) 484, has 28 modules and is associated with signals received and sent on the HICS (command and SIN lines). The other panel (URD 483) has 42 modules and is associated with other signals either entering or exiting the launcher (SIN line, security system, and standby power monitoring circuits). The function and operation of the modules are identical to those in the LCC.

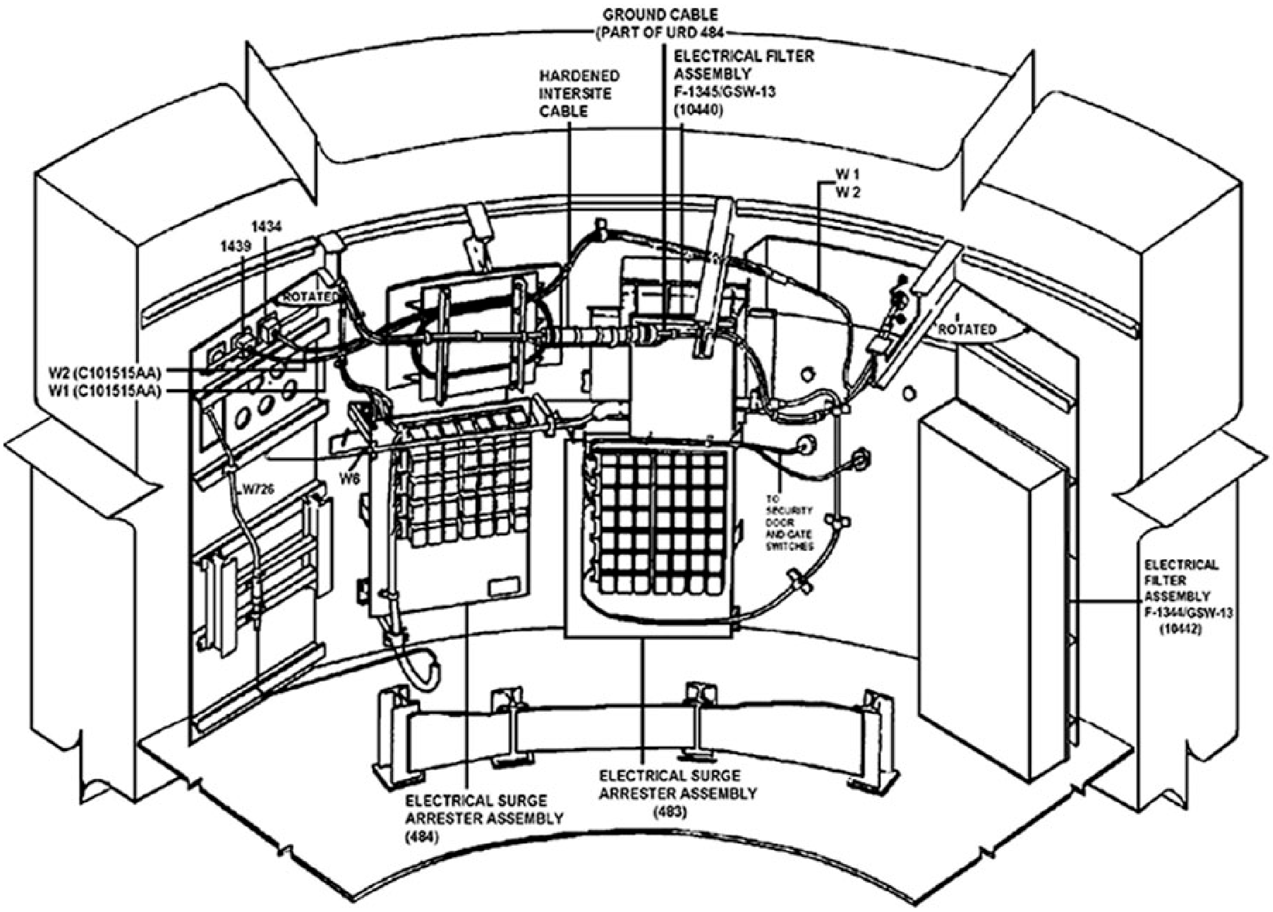


Figure 2–23. Typical launch facility ESA vault.

Electrical filter assembly

There are three electrical filter assemblies (EFA). Figure 2–23 shows the location of two EFAs in the ESA vault, F–1344/GSW–13 (URD 10442) and F–1345/GSW–13 (URD 10440). The third filter assembly, F–1343/GSW–13 (URD 10443) (fig. 2–24), is located on the launcher wall in the first level equipment room across from the launch tube access doors. These filters provide voltage limiting and attenuation, and prevent conducted EMP transient signals from affecting critical circuits within the LF. The filters protect 27 lines that penetrate the launchers.

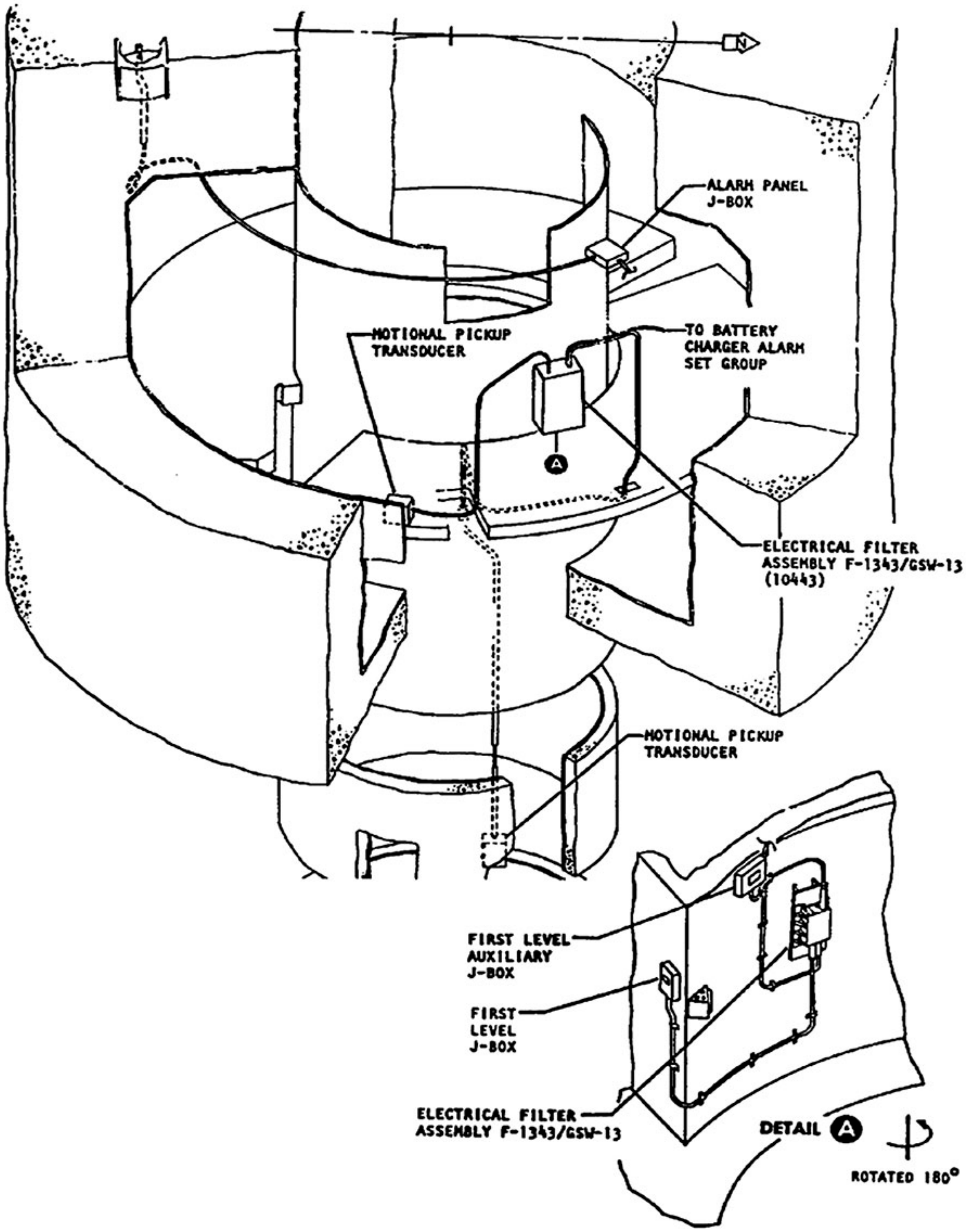


Figure 2–24. Location of electrical filter assembly F–1343/GSW–13 (URD 10443).

Electrical filter assembly F–1343/GSW–13 (URD 10443)

As you just learned in the security lesson, this EFA protects the security lines. The assembly (fig. 2–25) contains eight filter modules that are easy to replace. Each filter module consists of a pi-filter with an ESA (spark gap) between the input line and ground. Each filter module weighs approximately eight pounds. Pi-filter refers to the typical way the schematic is drawn to resemble the lower-case Greek letter pi (π). Two of the filter modules protect the inner zone (IZ) security switch loop lines and four protect the AC power lines for raising and lowering the secondary door.

The assembly interfaces with the battery charger-alarm set group, first level junction box (J-box), first level auxiliary J-box, alarm panel J-box, and the two motional pickup transducers. The lines for the transducers are straight through wiring.

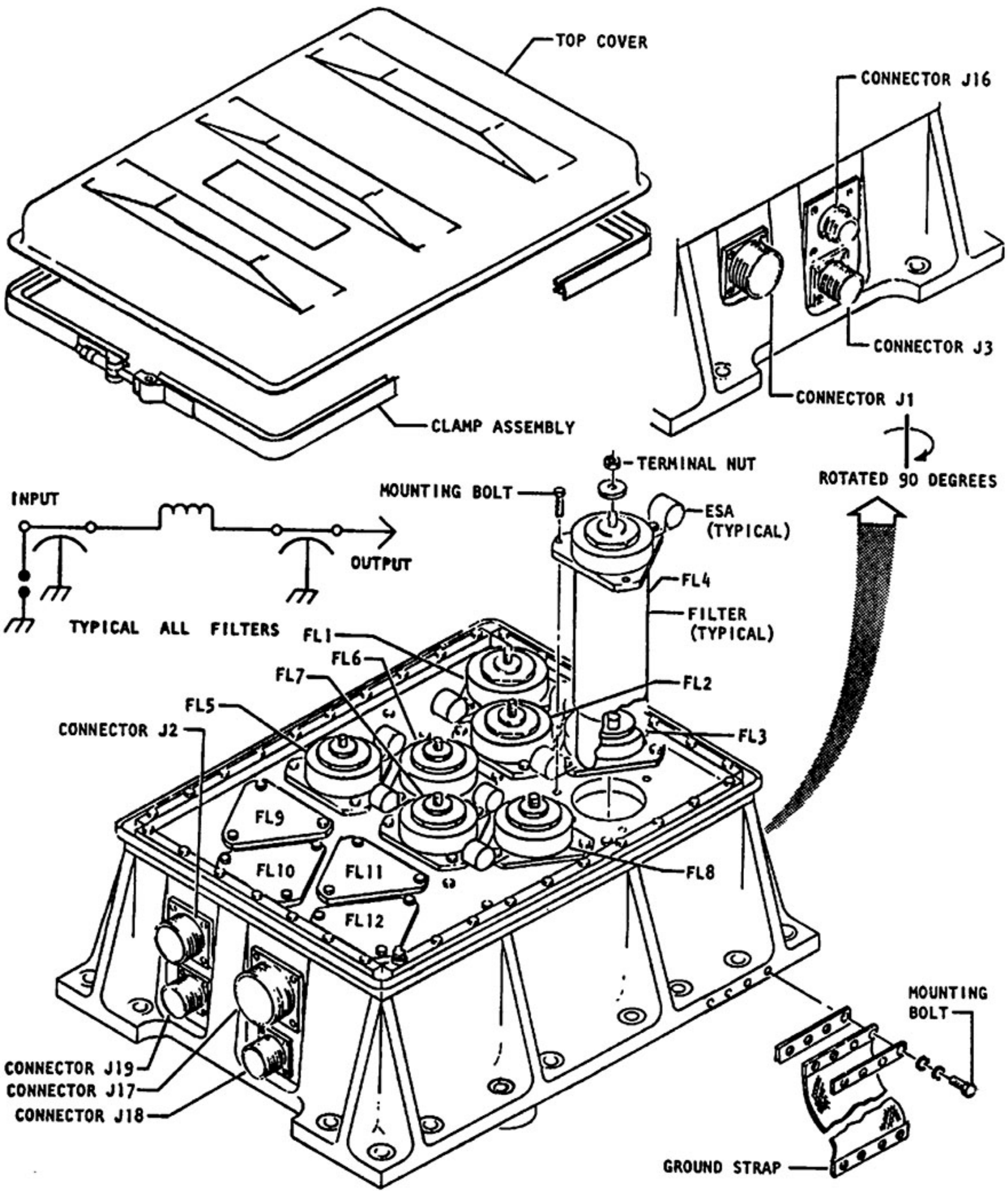


Figure 2–25. Electrical filter assembly F–1343/GSW–13 (URD 10443).

Electrical filter assembly F–1344/GSW–13 (URD 10442)

This EFA (fig. 2–26) provides EMP protection for the primary power lines entering the launcher. As you recall, the commercial power company or the standby diesel generator provides primary power. The filter assembly is connected into the three-phase power lines immediately upon entering the launcher, located in the ESA vault. The assembly consists of three separate filter sections, one for each power phase. The neutral line is grounded in the input sections of the assembly to prevent RFI noise beyond this point. Each of the three filter sections consists of double pi-type filters, with feed-through capacitors on the input and output, and an ESA (spark gap) on the input between line and ground. Each part (capacitors, feed-through capacitors, inductors, and ESAs) is a separate replaceable item; however, if a filter section does not check out properly, all parts in that section are replaced.

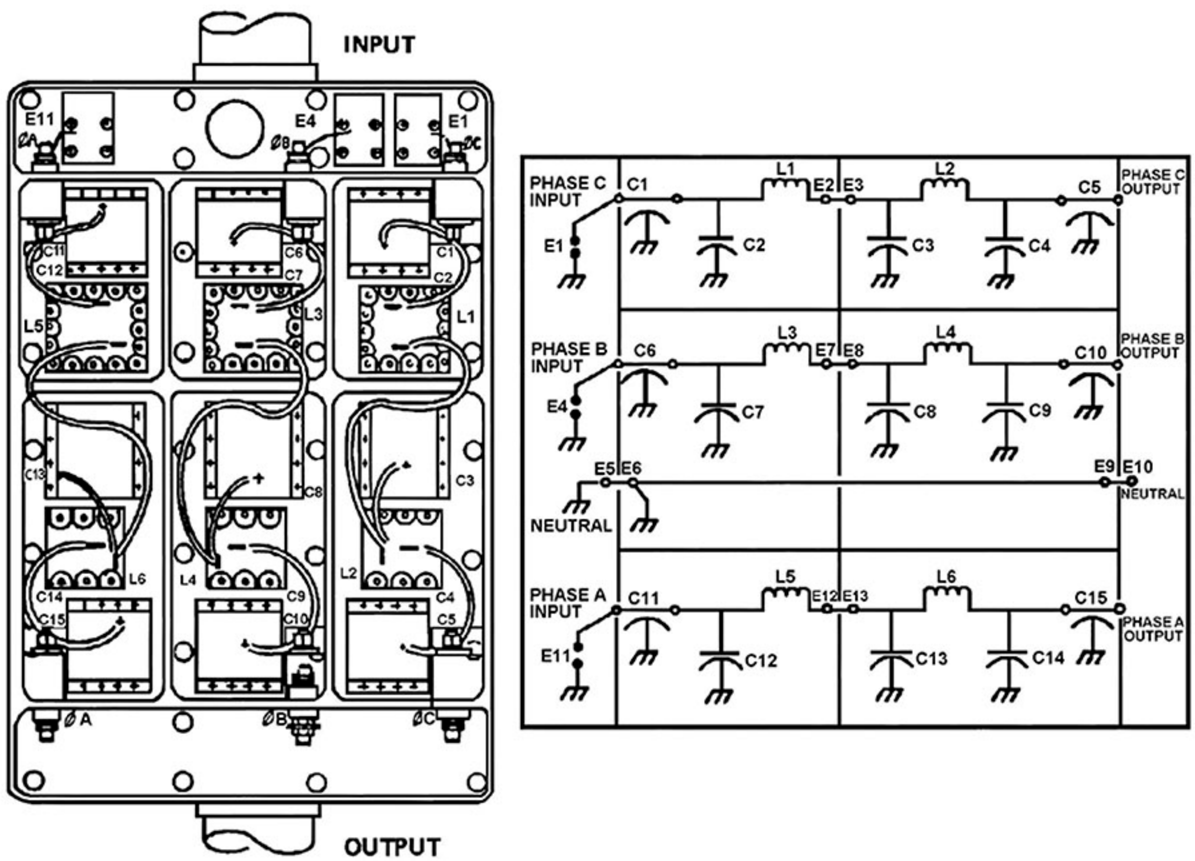


Figure 2–26. Electrical filter assembly F–1344/GSW–13 (URD 10442).

Electrical filter assembly F–1345/GSW–13 (URD 10440)

The EFA assembly (fig. 2–27) protects SIN lines, standby power monitor lines, and the outer zone (OZ) security lines that penetrate the launcher. It is connected between ESA assembly (URD 483) and the I-box, and between URD 483 and the battery charger-alarm set group. It contains 16 pi-filter modules, each weighing about eight pounds. There are two types of filter modules, differing in capacitive and inductive values only. The modules are easily replaced and are keyed so the different types cannot be installed in the wrong place.

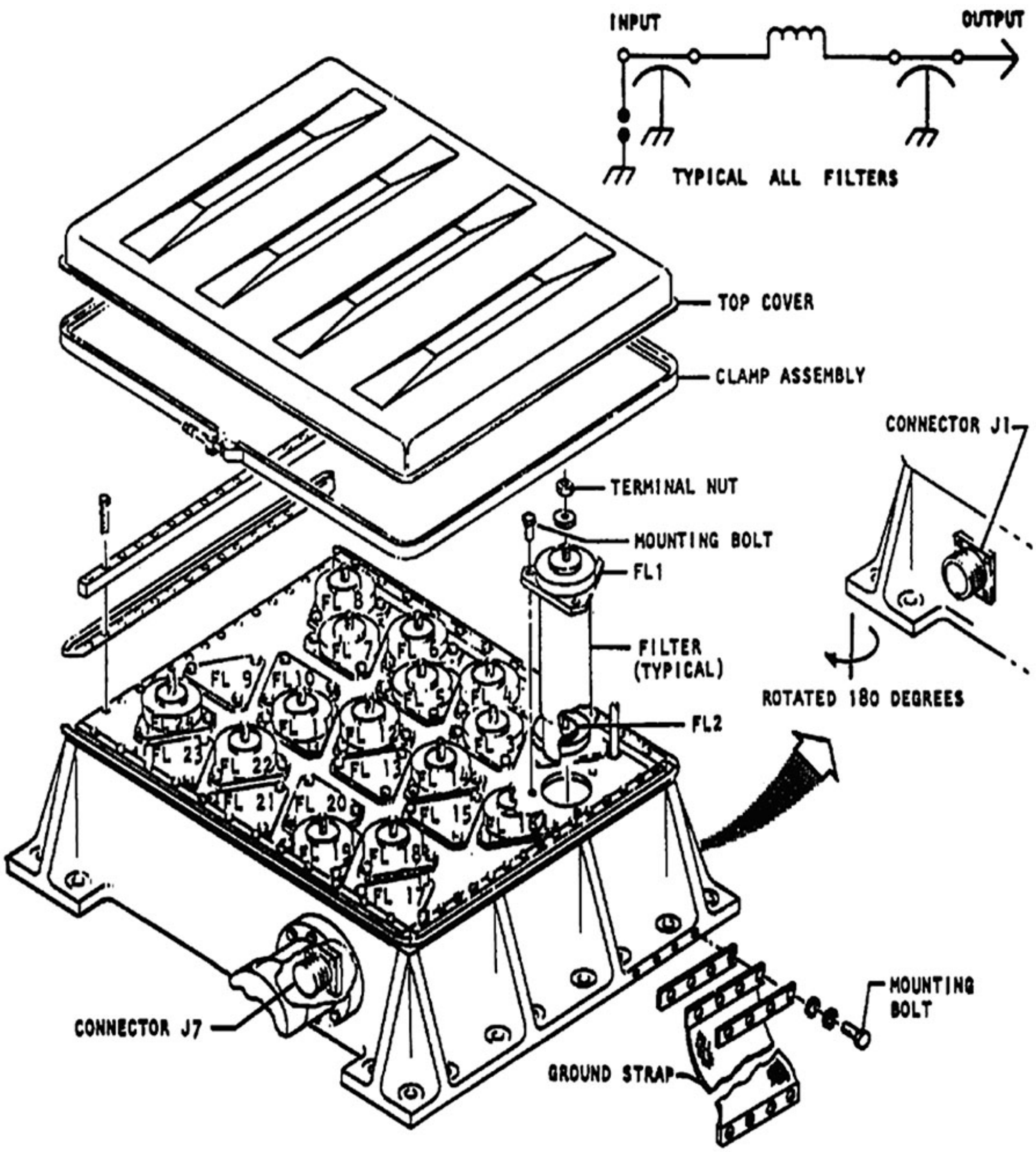
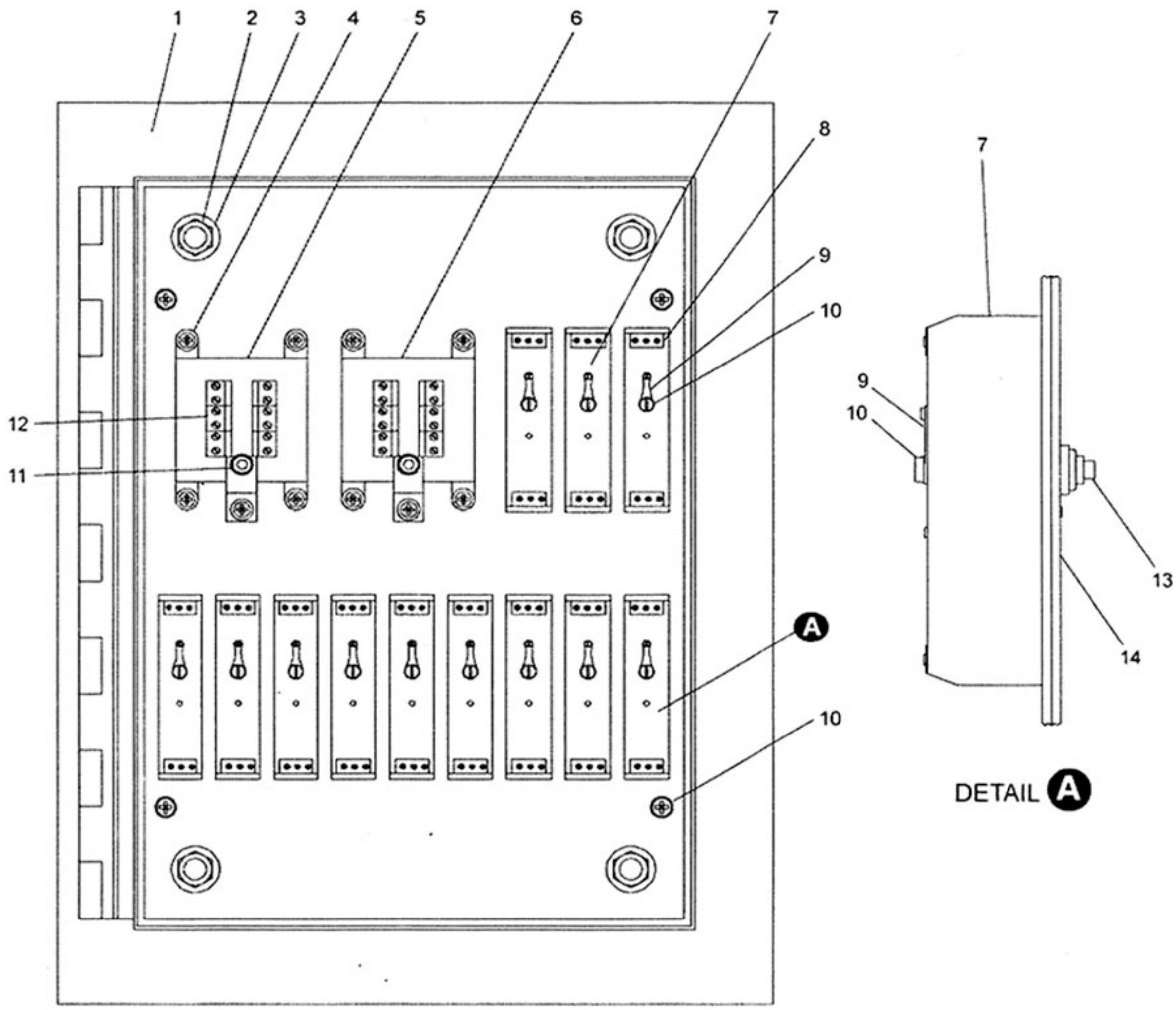


Figure 2–27. Electrical filter assembly F–1345/GSW–13 (URD 10440).

Secondary door electrical surge arrester assembly

The secondary door ESA assembly (fig. 2–28) is mounted in the first LER and has 14 ESA modules that provide EMI filtering for all power and signal lines between the site activation remote controller (SARC), security pit, and the secondary door control assembly (SDCA).



(CABINET SHOWN OPEN, DOOR NOT INSTALLED)

LEGEND:

1. ESA ASSEMBLY (SHOWN OPEN)
2. NUT (4 PLACES)
3. WASHER (4 PLACES)
4. SCREW (5 PLACES EACH, A1, A2)
5. ESA A1 MODULE
6. ESA A2 MODULE
7. ESA A3 THROUGH A14 MODULES (TYPICAL) (12 PLACES)
8. TERMINAL (TYPICAL) (2 PER MODULE)
9. GROUND (TYPICAL) (1 PER MODULE)
10. SCREW (4 PLACES)
11. NUT (2 PLACES)
12. TERMINAL (TYPICAL) (2 PER MODULE)
13. STUD
14. DIN RAIL

Figure 2–28. Secondary door electrical surge arrester assembly.

Self-Test Questions

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

309. Launch control center intrasite cabling system

1. How are LCC cables routed to the equipment racks?

2. How are cables routed between the LCC and the topside support building?

3. What type of cables is used for battery and ground cables?

4. What type of cable is used as signal cables between the LCC equipment and ESA vault?

5. What piece of equipment acts as an interface between the ESAs and electronic equipment?

6. What do the ESA modules protect the wire pairs from when entering the LCC?

7. How do the carbon block spark gaps protect equipment?

310. Launch facility intrasite cabling system

1. How are cables leading to the equipment racks on the shock-mounted floor routed?

2. What feature prevents damage to cables that go from the shock-mounted floor to a rigid structure when movement occurs?

3. How are cables routed from the launcher to the support or equipment building?

4. What device accomplishes signal distribution that is unique to each LF?

5. What device in an I-box suppresses undesirable signals that may have been noticed the HICS?

6. Which electrical filter assembly at an LF protects the IZ security switch loop lines?

7. What do the 14 ESA modules in the secondary door ESA assembly provide?

2–3. Command and Control Description

The C2 system may be complicated and a bit overwhelming at times to understand how it all ties together. However, if you take the time to study what each individual piece of equipment does, the overall system will become easier to understand. This section describes the C2 equipment at the LCC and LF, as well as how the C2 system works.

311. Missile alert facility equipment

In this lesson, we will introduce the LCC C2 equipment. We will look at the WSCC (commonly referred to as the REACT console), the command message processing group (CMPG), and the digital data group (DDG). Let’s begin with the WSCC.

Weapon system control console

The WSCC is a dual-position console that serves as the normal duty station for the missile combat crew (MCC). From this console the MCC can monitor the status of, and control the LFs in their flight (10 LFs). If another LCC in their squadron was to go down, the MCC can assume control over the LFs in the downed LCCs flight. In fact, one LCC can monitor and control any LF in its squadron (5 flights, 50 LFs).

During day-to-day activities, the dual-position console allows one MCC member to operate the console while the other is on crew rest. During launch critical activities, two MCC members will work side-by-side. The console C2 equipment (fig. 2–29) includes the following:

- Launch control panel (LCP).
- Cooperative launch switches (CLS).
- Launch enable panel (LEP).
- Floppy disk drive (FDD).
- Printer.
- Weapon system visual display units (VDU).
- Bulk storage/loader (BS/L).
- AAP.
- Master alarm reset (MAR).
- Keyboards.
- Trackballs.
- Time-of-day clock (TODC).
- Weapon system processor (WSP).
- Coder-decoder assembly (CDA).

LEGEND	
1	Trackball
2	Keyboard
3	LCP
4	MAR
5	CLS
6	WS VDU
7	TODC
8	AAP
9	Printer
10	LEP
11	FDD
12	CDA
13	WSP
14	BS/L

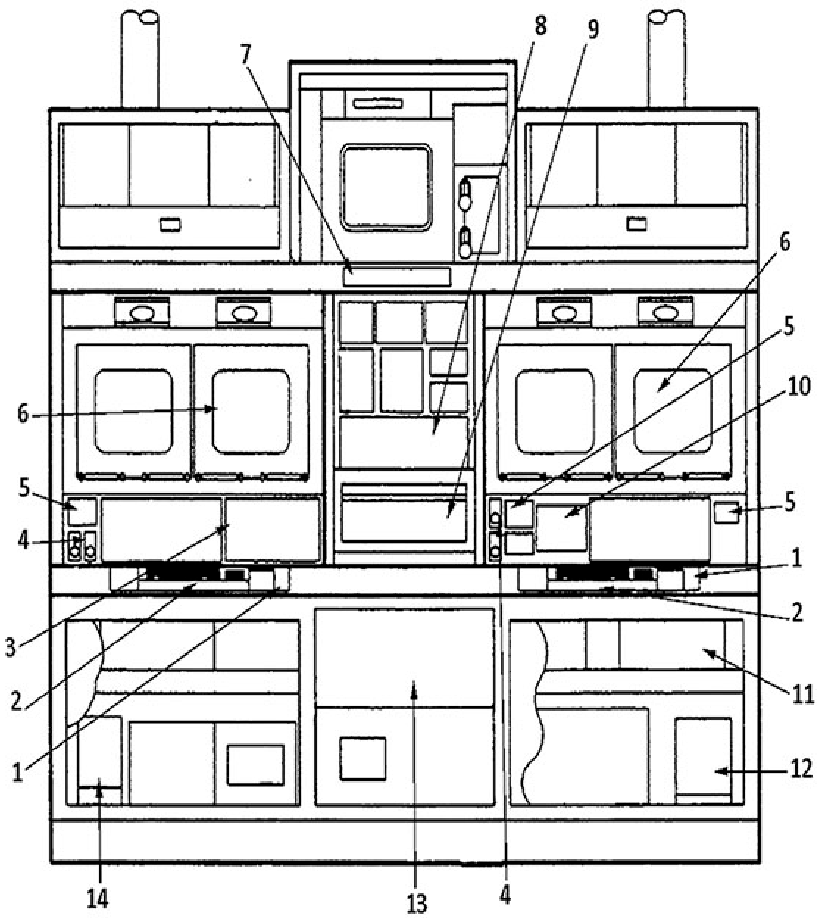


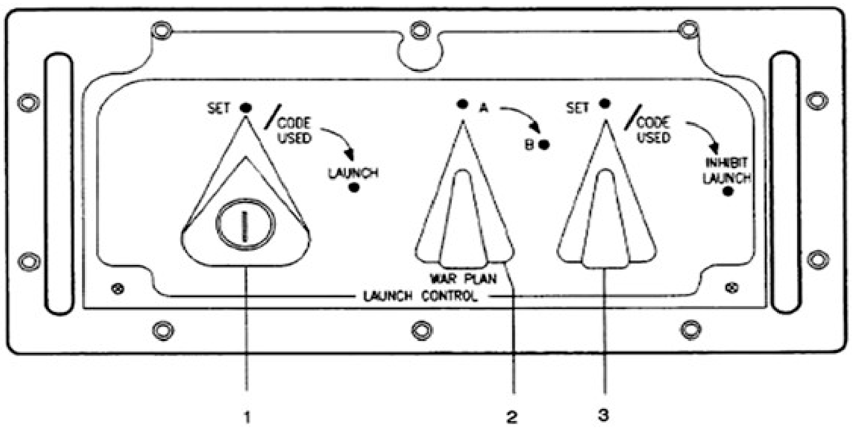
Figure 2–29. Weapon system control console (REACT console).

The higher authority (HA) communications equipment is not part of the C2 equipment; however, it does interact with the C2 equipment. The following is a list of the HA equipment.

- Handsets.
- Headsets.
- HA VDUs.
- Voice control panels (VCP).
- Journal memory loader (JML).
- Rapid message processor (RMP).
- Ultra-high frequency control panel (UCP).
- Rapid message processor backup (RMPB).
- Military strategic tactical relay (MILSTAR) control panel.
- Air Force satellite communication (AFSATCOM) control panel.
- Dual frequency minimum essential emergency communications network (MEECN) receiver (DFMR) miniature receive terminal (MRT) control panel.
- DFMR ground wave effect network (GWEN) control panel.

Launch control panel

The LCP (fig. 2–30) provides the initiating point for execute launch, inhibit, and inhibit test commands. Mechanical code units (MCU) mounted to the LCP provide the secure launch and inhibit codes. If you look at figure 2–29, the left side of the console is where the missile combat crew commander (MCCC) sits. The MCCC has control of one CLS and the LCP switch. The deputy commander sits on the right side and has two CLSs. To send out a successful launch command, all four switches must be turned at almost the same time. The reason for the spacing of the switches is to prevent only one person from being able to send out a launch command.

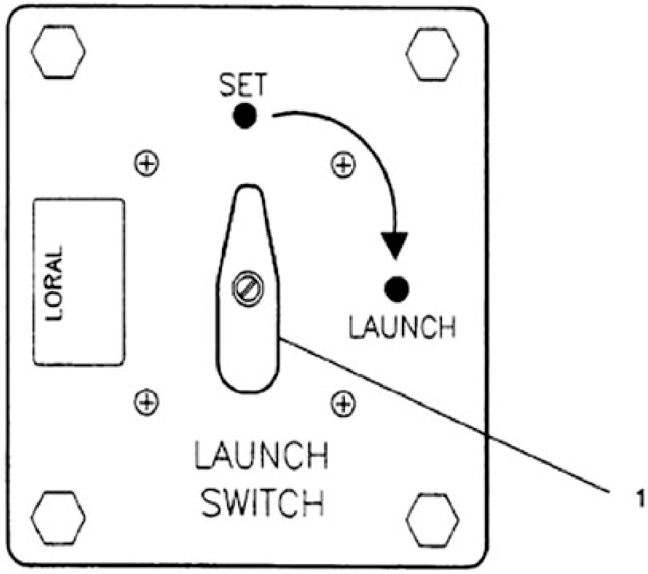


Index No.	Control / Indicator	Function
1	LAUNCH SWITCH	INITIATES EXECUTE LAUNCH COMMAND WHEN OPERATED IN CONJUNCTION WITH COOPERATIVE LAUNCH SWITCHES. ALL SWITCHES MUST BE ACTUATED WITHIN TWO SECONDS OF THE OTHER IN ORDER TO OBTAIN AN EXECUTE LAUNCH COMMAND. THE SWITCH IS SPRING-LOADED AND WILL RETURN TO THE CODE USED POSITION WHEN RELEASED.
2	WAR PLAN SWITCH	INOPERATIVE.
3	INHIBIT LAUNCH SWITCH	USED TO INITIATE INHIBIT COMMAND. CAUSES ENABLED LFs TO ENTER DISENABLE COMMANDED STATE WITH FIVE MINUTE TIMER. CAUSES LFs IN LAUNCH COMMANDED MODE TO ENTER LAUNCH INHIBITED MODE WITH FIVE MINUTE TIMER. LFs WILL RETURN TO DISENABLED STATE WHEN TIMERS RUN OUT IF NO ADDITIONAL EXECUTE LAUNCH COMMANDS ARE RECEIVED. ALSO USED TO TEST INHIBIT CAPABILITY WHEN LFs ARE DISENABLED. THE SWITCH IS SPRING-LOADED AND WILL RETURN TO CODE USED POSITION WHEN RELEASED.

Figure 2–30. Launch control panel.

Cooperative launch switch

Just like you read earlier about the LCP, the three discrete CLSs (fig. 2–31) electrically combined with the launch switch on the LCP provide two-person/four-hand operation during launch operations.



Index No.	Control / Indicator	Function
1	COOPERATIVE LAUNCH SWITCH	USED IN CONJUNCTION WITH THE LAUNCH SWITCH ON THE LAUNCH CONTROL PANEL TO INITIATE EXECUTE LAUNCH COMMAND. ALL SWITCHES MUST BE ACTU-ATED WITHIN TWO SECONDS OF EACH OTHER IN ORDER TO OBTAIN AN EXECUTE LAUNCH COMMAND.

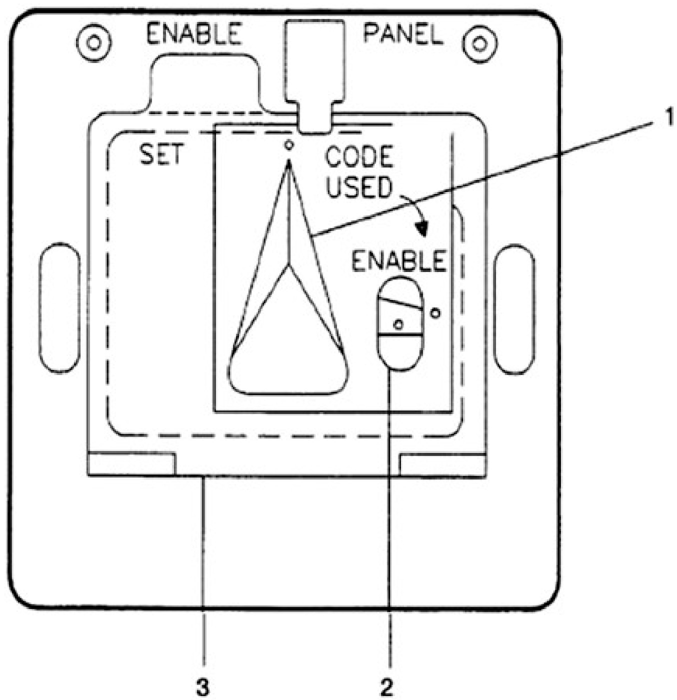
Figure 2–31. Cooperative launch switch.

Launch enable panel

The LEP (fig. 2–32) provides an enable code word that enables command transmission. A MCU secure code is provided by the LEP and is combined with a received unlock code in the WSP and, if applicable, the stored translate code to create the enable command secure code. The secure code is included in an enable command once the missile combat crewmember (MCCM) successfully completes cooperative enable procedures.

Floppy disk drive

The 3.5-inch FDD provides removable read/write storage for non-critical functions. Floppy disks load the technical order database and to reproduce the crew log periodically. Floppy disks reload targeting and other data files and to transfer data files from one LCC to another.

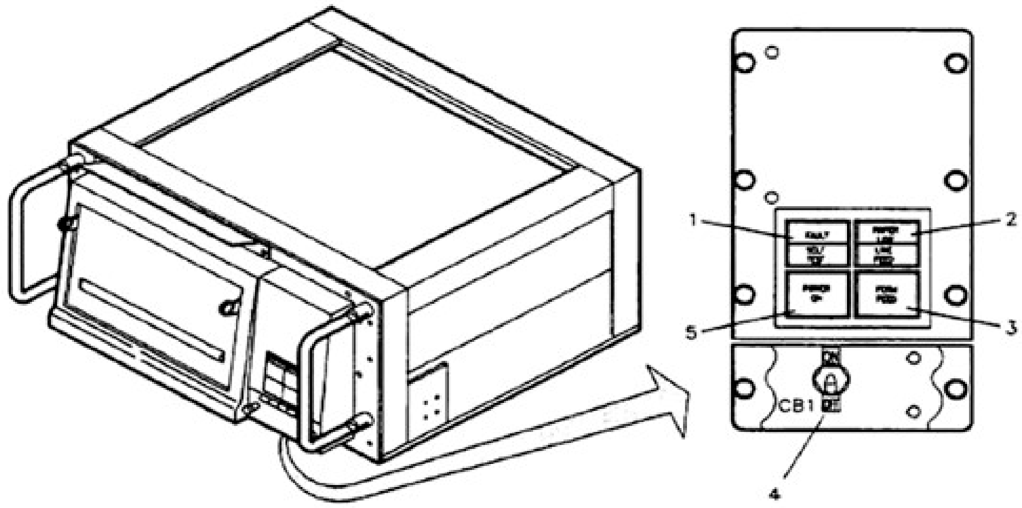


Index No.	Control / Indicator	Function
1	ENABLE SWITCH	WHEN SET TO ENABLE (LATCH HOLD), SECURE CODE IS AVAILABLE FROM MECHANICAL CODE UNIT FOR COMBINING BY THE WSP WITH CONTENTS OF UNLOCK CODE AND, IF APPLICABLE, TRANSLATE CODE. THE COMBINED CODE WORD IS USED FOR ENABLE COMMAND TRANSMISSION UPON SUCCESSFUL COOPERATIVE ENABLING PROCEDURES.
2	ENABLE SWITCH LATCH	HOLDS ENABLE SWITCH IN ENABLE POSITION. WHEN PRESSED, RELEASES ENABLE SWITCH, ALLOWING SWITCH TO RETURN TO CODE USED POSITION.
3	PROTECTIVE COVER	PROTECTS SWITCHES FROM BEING MOVED AND PROVIDES A PLACE FOR TDI SEALS TO BE INSTALLED.

Figure 2–32. Launch enable panel.

Printer

The printer (fig. 2–33) provides a hard copy printout of data from the WSP, the RMP, or the RMPB. The WSP must be operational to conduct printing except when used with the RMPB. The printer is a thermal, dot-matrix printer providing 80 characters per line and 66 lines per page at a 10-characters-per-inch printing capability.

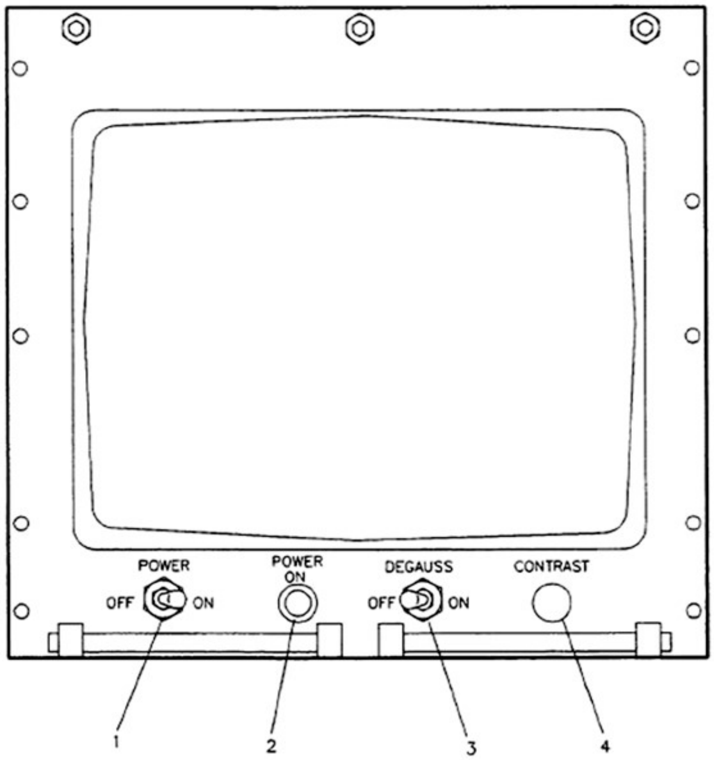


Index No.	Control / Indicator	Function
1	FAULT / SELF-TEST SWITCH / INDICATOR (RED / WHITE)	WHEN PUSHED, ADVANCES PAPER TO TOP OF FORM AND PRINTS OUT A TEST PATTERN. ILLUMINATES WHITE UNTIL SELF-TEST COMPLETED. ILLUMINATES RED WHEN PRINTER DETECTS AN INTERNAL FAULT SUCH AS POWER FAULT, OUT OF PAPER, PRINTHEAD OVER / UNDER TEMPERATURE OR MOTOR ERROR.
2	PAPER LOW / LINE FEED SWITCH / INDICATOR (AMBER / WHITE)	ILLUMINATED AMBER WHEN QUANTITY OF PAPER REACHES 20 SHEETS OR LESS. WHEN PUSHBUTTON MOMENTARILY PRESSED, PAPER ADVANCES ONE CHARACTER LINE AND MOMENTARILY ILLUMINATES WHITE.
3	FORM FEED SWITCH (WHITE)	WHEN MOMENTARILY PRESSED, ADVANCES THE PAPER TO TOP OF THE NEXT FORM. IF SWITCH IS PRESSED AND HELD, PRINTER WILL CONTINUOUSLY FORM-FEED THE PAPER AND SWITCH WILL REMAIN ILLUMINATED.
4	CB1 ON / OFF CIRCUIT BREAKER	CONTROLS INPUT POWER TO PRINTER AND TRIPS IN CASE OF EXCESSIVE CURRENT DRAIN.
5	POWER ON INDICATOR (GREEN)	INDICATES CB1 IS IN THE ON POSITION AND POWER IS APPLIED TO THE PRINTER.

Figure 2–33. Printer.

Visual display units

The VDUs (fig. 2–34) provide the principal display medium for the MCC. The VDUs are hardened high-resolution 15-inch color monitors. The HA VDUs, located at left side of each MCCM station, allow monitoring of RMP status and operations. The weapon system VDUs, located on the right side of each MCCM station, allow monitoring of LF and LCC status, messages received/transmitted, MCCM inputs, and targeting operations. The MCCM may interact with either the HA or weapon system VDU by selecting the corresponding processor/keyboard connection through a toggle switch located on each keyboard.



Index No.	Control / Indicator	Function
1	POWER ON / OFF SWITCH	ALLOWS OPERATOR TO TURN POWER ON AND OFF.
2	POWER ON INDICATOR (GREEN)	INDICATES POWER SWITCH IS IN ON POSITION.
3	DEGAUSS ON / OFF SWITCH	ALLOWS OPERATOR TO MANUALLY RESTORE COLOR PURITY.
4	CONTRAST CONTROL	ADJUSTS DISPLAY FOR THE DESIRED RATIO OF BLACK-TO-WHITE IMAGE.

Figure 2–34. Visual display units.

Bulk storage/loader

The BS/L is used for initial load of the WSP memory and for reloads in the event of main memory upset. It provides a secondary memory function for the weapon system programs and databases. The BS/L is composed of a storage enclosure, power supply, and a removable hard disk cartridge. The BS/L removable hard disk cartridge contains a nonvolatile, readable, and writeable medium.

Auxiliary alarm panel

The AAP provides controls and indicators for facilities related subsystems. The AAP (fig. 2–35) provides control and indicators for the following ancillary elements:

- Fire alarms.
- Power system status alarms.
- Water system controls and alarms.
- Blast door and security door controls and alarms.
- Environmental control system and sump pump status alarms.

The AAP also provides audio and lamp test controls, and alarm acknowledgment controls.

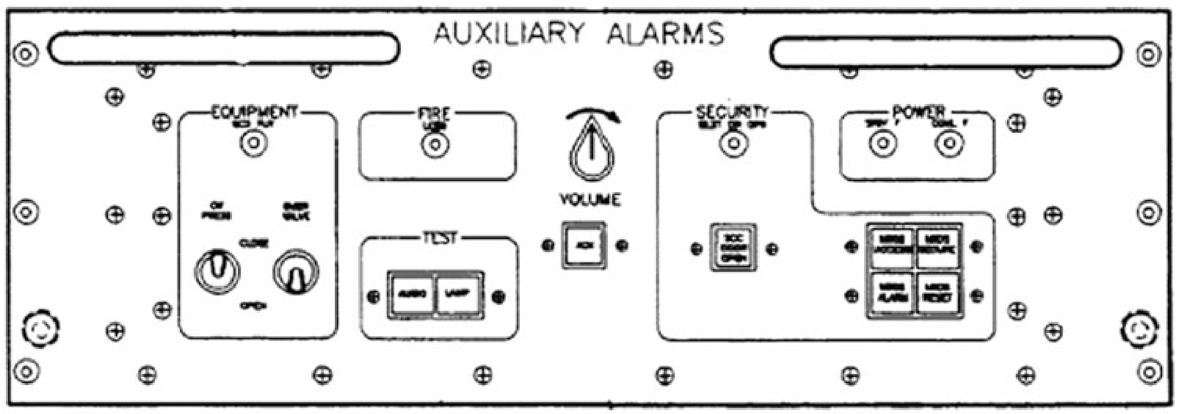


Figure 2–35. Auxiliary alarm panel.

Master alarm reset

The MAR switch provides alarm acknowledgment capabilities for the WS, HA communications, and facility status alarms. When the switch is pressed, audio and visual alarms shown on either VDU and on the audio alarm within the AAP are halted with the following *exceptions*:

- The indicators on the AAP are not reset.
- The audible fire alarm within the LCC is not reset.
- The critical alarm associated with the translate code alert is not reset until that alarm has been active for a minimum of five seconds.

Each operator can reset the audible alarms by using one of the MAR switches at their control stations.

Operator input devices

The operator input device (OID) consists of the keyboard and trackball. The OID provides the primary operator interface with the WSP and RMP computer processors. There is one OID for each operator station.

Keyboard

The keyboard is located at each MCCM position on the console. The keyboard provides operator interface with the WSP or RMP when used in conjunction with the appropriate VDU. The keyboard at each station can be connected to only one processor at a time (WSP or RMP). Connection is accomplished through a toggle switch on the keyboard that allows the MCCM to switch between the WSP and the RMP.

The keyboard is divided into the following three areas:

1. QWERTY keyboard. (QWERTY is not an acronym but refers to standard typewriter/keyboard layout.)
2. Numeric keypad.
3. Dedicated function keys.

The QWERTY keyboard allows for alphanumeric data entry to either the WSP or RMP. These keys are used to generate on-screen characters, command special functions, and initiate external processes.

The keypad also provides controls that duplicate the trackball capabilities whether or not the trackball is operational. Selection of the WSP or the RMP is controlled by a toggle switch.

Dedicated function keys control functions of emergency action message (EAM) release, load restart, memory erase, transmit, and abort. Barriers (raised key guards) surround selected critical keys to reduce the possibility of inadvertent activation.

Trackball

The trackball assembly, consisting of a trackball and three function keys (buttons), moves the pointer cursor, which is displayed on the selected VDU. The trackball is used in conjunction with the keys as a selection device to bring up status on the VDU, to scroll, to select items on menus, to select areas to edit, and to acknowledge alarms. There is one trackball for each MCCM station.

Time-of-day clock

The TODC displays time in military format and is accurate to at least one second within a 24-hour period. The time displayed on the TODC is displayed on the VDU screens also.

Weapon system processor

The WSP is a general-purpose digital computer that controls the flow of data within and through the LCC. Operator-initiated messages are processed by the WSP, sent to the secure data unit for encryption, and returned to the WSP for transmission. Incoming messages received by the WSP are decrypted by the secure data unit (SDU), stored by the WSP, and forwarded to the console VDUs for display. The WSP interrogates its associated LFs in a round-robin sequence; time-shared with other squadron LCCs. The WSP also controls and sequences target and execution plan calculations and remote data change operations.

Coder-decoder assembly

The CDA encrypts and decrypts LCC messages. The encryption and decryption are performed by the SDU within the CDA and are controlled by the WSP.

Command message processing group

The CMPG (fig. 2–36) processes data transmitted, received, or retransmitted by the LCC. The CMPG also performs message processing and storage of weapon system status.

The following items are located in the CMPG rack:

- Power supply.
- Message processing control drawer.
- Communication equipment interface unit (CEIU) (at the squadron command post only).

Communication equipment interface unit

At the squadron command posts only, the CEIU (fig. 2–37) receives and stores missile operational and ground data. The CEIU also establishes a telephone link with the MSB data collector through the base telephone line and transfers stored, inertial measurement unit (IMU) performance data (IPD), which comes from the missile guidance section (MGS), to the MSB data collector.

In the event of extended downtime of a squadron command post, a portable IPD terminal can be installed in a primary launch control center (PLCC). The portable IPD terminal consists of an electrical equipment cabinet, cables, and a CEIU. The portable unit is mounted in the tunnel junction just outside the LCC.

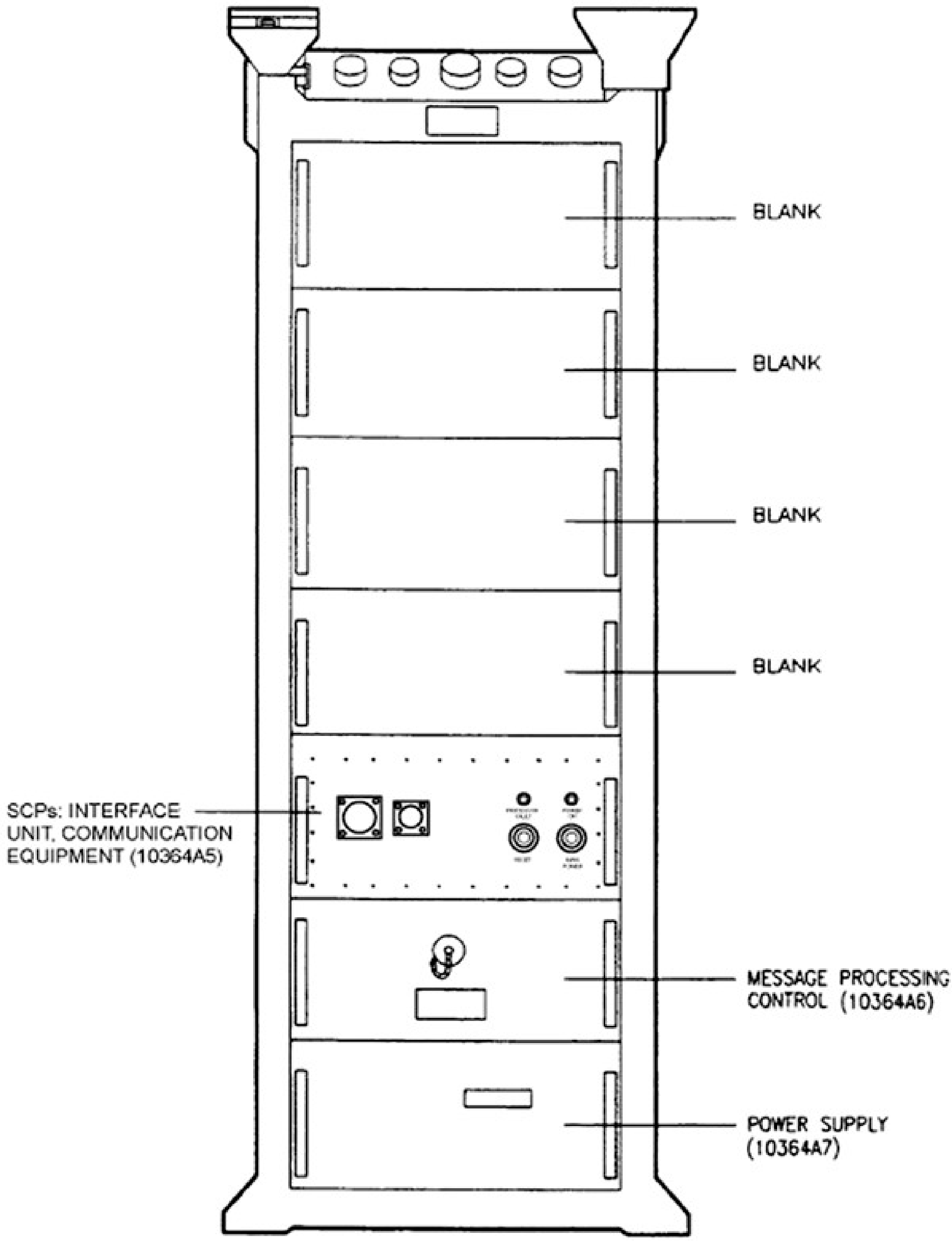


Figure 2–36. Command message processing group.

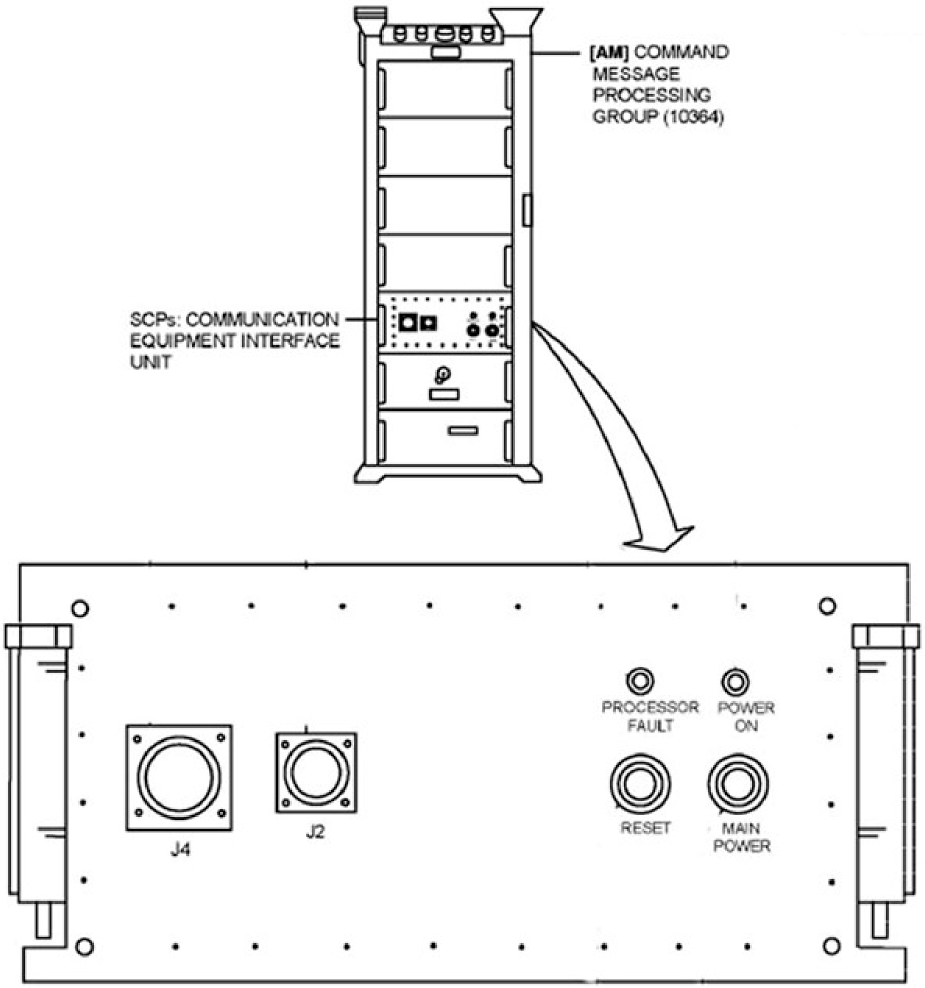


Figure 2–37. Communication equipment interface unit.

Message processing control

The message processing control drawer demodulates incoming digital diphase data from the LF, to digital data for processing by the WSP. The message processing control drawer also receives digital data from the WSP, which it modulates to digital diphase data for transmission to the outgoing lines.

Power supply

The power supply provides operating voltages used within the CMPG. The power supply drawer converts the 400-Hz input power to the regulated DC voltage required by the message processing control drawer.

Digital data group

The DDG (fig. 2–38) serves as the signal conditioning interface among the HICS, the SIN system, and the MAF C2. The following items are located in the DDG rack:

- Digital data transmitter.
- Two digital data receivers.
- Audio frequency amplifier.
- Station alert ringing unit.
- Missile-away indicator drawer.

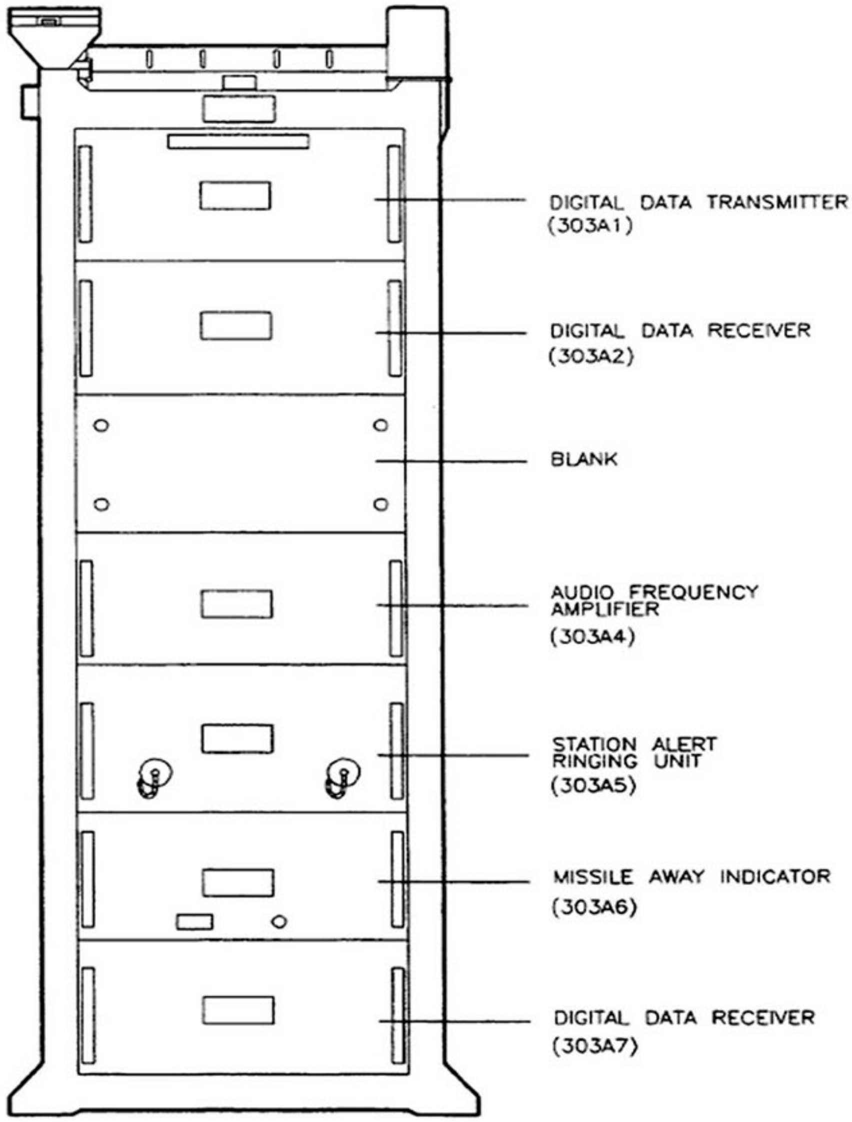


Figure 2–38. Digital data group.

Digital data transmitter

The digital data transmitter provides impedance matching and low-voltage protection on command transmit lines.

Digital data receiver

The digital data receiver provides impedance matching, low-voltage protection equalization, and amplification for command and receive lines.

Audio frequency amplifier

The audio frequency amplifier provides amplification and impedance matching or two-way, four-wire telephone circuits of the hardened voice channel (HVC).

Station alert ringing unit

The station alert ringing unit detects receipt of all-ring and a specific ring signal, and generates ringing signals for the HVC sub-network.

Missile-away indicator

The missile away indicator drawer monitors missile away status for a flight of missiles and provides signal voltage to the WSP for control of the missile away display on the weapon system VDUs. The missile away indicator drawer detects missile away status for each LF with direct SIN cable connections.

Digital data receiver

The digital data receiver provides low-voltage protection, amplification, and isolation for SIN receive lines.

312. Launch facility equipment

In this lesson, the LF C2 equipment will be introduced. We will look at the digital computer unit (DCU), the programmer group (PG), and the UHF radio receiver group. Let's begin with the DCU.

Digital computer unit

The DCU, also called the missile guidance computer, is located in the MGS (fig. 2–39). The DCU processes the commands and provides reports of missile and ground equipment status during ground operations. During flight, the DCU computes flight equations and controls all missile functions.

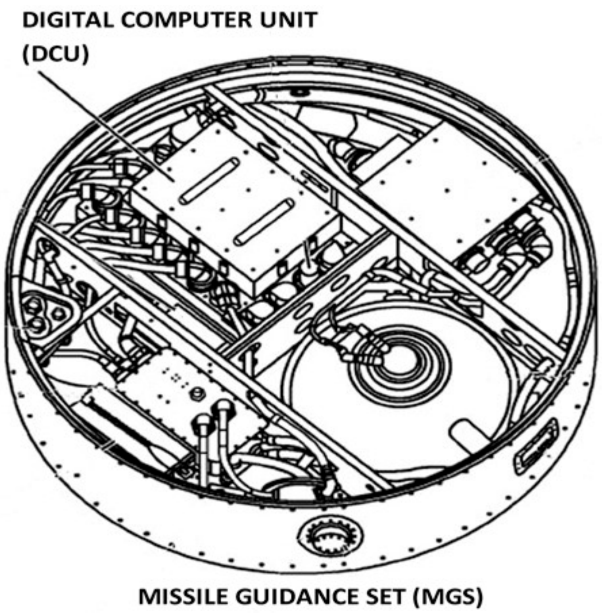


Figure 2–39. Digital computer unit location.

Programmer group

The PG (fig. 2–40) is located on the LER shock-isolated floor and contains the following drawers:

- Command signals decoder-ground (CSD[G]).
- Audio frequency detector.
- Digital data receiver-transmitter (DDRT).
- Message processor.
- Guidance and control (G&C) coupler.
- Control monitor.
- Power supply.

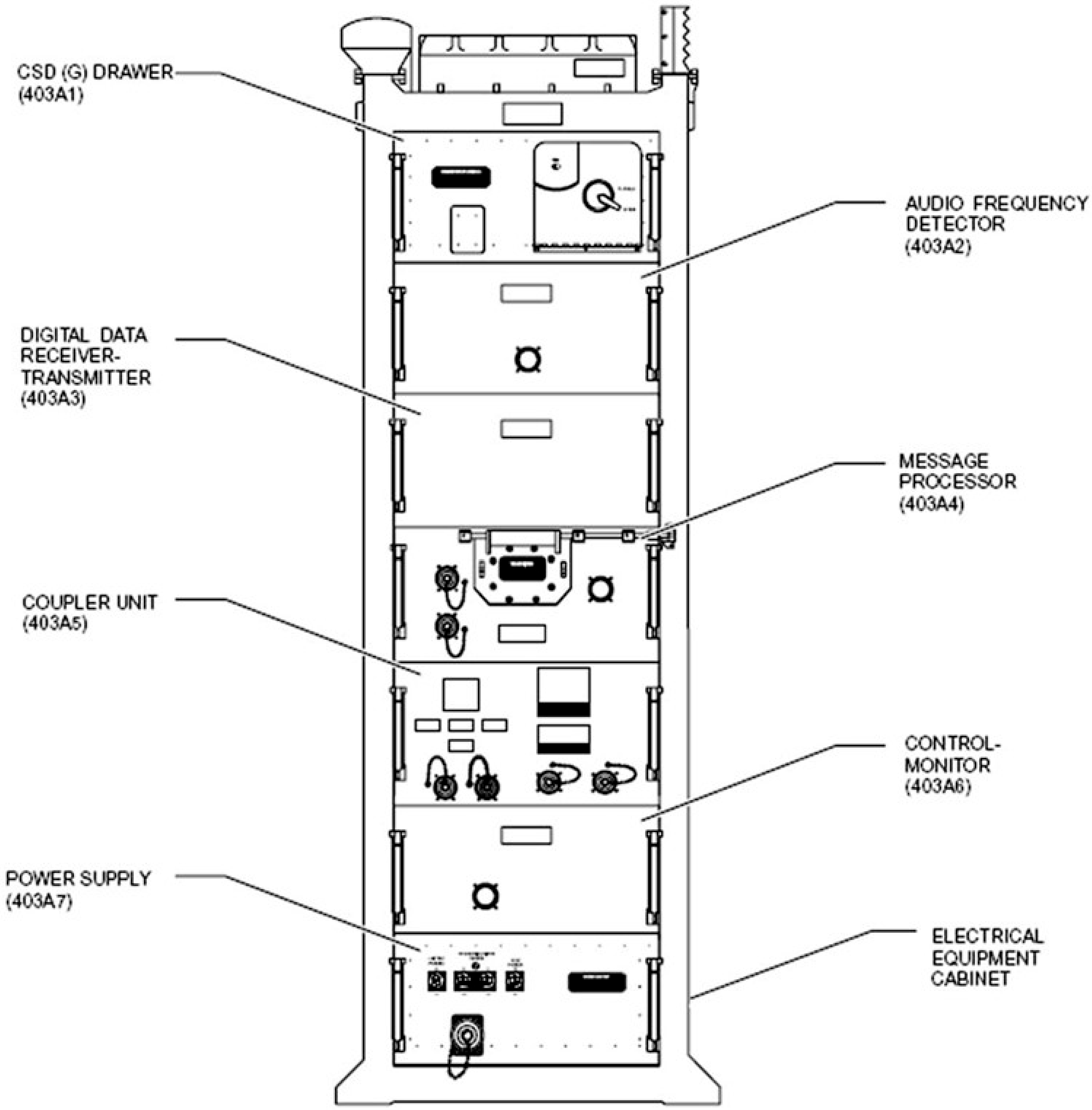
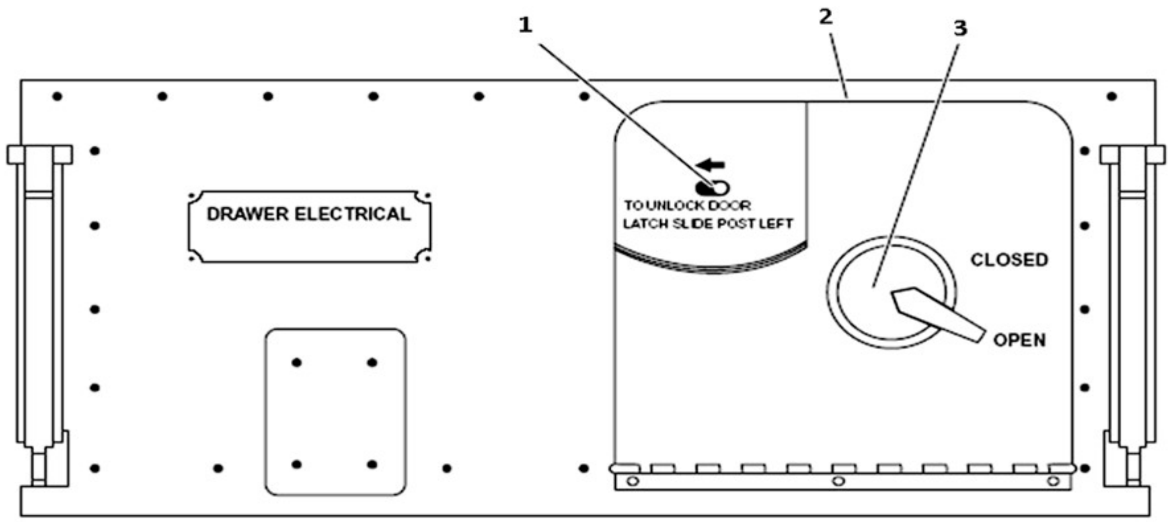


Figure 2–40. Programmer group.

Command signal decoder-ground

The electrical drawer (fig. 2–41) houses a removable electromechanical stepping decoder called the CSD(G), which is inserted into the drawer through an opening in the front. Testing the function of the CSD(G) is accomplished during remote missile tests. In order for the launch sequence to be successful, the CSD(G) must be armed to provide arming power to the launch enable switch (LES). The LES is in the D-box and controls ordnance-firing circuits. The DCU arms the CSD(G) during terminal countdown.



INDEX	NOMENCLATURE	FUNCTION
1	Door latch post	When moved to left, unlocks decoder access door latch.
2	Decoder access door	Provides access to CSD (G).
3	Door unlocking knob	At OPEN, enables opening decoder access door; at CLOSED, retains door in latched position.

Figure 2–41. Command signal decoder-ground.

Audio frequency detector

The audio frequency detector drawer provides equalization and amplification for MAF to LF telephone lines.

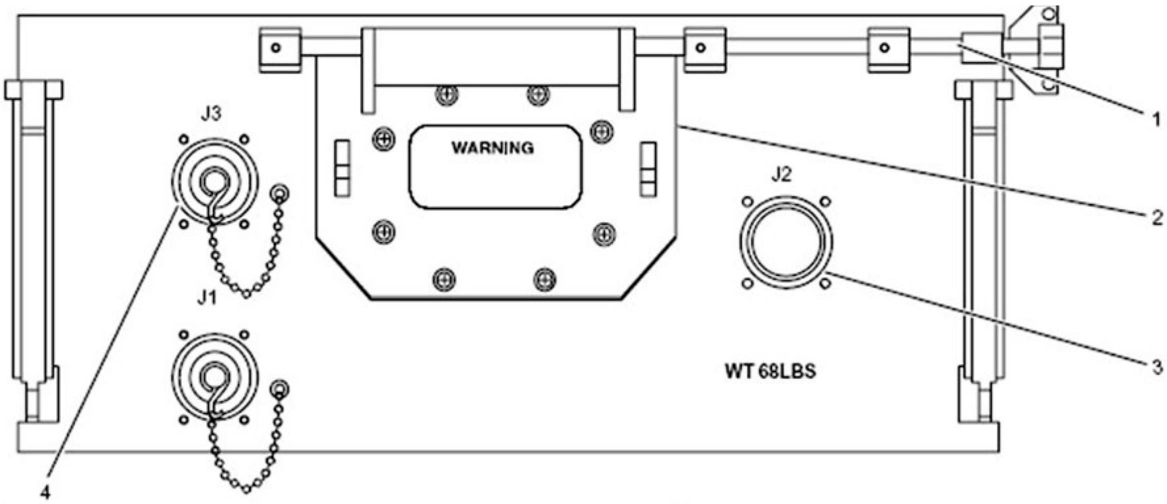
Digital data receiver-transmitter

The DDRT drawer provides DC isolation, low-voltage protection, and signal equalization and amplification on the digital data receive lines. It also provides DC isolation and low-voltage protection on digital data transmit lines.

Message processor

The message processor drawer (fig. 2–42) contains or performs the following:

- Contains digital data line scanning, seize, and lockout circuits.
- Controls message retransmission.
- Demodulates diphase to 1,300-bit-per-second non-return-to-zero (NRZ) data.
- Processes messages in and out of the SDU for encryption/decryption.
- Decodes certain message function codes.
- Performs message parity and validation checks.
- Transfers messages to and from the DCU.
- Contains registers for storing, decoding, and processing message data.



INDEX	NOMENCLATURE	FUNCTION
1	Locking bar	Prevents unauthorized access to sdu keying variable.
2	SDU access door	Provides access to SDU keying variable.
3	J2 receptacle	Receives site tailoring plug.
4	J3 receptacle	Receives fault locating indicator plug.

Figure 2–42. Message processor.

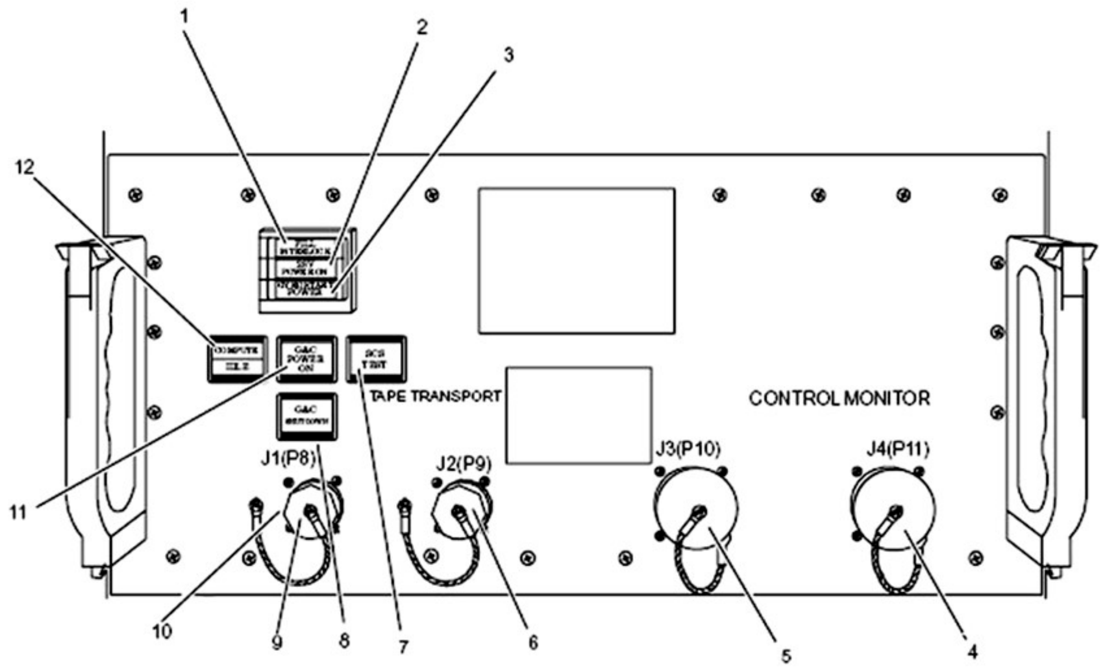
Secure data unit

The SDU fits in a cavity in the message processor drawer and is removable after removing the drawer's top cover. The keying variable contained inside the SDU is coded using a simple key loader (SKL). The front cover of the message process drawer allows access to the SDU fill port. The SKL is connected to this port during code change operations.

Guidance-control coupler

The G&C coupler (fig. 2–43) contains the components listed and described in the following table.

G&C Coupler Components	
Component	**Description**
Decoder	Decodes character outputs from the DCU and controller monitor.
Precision Timer	Provides timing signals to LF electronic ground system equipment and the MGS.
Status Multiplexer	Collects and transmits launcher status data to the MGS or controller monitor.
Activation and Control Unit	Controls startup, DCU program loading, and fuzing data flow between the MGS and the reentry system (RS).
NO-GO and Reset Control	Processes NO-GO status and issues logic reset signals as required.
Manual Switch Control and Display Unit	Converts coupler panel switch inputs to suitable control pulses and controls the coupler panel indicators.



INDEX	NOMENCLATURE	FUNCTION
1	FILL INTERLOCK indicator	Indicates an unsuccessful attempt to penetrate DCU memory has occurred and dcu will not accept data during fill mode.
2	28-V POWER ON indicator	Indicates 28-Vdc power has been applied to coupler unit.
3	GYRO START POWER indicator	Indicates gyro start power (at approximately 41.5 Vdc).
4	CONTROLLER-MONITOR J4 (P-11) receptacle	Interconnects coupler unit to controller-monitor (signal source).
5	CONTROLLER-MONITOR J3 (P-10) receptacle	Interconnects coupler unit to controller-monitor (signal source).
6	TAPE TRANSPORT J2 (P-9) receptacle	Interconnects coupler unit to CTU (signal source).
7	SCS TEST switch-indicator	When pressed, issues and instruction signal to DCU to perform SCS test during next SCNT. Indicator comes on when switch is pressed.
8	G&C SHUT DOWN switch	When pressed, initiates power removal from MGS. Switch does not have an indicator lamp.
9	Shorting plug	When installed, shorts receptacle J1 (P-8) pin connections.
10	TAPE TRANSPORT J1 (P-8) receptacle	Interconnects coupler unit to CTU (signal source).
11	G&C POWER ON switch indicator	When pressed, initiates application of power to mgs. Indicator comes on when switch is pressed.
12	COMPUTE/IDLE switch indicator	When pressed, commands coupler unit to enter compute mode or idle mode (alternate action); illumination of split indicator displays commanded mode.

Figure 2–43. Guidance-control coupler.

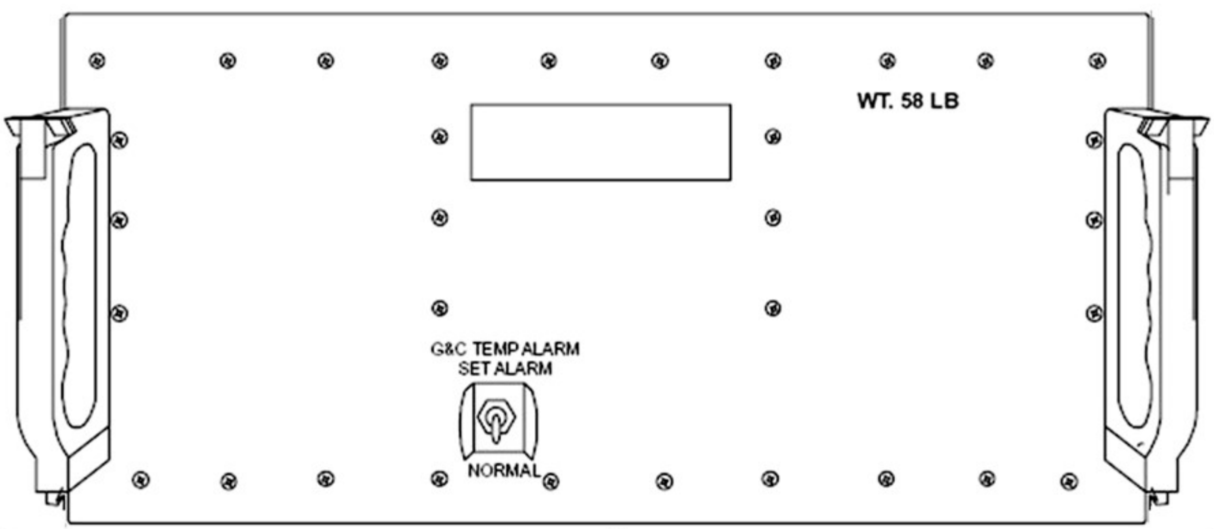
Controller monitor

The controller monitor, not to be confused with the control monitor drawer, is a piece of equipment you sign out from the equipment section and connect to the G&C coupler drawer. You will read more about how the controller monitor is used during a tape load in the next unit. However, the controller monitor has some additional uses in the command and control operation. At the LF, you may place the system into local control using the control monitor to perform a variety of functions. One of these functions would be reading data stored in the DCU, such as a missile operational status reply (MOSR).

Control monitor drawer

The control monitor (fig. 2–44) drawer contains the components listed and described in the following table.

Control Monitor Drawer Components	
Component	**Description**
Decoder	Decodes character inputs from the MGS and DCU (via the coupler).
Safety Device Control Unit	Controls LF ordnance arming and safing.
Ordnance Control Unit	Controls ordnance firing and first stage ignition.
NO-GO Monitor Unit	Monitors, collects, and retransmits NO-GO status and initiates NO-GO shutdown.
Alarm Monitor Unit	Monitors, collects, and retransmits alarm status.

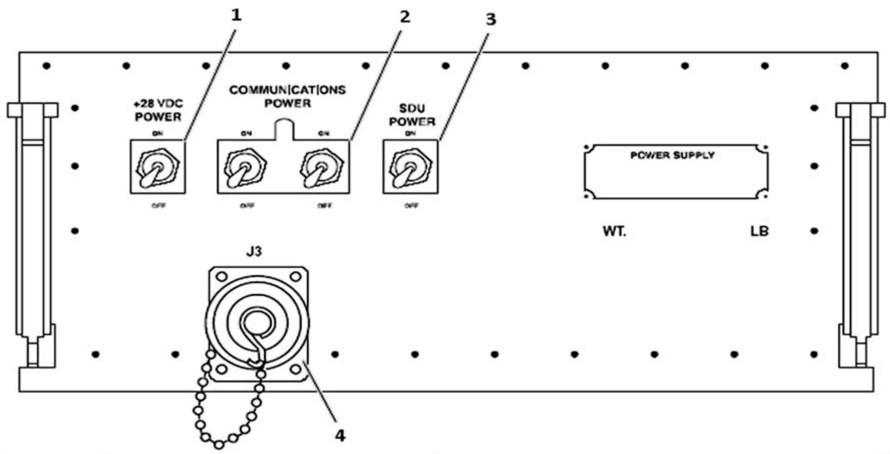


NOMENCLATURE	FUNCTION
G&C TEMP ALARM - SET ALARM/NORMAL switch	At SET ALARM, inhibits G&C temperature no-go to permit maintenance on G&C liquid cooler without causing shutdown; also used during site startup. At NORMAL, permits normal reporting of, and site reaction to, G&C temperature deviations sensed by G&C liquid cooler.

Figure 2–44. Control monitor.

Power supply

The power supply (fig. 2–45) drawer converts 400-Hz, three-phase power to various regulated DC voltages needed in the rack. It also filters incoming +28 VDC before distribution in the rack.



INDEX	NOMENCLATURE	FUNCTION
1	+28-VDC POWER-ON/OFF switch	Controls +28-volt power (from 12-amp power supply) to A5 and A6 drawers.
2	COMMUNICATIONS POWER-ON/OFF switch	Controls internally produced voltages and +28 volts to A2, A3, and A4 drawers.
3	SDU POWER-ON/OFF switch	Controls +6 volts to SDU.
4	J3 test receptacle	Used when measuring voltage output of programmer group power supply.

Figure 2–45. Power supply.

UHF radio receiver group

The UHF radio receiver group (fig. 2–46) is located on the LER shock-isolated floor. Our primary focus will be the receiver drawer, commonly referred to as the UHF receiver drawer (fig. 2–47).

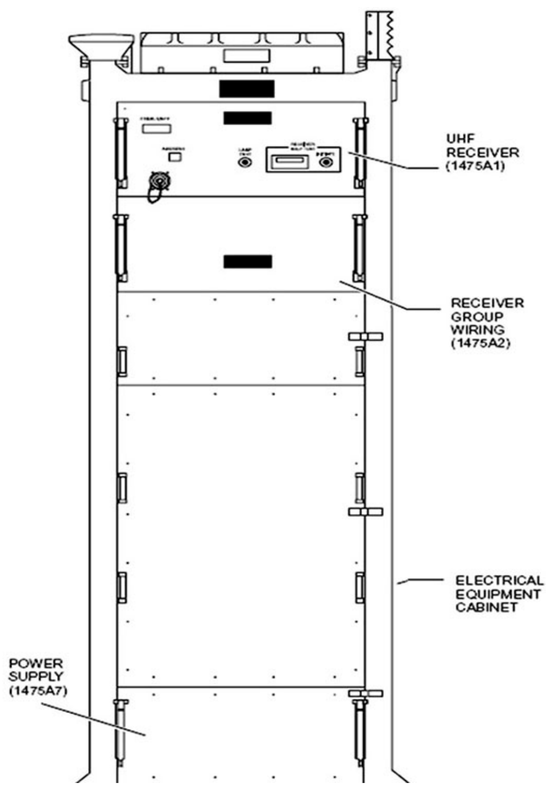
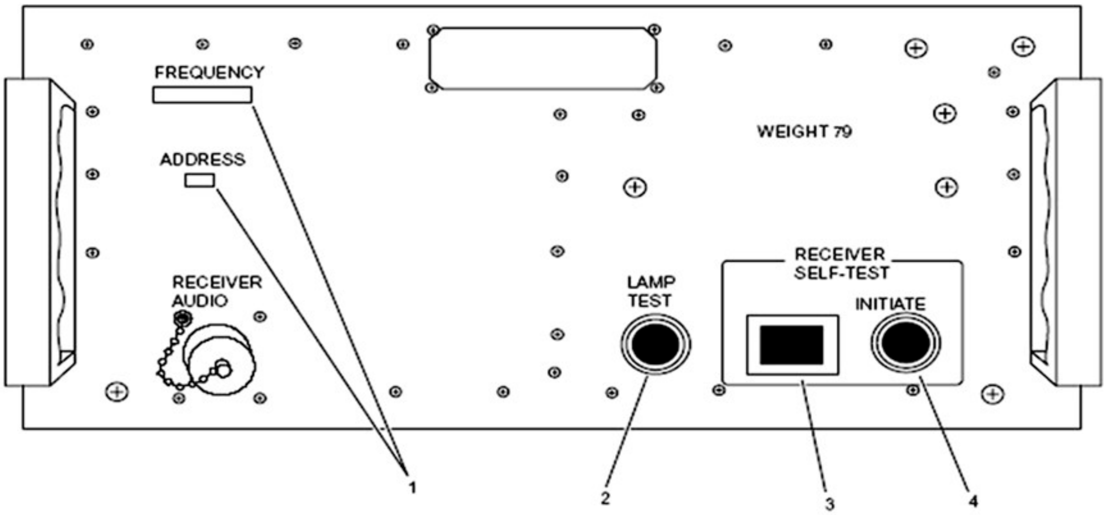


Figure 2–46. UHF radio receiver group.



INDEX	NOMENCLATURE	FUNCTION
1	FREQUENCY and address placards	Provides UHF receiver frequency and squadron address identity. this information is used to identify that a drawer is an equivalent replacement for drawer removed.
2	LAMP TEST pushbutton	When pressed, initiates test of receiver self-test - data present indicator lamp.
3	RECEIVER SELF-TEST - DATA PRESENT indicator	Indicates uhf receiver self - test successfully completed or data are present from incoming UHF signal.
4	RECEIVER SELF-TEST - INITIATE PUSH-BUTTON	When pressed, initiates receiver self-test.

Figure 2–47. UHF radio receiver drawer.

The purpose of the UHF drawer is to receive UHF secure code commands when the intersite cabling system is damaged or when the LCC no longer has the capability to transmit commands to the LF. In these situations, the airborne launch control center (ALCC) will issue commands that are received by the UHF antenna, located topside at the LF. The message data feeds into the UHF receiver, where it is amplified, and the information is extracted. The intended data for that LF is sent to the PG message processor.

The UHF receiver drawer also contains a test address decoder and test signal generator, which enables a sensitive command network test (SCNT) command to perform a self-test of the drawer during the SCNT. Another function of the drawer is EMP detection. When the drawer circuitry detects an EMP, via the UHF antenna, a signal is sent to the DCU to enter circumvention reset. This command holds the DCU logic in its current state to prevent malfunctions caused by EMP.

313. Command and control system description

After learning about the C2 equipment at the LCC and LF, it is time to see how all this C2 equipment comes together.

Overview

The C2 system is a squadron-wide, hardened, status monitor system. The system provides the capability for any LCC to control all LFs in the squadron. Data processing equipment at the LCCs and LFs perform the various C2 system functions, which include secure communications, squadron-wide status monitoring, missile launch, systems operational tests, and remote targeting.

Communications

The generation of messages accomplishes squadron-wide communications by the data processing equipment and the transmission of those messages over the HICS. The LCC or LF, upon receiving a message, in turn, retransmits the message to the other facilities. Due to the retransmissions and the interconnectivity of the HICS, messages spread throughout the squadron. Because of this message propagation capability, transmissions are time shared among the facilities to avoid transmission interference. To provide secure communications, cryptographic equipment encrypts messages before transmission. The cryptographic equipment also decrypts received messages, should the message require local processing. The system provides for clear-text bypass to facilities that are unable to encrypt or decrypt messages.

Squadron-wide status monitoring

The squadron–wide status monitoring involves 5 LCCs and 50 LFs. We will begin with LCC monitoring.

LCC monitoring

Status monitoring of the LCCs is accomplished by having each LCC monitor the transmissions of the other LCCs in the squadron. If a monitoring LCC detects that another LCC in its squadron is failing to transmit proper operational status interrogations (OSI) for 240 seconds, the monitoring LCC will register the other LCC as being down. Upon detection of a down LCC, the secondary LCC automatically takes responsibility of the downed LCC's LFs. The LCC is notified of this change by active alarms, and display notifications that the respective LCC is down. In addition, each LCC performs a self-test on its own system equipment at frequent intervals as part of its normal operation. Any malfunctions detected are displayed by means of audible alarms and/or updated displays.

Launch facility monitoring

Squadron-wide status monitoring of the LFs is accomplished as follows:

1. An LCC automatically transmits an OSI message to one LF as part of its normal routine.
2. The OSI causes the LF to transmit an operational status response (OSR), which reports its status as gathered by the LF monitoring equipment.
3. The OSI and OSR cycle is repeated for each LF, ensuring all LFs in the squadron are continually interrogated.

Normally, each LCC interrogates one of the five flights; however, each LCC is capable of interrogating the entire squadron. Each LCC receives, stores, and compiles OSRs from all LFs. The status of these LFs is displayed on the weapon system VDUs as either the FLIGHT STATUS display or SQUADRON STATUS display.

- The FLIGHT STATUS display provides the status of five categories for the currently displayed flight.
- The SQUADRON STATUS displays the *highest* priority status of all LFs in the squadron.

Alarms and updated displays are provided whenever a change in LF operational status occurs.

Missile launch

The LCC initiates and controls missile launch functions by transmitting appropriate command messages. Command messages allow for the selection of a squadron-wide launch execution plan or an individual missile launch execution plan. The plan includes launch times. The command messages also allow for missile enabling and execute launch. For a missile to launch, it must receive a valid enable command followed by two launch commands from two different LCCs. Command messages are initiated through the LAUNCH menu option and panels located on the console.

System tests

The C2 system provides programmed system tests to check both the LCC and LF for operational capabilities that are not checked during normal operation. These system tests check the missile for operational readiness, LF ground equipment for launch readiness, LF monitoring equipment and LCC system equipment for operability. The tests are initiated through the LF TEST and LCC TEST menu options. Upon initiation, the tests are executed, and test results are provided to the LCC for subsequent display in a command summary report (CSR).

Remote data change

Remote data change (RDC) provides for the secure transmission of specific data from the LCC to the LF over the HICS. Information that can be transferred by RDC consists of targeting data for remote targeting operations.

Command and control system operation

The C2 system provides the capability for any LCC in the squadron to generate and transmit digital messages to the 50 LFs in the squadron. The types of messages are interrogations, commands, test messages, and remote targeting messages. Interrogations from LCC to LF make the LF transmit status responses. The LCC computer sends OSIs automatically and the LFs respond automatically. The other message types are generally operator controlled and make the LF equipment or missile change status, or run a test and report results. All LFs and LCCs in the squadron receive messages; but only the LFs addressed for action are acted upon. There are two addressing choices—any single LF (individual) or the entire squadron (all-call). For missile operational status interrogation (MOSI), all-call is not available. However, a second choice is, in which as many as 10 LFs can be addressed (optional). Current operational status for the entire squadron is computer-stored at each LCC. As mentioned earlier, operational status is displayed on the weapon system VDUs. Now we will look at several facets of message processing, including time-slots, message transmission, and encryption.

Time-slot concept

Messages in a squadron normally originate from each of five LCCs and 50 LFs and propagate throughout the squadron. The use of time-sharing of the cable network is to prevent these messages from interfering with one another. Each of the five LCCs is assigned a time-slot (fig. 2–48) in which to transmit their interrogations. The time slots are synchronized by the LCC occupying time-slot No. 1, which is the master transmitter. The master transmitter inserts a slot sync code in the first message transmitted in time slot No 1. The other LCCs detect the slot sync to determine their time phasing with their time slots. Time slotting of LCC transmissions also controls LF transmissions, since each LF transmits only because of LCC interrogation. A timeframe consists of five sequential time-slots during which each LCC in the squadron has an opportunity to transmit.

The assignment of time-slots to LCCs is coordinated among the LCC operators, who can manually select any one or any combination of five time-slots in which to operate. Normally, each LCC is assigned one time slot in a one-for-one fashion. If fewer than five LCCs are operable, the remaining LCCs coordinate and one assumes transmission in the otherwise empty time-slot.

In normal operation, each LCC automatically generates and transmits an OSI to each of its LFs. The LCC sequentially interrogates the LFs in its own flight and receives an OSR from each LF. During one time-slot, the LCC interrogates and receives replies from two LFs in its own flight. An interrogation sequence of all LFs in the squadron (a “round robin”) requires five timeframes.

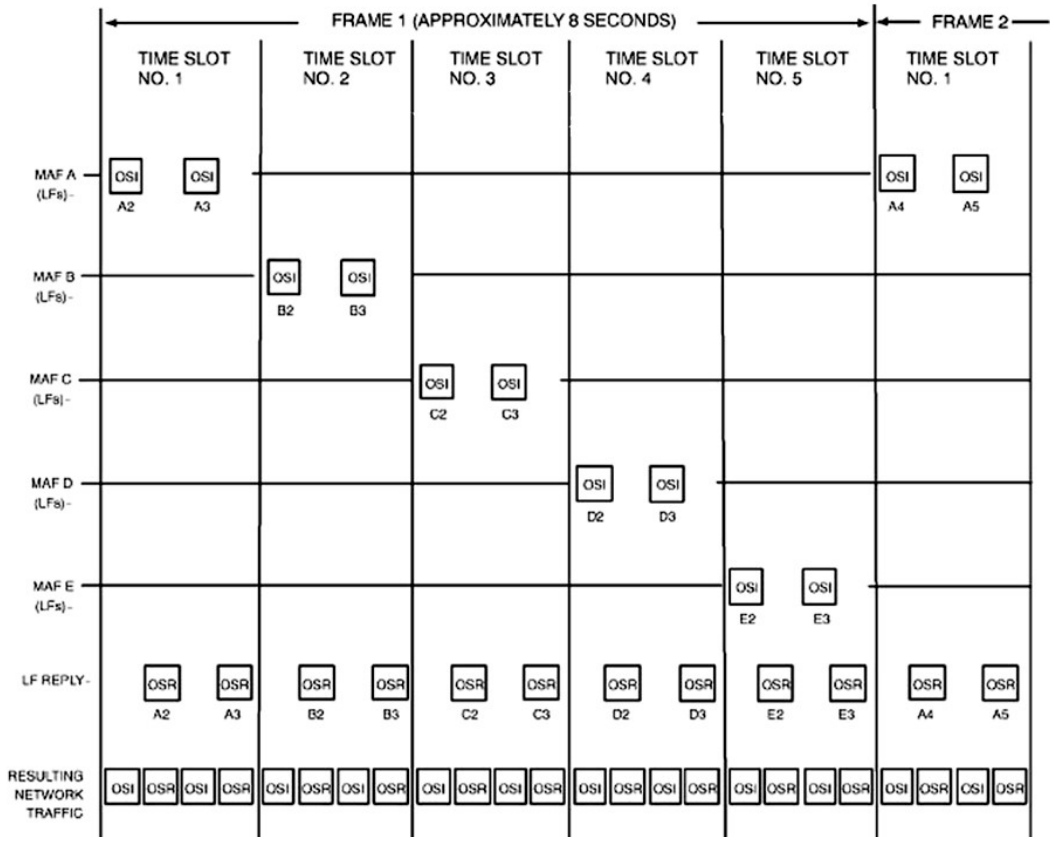


Figure 2–48. Time-sharing schedule.

Messages

We gather information in the Minuteman weapon system through messages. The types of messages are interrogations, responses, commands, and tests.

Interrogations

The function of an interrogation message is to seek specific information about a weapon system condition. Interrogations are initiated either automatically or manually. The C2 system uses the following interrogations:

- OSI.
- MOSI.
- Target verification interrogation (TVI).
- Resync inquiry (RSI).
- Ground maintenance interrogation (GMI).

Responses

The function of a response is to furnish specific information about a weapon system condition. The initiated response is a result of an interrogation or a command. The C2 system uses the following responses:

- OSR.
- MOSR.
- Target data response (TDR).

- Target verification response (TVR).
- Resync response (RSR).
- IPD response (IPDR).
- Ground maintenance response (GMR).

Command messages

The function of command messages is to initiate specific LF operational modes or states. Most of the following command messages are associated with missile launch operations.

- Preparatory launch command-A (PLC-A).
- Preparatory launch command-B (PLC-B).
- Enable command (ENC).
- Execute launch command (ELC).
- Inhibit launch command (ILC).
- ALCC hold off command (AHC).
- Pendulous integrating gyroscope accelerometer (PIGA) leveling command.
- PIGA leveling reset command.
- Remote LF overwrite command (OWC).
- Remote LF overwrite terminate command (OWT).
- IPD command (IPDC).
- IPD halt (IPDH).
- Short ALCC hold off command (SAHC).

Test messages

The function of test messages is to periodically exercise and check portions of the weapon system not ordinarily exercised during normal operations. Normally, these tests are commanded from the LCC. However, missile test, IMU calibration (IMU CAL) 1 and 2, perturbation self-alignment technique calibration (PSAT CAL), and Phi calibration (PHI CAL) may also be commanded from the LF using the controller-monitor. The C2 system uses the tests messages listed in the following table:

C2 Test Messages	
LF Test Messages	**MAF Test Messages**
SCNT.	LCC subsystems test.
Missile test.	HA subsystems test.
IMU CAL.	BS/L test.
PSAT CAL.	FDD test.
Enable test (ENT).	CDA/IPD test.
Inhibit test (INT).	
Computer memory verification check (CMVC).	
PHI CAL.	

All test messages at the MAF are initiated manually. The LF test messages are transmitted to the entire squadron while MAF test messages are not transmitted out of the MAF. Successful completion of each test results in activation of the weapon system status displays and/or printouts.

Remote data change messages

The function of remote data change messages is to transfer change data from the MAF to an LF. The following remote data change messages are used:

- Remote data change target (RDCT) command.
- Remote data response (RDR).
- Remote data word (RDW).
- Remote data interrogation (RDI).
- Remote data terminate (RDT) command.
- Remote data halt (RDH) command.
- Remote data authorized (RDA) command.
- Remote data change program (RDCP) command.

Message processing

Figure 2–49 is a signal flow block diagram of the C2 system for one LCC and one LF. Operator initiation at the OIDs (keyboard and trackball) generates command messages from the LCC after the appropriate menu selection or actuation of one of the LCP switches. When the operator does not initiate a command, the WSP generates an OSI.

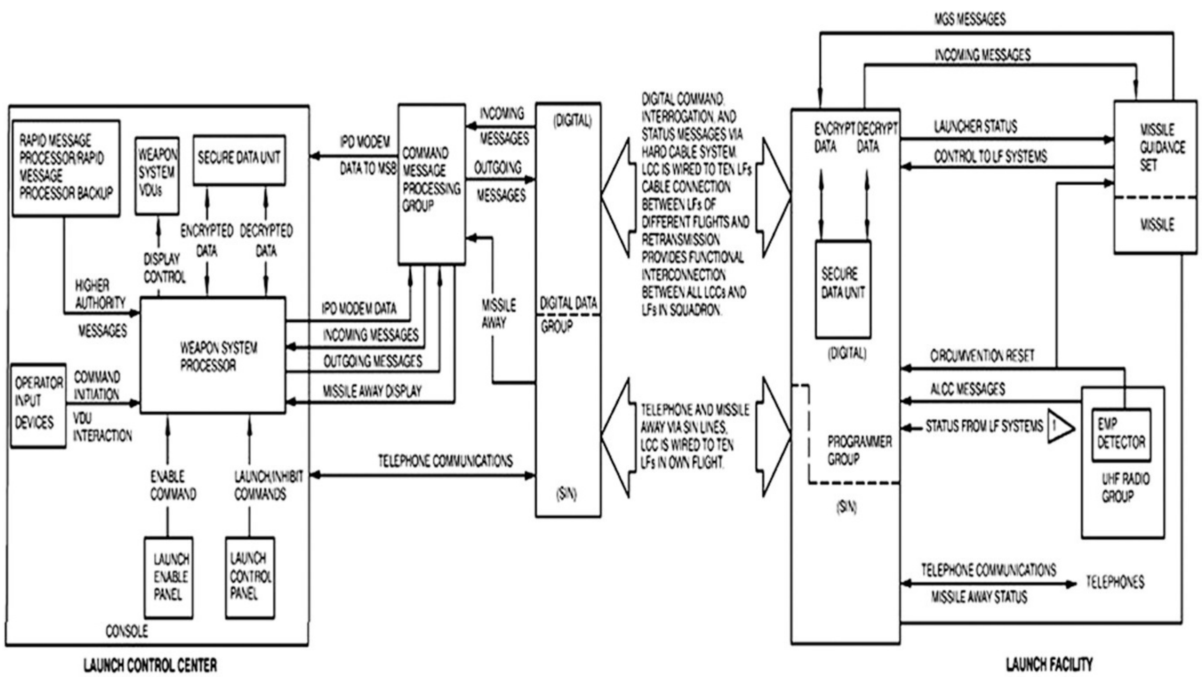


Figure 2–49. Signal flow block diagram.

The WSP formats the operator-initiated message. At the beginning of the assigned time slot, the WSP sends the message to the message processing control drawer for modulation into diphase data. The digital data group transmitter transmits the diphase data to all LFs in the flight via the HICS. If the message is an OSI, the WSP formats the OSI automatically and initiates transmission at the beginning of the assigned time slot. Refer to figure 2–50 for message processing at an LF.

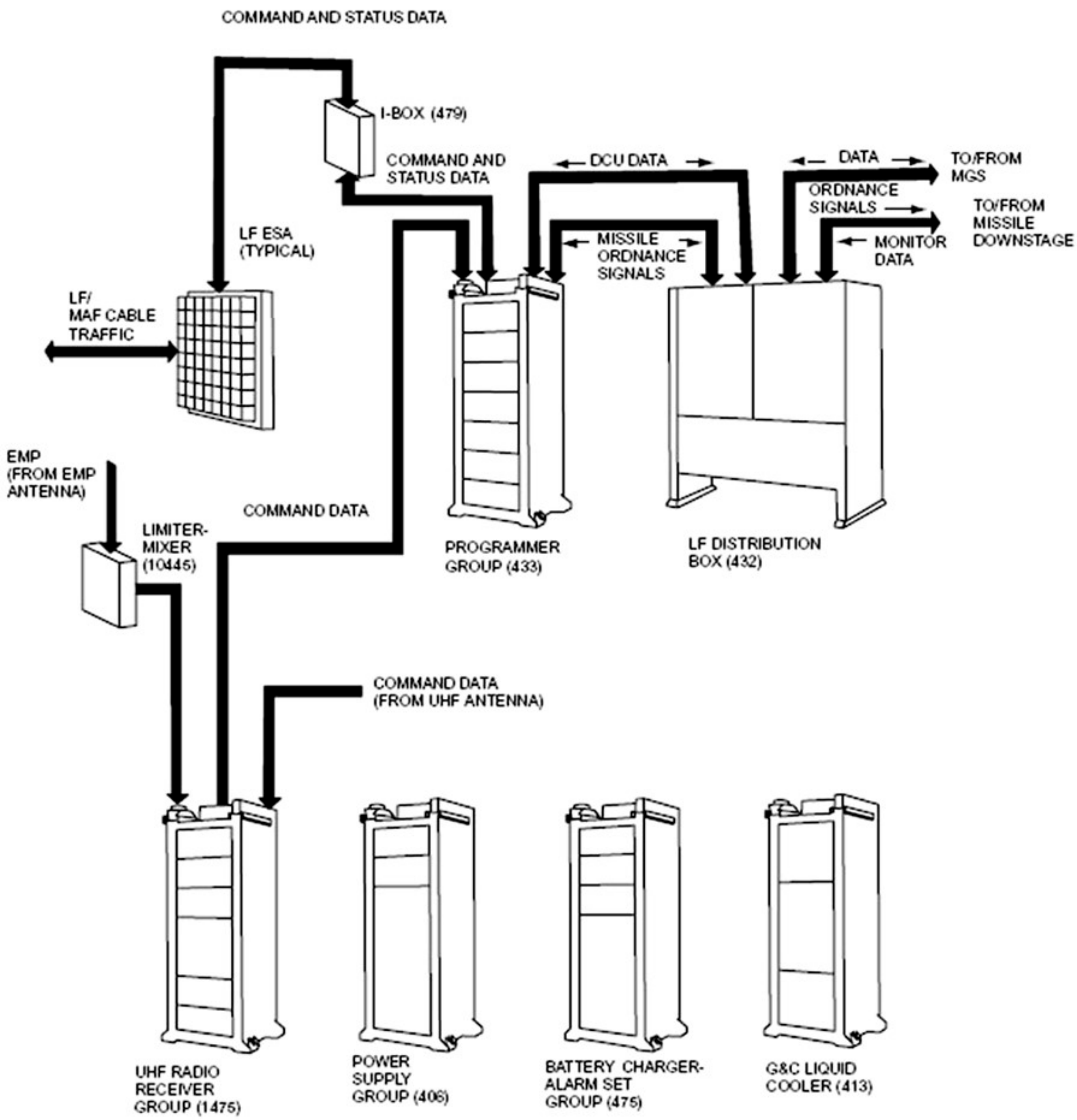


Figure 2–50. LF message processing.

At the LF, the DDRT in the PG accepts the data from the HICS. The message then goes to the message processor, which converts the diphase data to digital information suitable for processing. Following this demodulation, the message is stored for processing. The message processor also modulates the digital message into diphase data and routes it to the DDRT for retransmission on all outgoing lines.

The message processor for message sync, originator (LCC or LF), parity, message address, and a message-type code examines the stored message. If the message sync is absent, the originator is an LF. If incorrect parity is detected, the message is rejected. If the message passes these checks, it transfers to the DCU. Additional ground processing of the message may occur, depending on the message address and message-type code.

The DCU examines the message for validity and, if valid, initiates its message processing routine. Depending on message type, the DCU may command the G&C coupler and/or PG control monitor drawer to perform operational or test functions. Any command executed by the G&C coupler goes directly to the coupler. The G&C coupler executes the command and provides the appropriate responses, if any, to the DCU.

DCU commands to be executed by the control monitor drawer are first routed to the G&C coupler, which then transfer the commands to the control monitor drawer. Control monitor drawer responses that are reportable to the DCU go to the G&C coupler, which then transfer the responses to the DCU.

If a reply is required, the DCU collects the required data into a message, adds a message identifier, and sends the message to the message processor, which examines the message and adds applicable ground equipment status. It is then diphase modulated and transferred to the digital data receiver-transmitter for transmission on all outgoing lines.

The digital data group at the LCC receives the incoming message from the HICS and transfers it to the message processing control drawer for demodulation into digital data. The digital data goes to the WSP for processing. The message processing control also diphase modulates the digital data and routes it to the digital data group for retransmission on all outgoing lines.

The WSP examines the message and discards those messages that are not valid. The accepted messages are decoded and identified. Depending on message type, the WSP enters a routine that analyzes the operational condition of all squadron transmitters using the address of the message originator. If required, additional processing can be performed to satisfy active operational functions, or the message content can be stored for subsequent processing, or information in the message can be displayed.

Message retransmission and lockout

The squadron C2 cable net provides multiple paths to carry messages through the squadron. Figure 2–51 shows that a message originating at any site must pass through several other sites to be distributed through the squadron. The message passes through other sites by active retransmission. That is, each site that detects message data on any incoming line seizes that line, demodulates the data, starts processing the message to determine whether it affects that site, and at the same time, remodulates the data and transmits it on all outgoing lines.

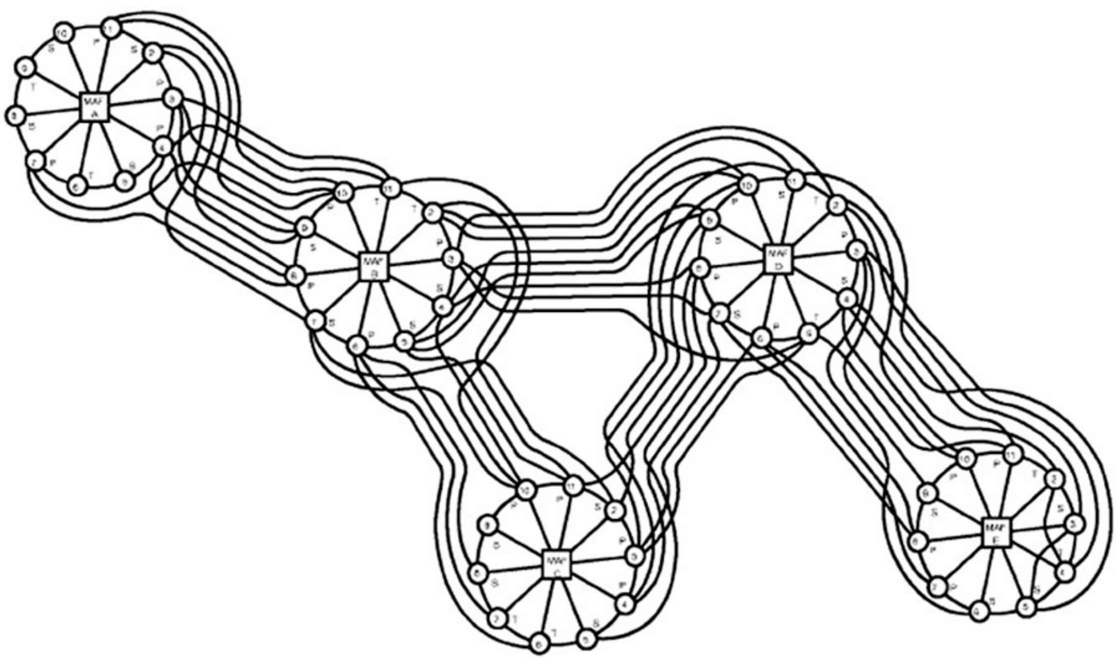


Figure 2–51. Command and control cable network.

The retransmission starts as soon as a few bits of message data are received and continues until the complete message is received and retransmitted. As more sites receive the message and retransmit it on all of their outgoing lines, the rate of message propagation through the squadron increases rapidly. The message reaches all sites very soon. Retransmission is prevented from continuing indefinitely by locking out the receiving lines in each site (LF and MAF) that receives and retransmits the message. The lockout prevents sites from processing the message more than once. When the last site receives and retransmits the message, no other site can process that retransmission because they are all locked out.

Timing is such that the squadron network is cleared and ready for the next message before it is due for transmission. Data detection, line seize, demodulation, and lockout are done at the LCC in the CMPG message processing control drawer and at the LF in the PG message processor drawer.

Message encryption and decryption

The operation of the encrypted communications system depends primarily on the SDUs at all LCCs and LFs. This device, occupying a small portion of a drawer at each location, provides the mechanism for encrypting and decrypting messages transmitted between facilities. Each of the SDUs is provided with special code words contained in a removable assembly called a keying variable. The keying variable code words used in a squadron are unique to that squadron so identical data transmitted in one squadron will differ from, and not be usable in, another squadron.

Launch sequence

Command messages are used to initiate and control proper missile launch. The entire launch sequence includes the time from when the decision to launch is made until first-stage ignition. During this period (or before), the MCC can make certain changes to the launch plan.

Enable command

Before a missile can be launched, it must be enabled. Transmitting an enable command to the LF(s) places a missile in the enabled state. Enable commands can be addressed to an individual LF or all LFs in the squadron. The enable command arms the command signal decoder in the missile. Missiles that process an enable command with their own address or an all-call address will enter the enabled state. Missiles that process an enable command with the address of another LF will reject the command and remain in their present state.

Launch command

Before transmitting the first ELC, the execute launch option can be changed by PLC-A or modified by a PLC-B. After an LF processes the first ELC, the LF will accept an ILC or a second ELC only.

The time of first-stage ignition depends on the target delay time, which is part of the execution plan. The first execute launch command places the LF in the launch commanded mode and starts the launch-commanded timer. A second ELC from a different LCC places the LF in the launch-in-process mode.

On entering the launch-commanded mode, the DCU starts the launch commanded (one vote) timer, which has been preprogrammed from two to 24 hours. If a second ELC from another MAF or an ILC is not received before the timer runs out, delay times are ignored and the DCU enters terminal countdown.

When the total time remaining before first-stage ignition is equal to about 20 seconds, the LF enters terminal countdown and ceases to process messages. At this point, the DCU assumes control of the launch countdown and begins issuing commands to the ground equipment in preparation for missile lift-off.

Airborne launch control center entry and capabilities

The ALCC (fig. 2–52) provides a secure secondary C2 capability for enabling and launching missiles. The ALCC is able to send the enable command, ELC, and inhibit command to the LFs, but it does not have any LF ground status monitoring capability. The ALCC is an aircraft equipped to transmit digital commands to LFs over a simplex UHF/frequency modulated link. The ALCC interface equipment at the LF consists of an UHF antenna, receiver, and associated interconnecting wiring. The antenna is a hardened unit buried within the LF service area. The UHF receiver converts ALCC UHF signals to digital data compatible with the cable control and monitoring system. The LF cable system processes an ALCC command as though it were a ground-originated cable command.

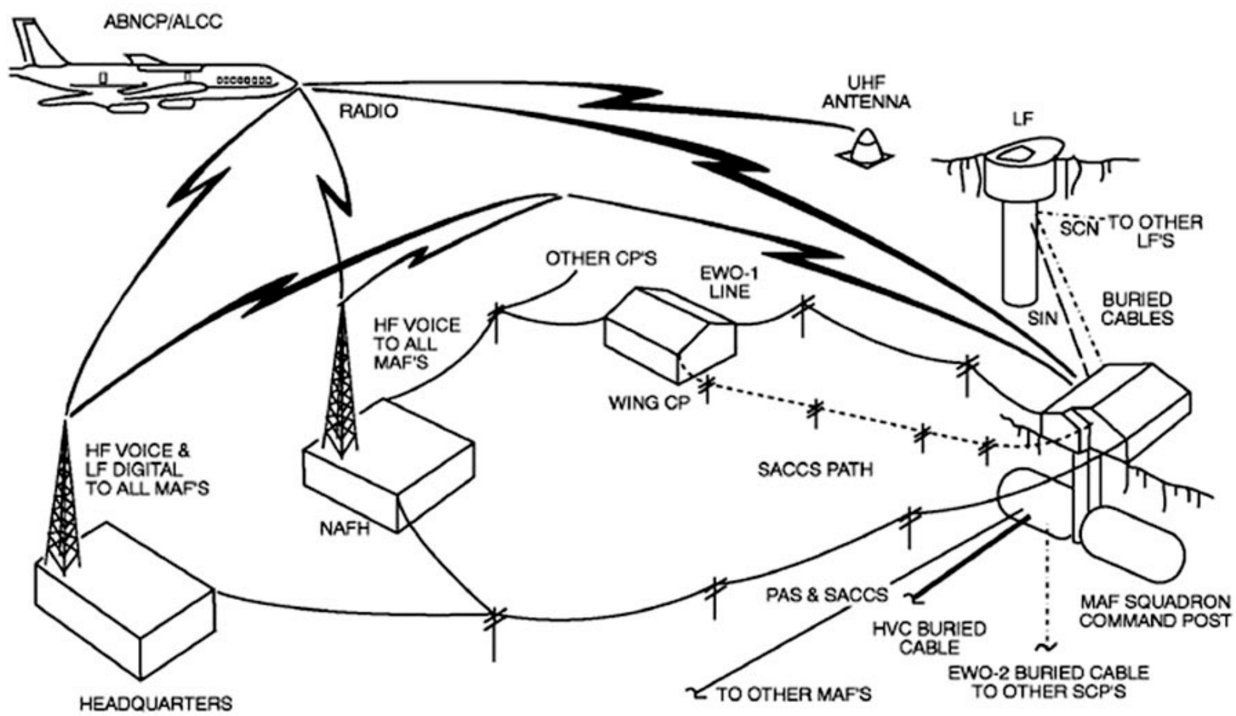


Figure 2–52. Airborne launch control center.

The ALCC command entry to an LF is permitted under either of the following conditions:

- The ALCC hold off timer has expired.
- In a 240-second period, the LF has not registered a valid encrypted OSI.
- The LF has an SDU alarm and has not registered a valid clear text OSI for 330 seconds.

During normal ground operation, the ALCC can send an operational test that consists of appropriate squadron tones and simulated digital message data. The only LF response, if ALCC access is not permitted, is an operational status indication that radio data was present at the transfer link.

Self-Test Questions

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

311. Missile alert facility equipment

1. Match the descriptions in column A with the equipment in column B. Items in column B may be used once, more than once, or not at all.

Column A	*Column B*
___(1) Used for generating onscreen characters, commanding special functions, or initiating external processes.	a. WSCC.
___(2) A dual-position console that serves as the normal duty station for the MCC.	b. VDU.
___(3) Demodulates incoming digital diphase data from the LF, to digital data for processing by the WSP.	c. LEP.
___(4) At the squadron command post only, this rack contains the CEIU.	d. CLS.
___(5) This provides controls and indicators from facilities related subsystems.	e. MAR.
___(6) Contains a MCU combined with a received unlock code in the WSP and, if applicable, the stored translate code is used to create the enable command secure code.	f. OID.
___(7) Provides alarm acknowledgment capabilities for the WS, HA communications, and facility alarms.	g. Trackball.
___(8) This controls the flow of data within and through the LCC.	h. Keyboard.
___(9) Provides the principal display medium for the MCC.	i. FDD.
___(10) Encrypts and decrypts messages at the LCC.	j. CDA.
___(11) Provides the initiating point for execute launch, inhibit, and inhibit test commands.	k. AAP.
___(12) Demodulates incoming digital diphase data from the LF.	l. Printer.
___(13) Detects missile away status for each LF.	m. WSP.
___(14) Serves as the signal conditioning interface between the HICS, the SIN system, and the MAF C2.	n. BS/L
___(15) Used to provide removable read/write storage for non-critical functions.	o. LCP.
	p. CMPG.
	q. DDG.
	r. Message processing control drawer.
	s. Status analog-to-digital converter.
	t. Command analog-to-digital converter.
	u. Status signal receiver.
	v. Missile-away indicator.

312. Launch facility equipment

1. Match the descriptions in column A with the equipment in column B. Items in column B may be used once, more than once, or not at all.

Column A	*Column B*
___(1) Contains a safety device to control LF ordnance arming and safing.	a. CSD(G).
___(2) Provides DC isolation for digital data transmit and receive lines.	b. Audio frequency detector.
___(3) Converts 400-Hz three-phase power to regulated DC voltages.	c. DDRT.
___(4) An electromechanical stepping decoder that must be armed to provide arming power to the LES.	d. Message processor.
___(5) Contains a test address decoder and test signal generator, which perform a self-test during SCNT.	e. G&C coupler.
	f. Control monitor.
	g. Power supply.
	h. UHF radio receiver drawer.
	i. Computer control.

___(6) Contains a status multiplexer to collect and transmit launcher status data to the MGS or controller monitor.
___(7) Contains circuits for scanning, seizing, and lockout circuits.
___(8) Contains an ordnance control unit to control ordnance firing and first stage ignition.
___(9) Processes messages in and out of the SDU for encryption and decryption.
___(10) Contains an activation and control unit to control startup and DCU program loading.

313. Command and control system description

1. What ensures messages are propagated throughout a squadron?

2. Under what conditions will an LCC register another LCC as being down?

3. Describe how a LCC monitors the operational status of a LF.

4. What type of messages are initiated from control panels in the LCC to select execution plans and to enable missiles?

5. The C2 system tests check for which operational capabilities?

6. What provides the secure transfer of targeting data for remote targeting operations?

7. What does time-sharing of the cable network prevent?

8. How are time slots synchronized among the five LCCs of a squadron?

9. What equipment generates an OSI when an operator does not initiate a command?

10. What LCC equipment converts a WSP formatted message into diphase?

11. What LF equipment converts diphase data to digital data suitable for processing?

12. How are message retransmissions prevented from continuing indefinitely?

13. What device provides the mechanism for encrypting and decrypting messages?

14. What piece of equipment provides the SDU with special code words?

15. What state must a missile be in before it can be launched?

16. What happens when a missile processes an enable command with the address of another LF?

17. What type of status is the ALCC incapable of monitoring?

Answers to Self-Test Questions

307

1. Distributes commercial power to the LCEB, tunnel junction, and LCC. In addition, it automatically generates and distributes standby power when commercial power fails.
2. Provides standby power in the event of a commercial power failure.
3. Automatically starts the DEU as a backup power.
4. LCPA.
5. As long as primary power is received from the LCPA panel.
6. The storage batteries provide power to the DC motor in the MG that drives the AC generators.
7. They are connected in series-parallel to produce 28–36 VDC.
8. Convert the motor generator’s AC voltage output into 28 VDC for use by the communications and REACT console equipment in the LCC.

308

1. The service disconnect breaker, PLPA, and the DEU.
2. Sixty amps of charging power at 36 VDC.
3. Emergency ECS and the DC motor on the MG.
4. The LF does not have an additional 60-Hz generator.
5. The ordnance devices of the missile are connected to the D-box and are ready for launch signals.

309

1. Routed in two overhead cable trays or clamped to the walls and other structures.

2. Through a conduit.
3. Single conductor cables.
4. Multi-conductor shielded cables.
5. The I-box.
6. They protect from excessive voltage and current surges due to the lighting or other electromagnetic pulses
7. Clamping the voltage and shunting excessive current to ground.

310

1. In a double-decker cable tray above the air conditioning duct.
2. Sufficient slack (shock loop).
3. Through conduit.
4. A sorting plug.
5. A pulse suppressor assembly.
6. F–1343/GSW–13.
7. EMI filtering for all power and signal lines between the SARC, security pit, and SDCA.

311

1. (1) h.
   (2) a.
   (3) r.
   (4) p.
   (5) k.
   (6) c.
   (7) e.
   (8) m.
   (9) b.
   (10) j.
   (11) o.
   (12) r.
   (13) v.
   (14) q.
   (15) i.

312

1. (1) f.
   (2) c.
   (3) g.
   (4) a.
   (5) h.
   (6) e.
   (7) d.
   (8) f.
   (9) d.
   (10) e.

313

1. The retransmissions of messages by LCCs and LFs and the interconnectivity of the HICS.
2. When the other LCC fails to transmit proper OSIs for 240 seconds.

3. The LCC automatically transmits an OSI message to one LF as part of its normal routine. The OSI causes the LF to transmit an OSR. This OSI and OSR cycle is repeated for each LF, ensuring all LFs in the squadron are continually interrogated.
4. Command messages.
5. Missile for operational readiness, LF ground equipment for launch readiness, LF monitoring equipment, and LCC system equipment for operability.
6. RDC.
7. The messages from interfering with one another.
8. By designating the LCC occupying time slot No. 1 as a master transmitter.
9. The WSP.
10. The message processing control drawer.
11. The message processor.
12. By locking out the receiving lines in each site (LF and MAF) that receives and retransmits the message.
13. The SDU.
14. A removable assembly called a keying variable.
15. Enabled.
16. The LF will reject the command and remain in their present state.
17. LF ground status.

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.

11. (307) Which *best* describes a purpose of the missile alert facility power system?
    a. Distribute direct current (DC) power to the missile and other loads.
    b. Distribute alternating current (AC) power to the launch control center.
    c. Generate and distribute AC power to the launch facility support building.
    d. Generate and distribute DC power to the launch control equipment building.

12. (307) Select the component that provides the missile alert facility with power during a commercial power failure.
    a. Storage batteries.
    b. Motor generator.
    c. Diesel electric unit.
    d. Automatic switching unit.

13. (307) Identify the Wing 3 and 5 launch control centers that have no more than 10 storage batteries connected in series-parallel.
    a. Squadron command post.
    b. Alternate command post.
    c. Wing command post.
    d. Primary.

14. (307) The battery charger for the missile alert facility storage batteries is contained in the
    a. motor generator.
    b. power supply group.
    c. automatic switching unit.
    d. diesel electric unit battery charger.

15. (308) Which power source(s) provides power to the launch facility battery charger?
    a. Emergency and commercial.
    b. Standby and commercial.
    c. Emergency and standby.
    d. Commercial only.

16. (308) When the distribution box connects ordnance devices in order to test loads, it means the
    a. missile is ready for launch signals.
    b. emergency backup power is sufficient.
    c. safety control switch (SCS) key is installed.
    d. monthly weapon systems test is being conducted.

17. (309) The launch control center's interconnecting box provides an interface between the
    a. electrical surge arresters and electronic equipment.
    b. electrical surge arresters and power filter.
    c. power filter and electronic equipment.
    d. power filter and circuit breaker panel.

18. (309) Identify the components of an electrical surge arrester module that limits the current entering the system during a surge condition.
    a. Carbon blocks.
    b. Gas-filled tubes.
    c. Spark gap assemblies.
    d. Twenty-ohm resistors.

19. (310) Which feature prevents various cables from being damaged when the shock-mounted floor moves?
    a. Foam blocks.
    b. Shock loops.
    c. Cable attenuators.
    d. Automatic cable reels that release when tension is applied.

20. (310) Identify the launch facility interconnecting box component that will accomplish signal distribution based on the unique signal for each site.
    a. Sorting plug.
    b. Shorting plug.
    c. Site addressing plug.
    d. Keying variable plug.

21. (310) Which device in a launch facility interconnecting box protects against undesirable signals that may have been picked up on the hardened intersite cabling system cables?
    a. Metal oxide varistor.
    b. Feed-through capacitor.
    c. Pulse suppressor assembly.
    d. Alternating current electrical surge arrester.

22. (310) Which electrical filter assembly located outside the electrical surge arrester vault protects the security lines?
    a. F-1344/GSW-13 (unit reference designator (URD) 10442).
    b. F-1343/GSW-13 (URD 10443).
    c. F-1346/GSW-13 (URD 10439).
    d. F-1345/GSW-13 (URD 10440).

23. (310) Electromagnetic interference filtering for the secondary door is through
    a. 14 electrical surge arrestor (ESA) modules.
    b. 8 ESA modules.
    c. 14 pi-filters.
    d. 8 pi-filters.

24. (311) Which weapon system control console component provides an indicator for a fire alarm?
   a. Master alarm reset.
   b. Visual display unit.
   c. Auxiliary alarm panel.
   d. Rapid message processor.

25. (311) Which group serves as the signal conditioning interface for the hardened intrasite cable system and the missile alert facility command and control system?
   a. Programmer group.
   b. Digital data group.
   c. Power supply group.
   d. Command message processing group.

26. (312) Identify the component that processes commands and provides reports of missile and ground equipment status during ground operations.
   a. Digital data terminal.
   b. Digital computer unit.
   c. Rapid message processor.
   d. Command signals decoder-ground.

27. (312) Which launch facility component contains digital data line scanning, seize, and lockout circuits?
   a. Command signals decoder-ground.
   b. Message processor drawer.
   c. Audio frequency detector.
   d. Digital computer unit.

28. (312) Identify the launch facility drawer that contains electromagnetic pulse sensing circuitry.
   a. Control monitor.
   b. Message processor.
   c. Ultra-high frequency receiver.
   d. Guidance and control coupler.

29. (313) Under which condition will a launch control center register another launch control center as being down?
   a. Failing to transmit proper operational status interrogations (OSI) for 240 seconds.
   b. Transmitting proper operational status responses within 240 seconds.
   c. Failing to transmit proper ground test interrogations for 240 seconds.
   d. Transmitting proper OSIs within 240 seconds.

30. (313) Identify the component that generates an operational status interrogation (OSI) when an operator does *not* initiate a command.
   a. Digital data group.
   b. Digital data terminal.
   c. Weapon system processor.
   d. Command message processing group.

31. (313) Which is permitted if a launch facility does *not* register a valid encrypted operational status interrogation (OSI) for 240 seconds?
    a. Airborne launch control center command entry.
    b. Digital computer unit launch command mode.
    c. Ultra-high frequency radio transmissions.
    d. Forced digital computer unit operational status response.

Please read the unit menu for unit 3 and continue ➔

Unit 3. Missile Cooling System, Startup, Coding, and Launch Facility Security

AN IMPORTANT SYSTEM you will be working on is the guidance section liquid cooler. The liquid cooler's sole function is to remove the excess heat generated by the MGS. Normally this system requires very little maintenance; however, like any other piece of equipment that operates 24 hours-a-day, seven days-a-week, it can develop problems. When this happens, you must be able to isolate and remedy the fault quickly to minimize the amount of time the missile is off alert. Generally, isolating problems will require removal of the aerospace vehicle equipment (AVE) power and then reapply power when the problem is fixed.

There are numerous reasons why OGE and AVE power may have been removed. One particular reason for shutting down OGE power would be to replace the LF MG. If OGE power is to be removed, then AVE power has to be shut down first. AVE power on the other hand, stems around the MGS and the guidance liquid cooler, so if you are dispatched to an LF to perform a tape load after a MGS was replaced, then you will primarily be verifying OGE power and then performing AVE startup.

We will cover the LF security system, too. Given the awesome power of the Minuteman weapon system and the remote locations that it is employed a robust security system is paramount to the safety and surety of this system.

3–1. Missile Guidance Set Liquid Cooling System Description

Your responsibilities, while working on the G&C liquid cooling system, consist of ensuring proper operation, system checkout, troubleshooting, and repair. Having a thorough knowledge of this system will greatly help you in fulfilling those obligations. In this section, you will learn about the components that comprise the G&C liquid cooling system as well as how the system operates.

314. Guidance and control liquid cooling system equipment

In this lesson, we will look at the G&C liquid cooling system equipment. This particular system is one unit in the overall plan for weapon system environmental control. It is located on the south end of the shock-isolated floor next to the D-box. Its function is to control the temperature of the MGS. The following components (fig. 3–1) make up the G&C liquid cooling system:

- Plumbing set.
- Coolant chiller unit.
- Coolant pump assembly.
- Control valve assembly.
- Coolant tank.

- Filter assembly.
- Electronic control amplifier.
- Wiring harness.

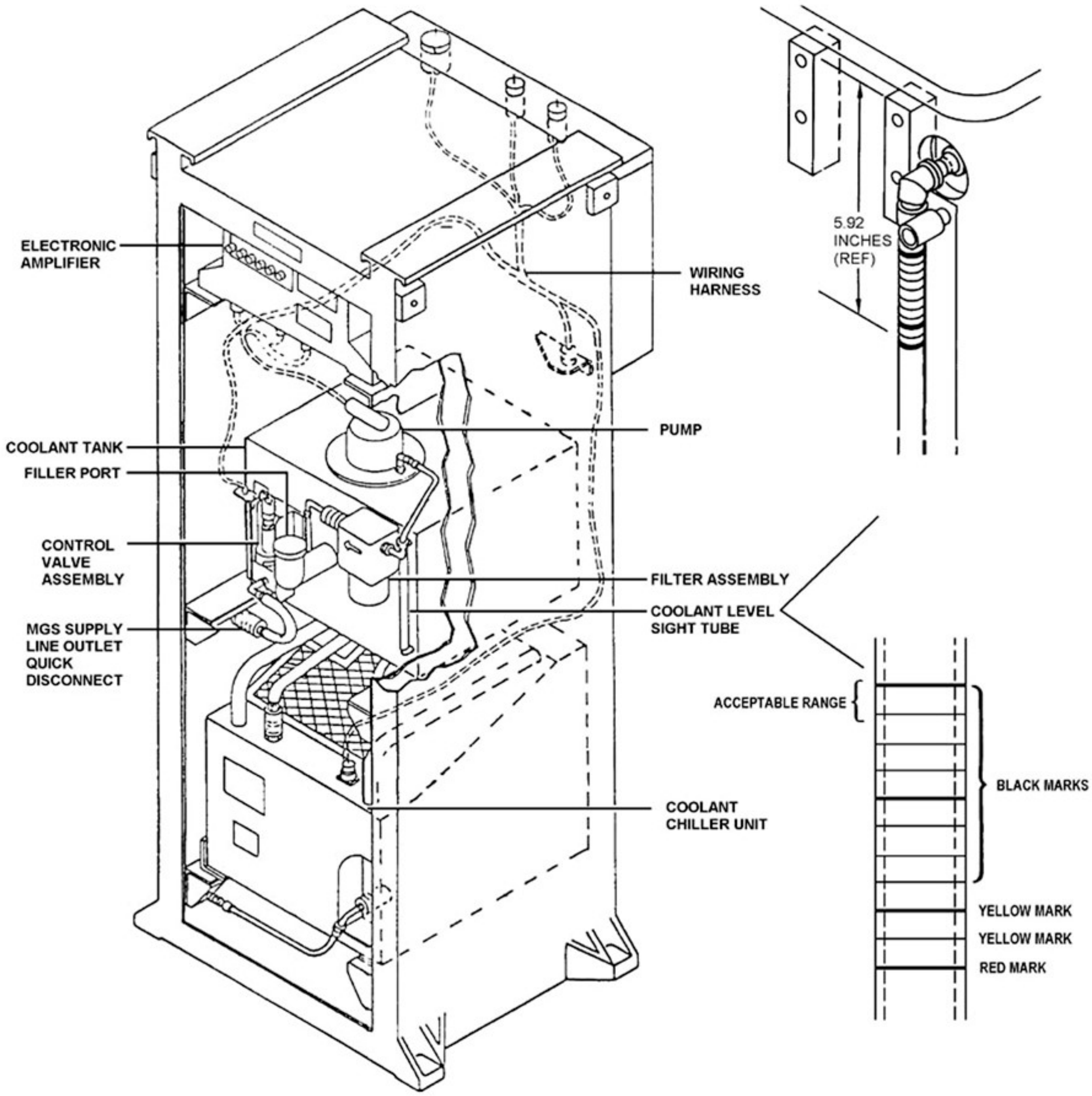


Figure 3–1. G&C section liquid cooler.

Plumbing set

The plumbing set includes the coolant supply and return hoses. These hoses are routed from the chiller unit in the first LER down into the second LER and are joined with the umbilical cables from the D-box through an opening in the launch tube. The hoses are connected to the umbilical connector that is connected to the MGS. This links the G&C section liquid cooler to the MGS.

Coolant chiller unit

The coolant chiller unit operates at all times on 120/208 VAC, three-phase, and 400-Hz power. The evaporator chills the coolant to 44(±3) degrees Fahrenheit (°F) for all operating conditions, with a flow rate from 0.7 to 4.5 pounds per minute. In addition to the evaporator coil, the unit consists of a compressor, a heat exchanger, a condenser coil and fan, an automatic expansion valve, and a filter.

Coolant pump assembly

The coolant pump assembly circulates the coolant through the system. It also operates on 120/208 VAC, three-phase, and 400-Hz power. The motor is on top of the tank, and the impeller is submerged in the coolant.

Control valve assembly

The control valve assembly (fig. 3–2) controls the flow rate of the coolant through the system. It can vary the flow rate from 0.15 to 4.5 pounds per minute. With each (open or close) pulse the DC stepper-motor receives from the electronic control amplifier, it increases or decreases the valve opening slightly, continuing until the valve is fully opened or fully closed.

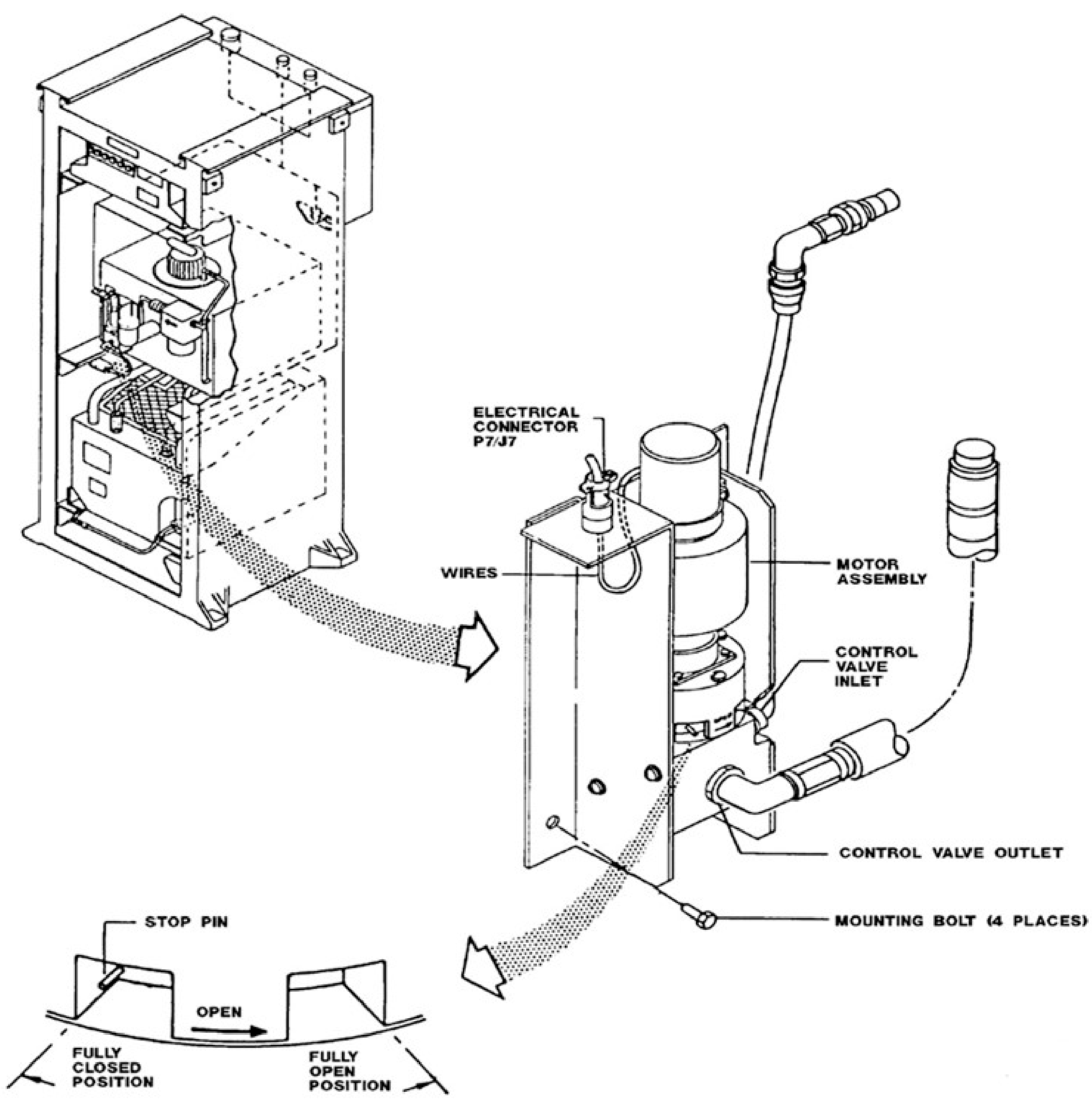


Figure 3–2. Control valve assembly.

The following table shows various flow rates depending on the cooling demand.

Coolant Flow Rates	
Flow Rate	**Description**
Normal	Flow rate is 3(±0.5) pounds per minute.
Maximum	Flow rate (short emergency conditions) is 4(±0.5) pounds per minute.
Minimum	Flow rate (control valve closed) 0.15 to 0.7 pounds per minute.
Low	Usually 0.7 to 2.5 pounds per minute.

Minimum flow rate is achieved when power is removed from the MGS or when the guidance section liquid cooler test set simulates the guidance section power-off condition.

Coolant tank

The coolant tank stores about seven gallons of refrigerated coolant from the coolant chiller unit. Coolant temperature in the tank for all operating conditions is controlled at 44(±3) ºF. The coolant temperature to the guidance section does not exceed 48 ºF.

Filter assembly

A filter assembly with a 150-micron filter element is mounted on the coolant tank to remove contaminants from the cooling system.

Electronic control amplifier

The electronic control amplifier is installed at the top of the guidance section liquid cooler rack. It operates on 36 VDC battery power through a circuit breaker in the D-box. The amplifier has six indicator lights: two indicate hot and cold temp alarms; one indicates a gross temp alarm; one indicates a NO-GO alarm; and the last two indicate the direction the control valve is moving (open or close). The thermistor in the MGS is one leg of a bridge network of the electronic control amplifier of the MGS cooling system. The output of the bridge circuit is used to drive four amplifiers: ALARM, GROSS TEMP, NO-GO, and CONTROL. The following table below lists and describes the four amplifiers.

Amplifiers	
ALARM	Is driven if the thermistor senses a temperature ±0.5 ºF (approximate resistance ±28 ohms) above or below the MGS temperature null point of 71.2(±1) ºF (null point resistance 2,466 (±29) ohms). A ground maintenance response (GMR) 25 will be reported to the LCC.
GROSS TEMP	Is driven when the MGS temperature of 80 ºF (thermistor resistance of 1875 (±40) ohms) has been reached. The GROSS TEMP indicator on the control amplifier will illuminate and a GMR 25 will continue to report to the LCC.
NO-GO	Is driven when the MGS temperature has reached 85 ºF (thermistor resistance of 1710 (±50) ohms). The NO-GO indicator on the control amplifier will be illuminated. This will also report a GMR 25 launch facility no-go (LFNG) to the LCC. The LFNG means the MGS has undergone a controlled shutdown to prevent overheating.
CONTROL	Provides power to the control valve motor. The control amplifier is driven anytime an alarm condition is reporting and when power is removed from the MGS because it needs to send power to the control valve to increase or decrease the coolant flow rate. The respective open/close indicator on the control amplifier will be flashing.

Thermistor

The thermistor is a temperature-sensitive element that monitors temperature changes within the MGS.

Wiring harness

The wiring harness routes 120/208 VAC, three-phase, 400-Hz power, 36 VDC battery power, and signals throughout the guidance section cooler.

315. Guidance and control liquid cooling system operation

Now, let's tie how each component of the G&C section cooler operates together as a system. We will also look at the general maintenance of the G&C liquid cooler system.

Coolant flow

Chilled coolant flows through the coolant supply hose into heat exchangers in the MGS. The coolant picks up heat from the MGS components, thereby controlling their temperature. The absorbed heat in the coolant returns to the coolant chiller unit through the coolant return line. In the chiller unit, the warmed coolant enters the evaporator. The refrigerant coils in the evaporator remove heat from the coolant, chilling it before it enters the coolant tank. The coolant pump sends the coolant through the system by way of the filter assembly, control valve assembly, and back through the MGS to complete one coolant flow cycle.

As stated earlier, the flow rate varies depending on the control valve setting. This setting depends on the number of close or open pulses the control valve receives from the electronic control amplifier in response to changes in the MGS thermistor resistance.

Refrigerant flow

Inside the coolant chiller unit, liquid refrigerant passes through the expansion valve that acts as a pressure regulator. The high-pressure liquid then passes to the evaporator's low-pressure chamber. At the lower pressure, heat transfers from the coolant surrounding the coils to the refrigerant, thus cooling the coolant. From the evaporator, the vaporized refrigerant passes through the regenerative heat exchanger's coils to complete the vaporization process and then into the compressor, where it is pressurized.

The regenerative heat exchanger's coils, that completed the vaporization process, are heated by the pressurized vapor leaving the compressor. The compression process creates a high-pressure, high-temperature vapor that is cycled back through the regenerative heat exchanger and over its coils.

From the regenerative heat exchanger, the high-pressure refrigerant enters the condenser, where it is cooled, condensing to a liquid. The cooling fan draws air over the condenser coils to speed up the cooling rate. From the condenser, the liquid refrigerant flows through a filter-drier and then enters the expansion valve, completing a refrigerant cycle.

Electronic control

The electronic control amplifier monitors the temperature of the MGS. As the MGS temperature changes, the thermistor's resistance value changes inversely. The thermistor senses temperature change in the guidance section and causes a change in the amplifier. The amplifier evaluates the resistance change and if necessary, sends an open valve or close valve signal to make the control valve assembly adjust the flow rate. Coolant flow through the guidance section increases as temperature rises, and decreases as the temperature lowers.

The electronic control amplifier also triggers out-of-tolerance signals. When an alarm signal represents an out-of-tolerance greater or less than 0.5 ºF, the HOT or COLD indicator on the amplifier will illuminate and the OPEN or CLOSE indicator will be flashing. This indicates the control valve is either opening or closing. The C2 system will report a GMR 25 until the condition clears.

At a greater out-of-tolerance condition on the high side (80 ºF), the GROSS TEMPERATURE warning light will illuminate on the control amplifier and the GMR 25 will continue to report. At 85 ºF, a greater out-of-tolerance condition causes the NO-GO indicator to illuminate. A NO-GO shutdown of the MGS will commence and the alarm is reported to the LCC as a GMR 25 LFNG.

The normal operating temperature (balance point or amplifier null point) of the guidance section is 71.2(±1) ºF. This temperature is controlled to within 0.2 ºF. Thermistor resistance value at the amplifier null point is 2466(±29) ohms. The resistance value change of the thermistor is 56 ohms per degree Fahrenheit.

Maintenance

You can perform checkout on the G&C liquid cooler system with or without power to the MGS. The high points of each checkout (with and without power) are explained in the following paragraphs.

Power-applied checkout

The power-applied checkout simply means testing the cooling system while the MGS is running. You are making sure the system is functioning properly. When there is a fault within the cooling system, the power not applied checkout is performed. This checkout will cover some pre-inspection requirements, electrical and hydraulic connections, checkout, and will finish with some post requirements.

For safety reasons, it is mandatory to wear the appropriate personnel protection whenever there is a possibility of contacting coolant. Refer to the technical order's safety precautions for the correct personnel protection equipment.

Pre-inspections

The power applied checkout starts with using a thermometer to check the ambient air temperature being drawn into the G&C chiller. The ambient air temperature should be between 60 and 80 ºF. It is very important to inspect the G&C liquid cooler and missile supply and return coolant lines for leakage, kinks, structural damage, or insulation damage. This requires a physical inspection of the G&C liquid cooler and coolant lines from the G&C chiller rack, to the second LER, through the launch tube and up to the missile umbilical connection. Use a flashlight to inspect the lines in the launch tube. If the G&C line quick disconnects connected to the umbilical head are leaking, the light will often reflect off and flash as the drips fall. When inspecting quick disconnects on the system and test set up, always ensure that the green band on the quick disconnect is visible.

The coolant level at the graduated sight tube should be between the top and second black mark (refer back to fig. 3–1). A low coolant level could indicate a leak in the G&C cooling system or the MGS. A low coolant level must be investigated. Internal leaks within the MGS could result in contamination of the solid fuel (wet missile), possibly impacting launch capability. If the test is performed after a MGS was replaced, then the coolant level in the site tube might be high. This is because a missile maintenance team (MMT) purged the old MGS.

Electrical connections

When the guidance section liquid cooler test set electrical cables are connected to the G&C section liquid cooler (fig. 3–3), the NO-GO shutdown must be inhibited. NO-GOs are inhibited while the G&C TEMP ALARM switch on the PG is in the SET ALARM position. Setting the G&C TEMP ALARM toggle switch to the NORMAL position with the cooler test set electrically connected shuts the MGS down. Therefore, the G&C TEMP ALARM toggle switch must remain at the SET ALARM position until otherwise directed by the technical order.

Since the MGS can no longer shut down with the G&C temporary alarm switch in the set alarm position, a technician must monitor the NO-GO indicators on the electronic control amplifier and test set during the checkout procedure. If the red NO-GO indicator on the electronic control amplifier illuminates and/or the NO-GO indicator on the test set goes off at any time, you must manually shutdown the MGS. Manual shut down of the MGS is accomplished by pressing the G&C

SHUTDOWN switch on the PG (fig. 3–4). This action does not require coordination if it is required due to a GROSS TEMP alarm or NO-GO condition.

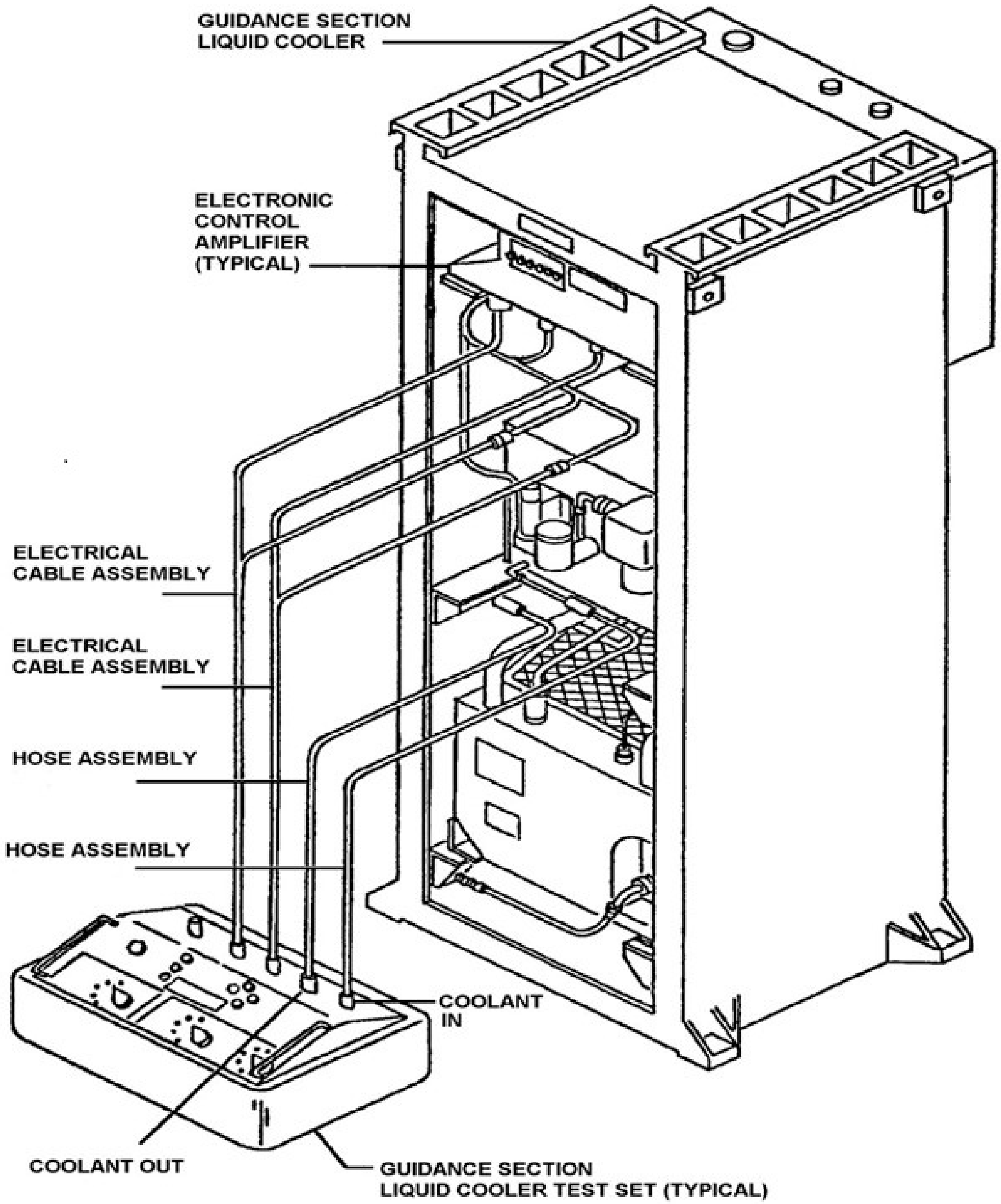


Figure 3–3. Power applied test hookup.

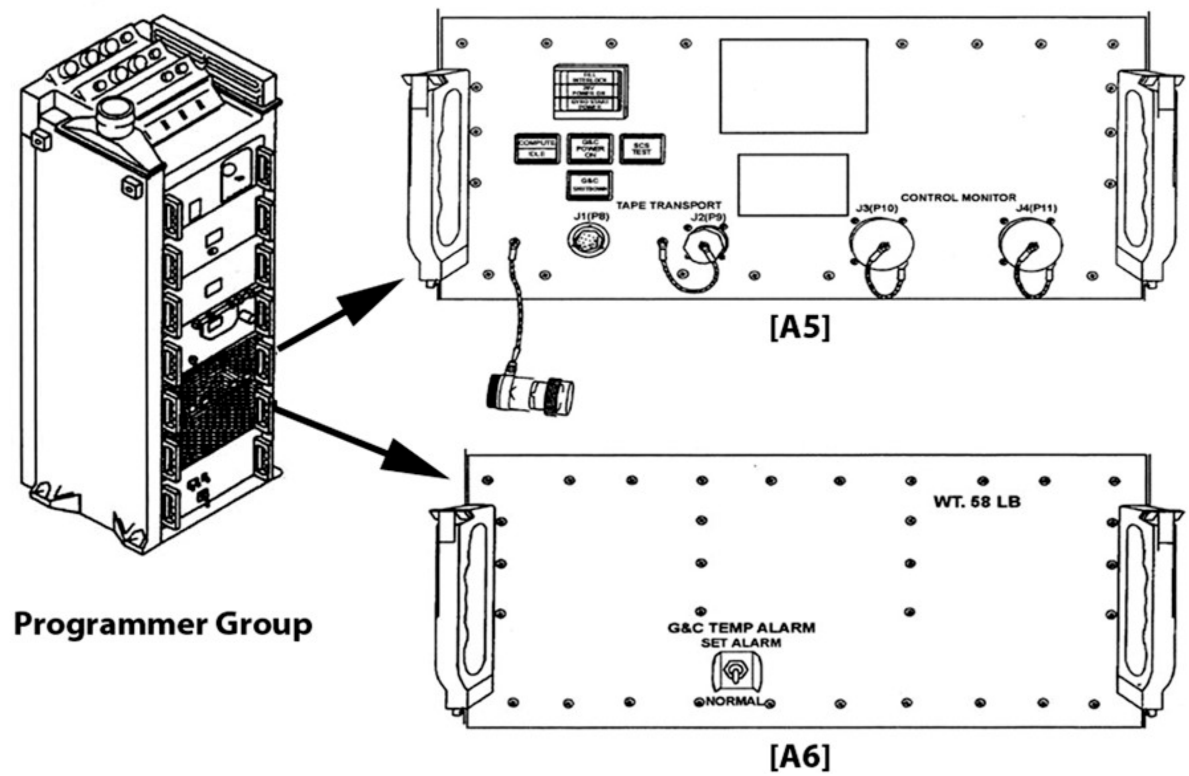


Figure 3–4. G&C shutdown switch.

Hydraulic connections

During the installation of the hydraulic portion of the test set, the GROSS TEMP indicator on the electronic control amplifier must be monitored. If the GROSS TEMP indicator illuminates while the hydraulic hoses are being connected, power to the MGS must be removed by pressing the G&C SHUTDOWN switch on the PG. Once the hydraulic hoses are connected, the test set is now connected in-line with the MGS cooling system. This setup allows monitoring of MGS cooling system operation with the MGS operating.

Checkout

The checkout consists of checking and recording status of all indicators on the electronic control amplifier, test set, and control value position. The technical order will provide tolerances, proper indication for INDICATOR display and corrective actions. An advantage of a power-applied check is determining if the chiller can lower the temperature of coolant that is being heated constantly by the MGS. Also, the amplifier can be monitored to see if it is correctly recognizing signals sent by the MGS.

Post requirements

Once the checkout is complete, technicians must drain the test set and coolant hoses into a clean container or back into the coolant tank. The coolant level site tube must also be checked for proper coolant level. If there is excess or contaminated coolant, the coolant must be labeled appropriately and returned to the MSB for neutralization and disposition.

Power not applied checkout

The real difference between a power not applied and a power-applied checkout is that during power not applied checkout, the G&C test set is simulating the operation of the MGS electronically and hydraulically (fig. 3–5). This configuration allows you to input different thermistor resistance values to see if the G&C section liquid cooler will respond accordingly and adjust flow rates and temperature levels. The hydraulic lines leading to and from the MGS are bypassed. Therefore, the coolant will flow from the chiller into the test set and from the test set back into the chiller. Finally, the MGS will never be powered up during a power not applied checkout.

The procedures also discuss the importance of monitoring the chiller unit during closure of the G&C COOLER AC circuit breaker for a locked rotor condition. A 400-Hz tone (high-pitched hum) indicates a 400-Hz compressor locked rotor condition. If allowed to continue, the 400-Hz compressor motor will burn up.

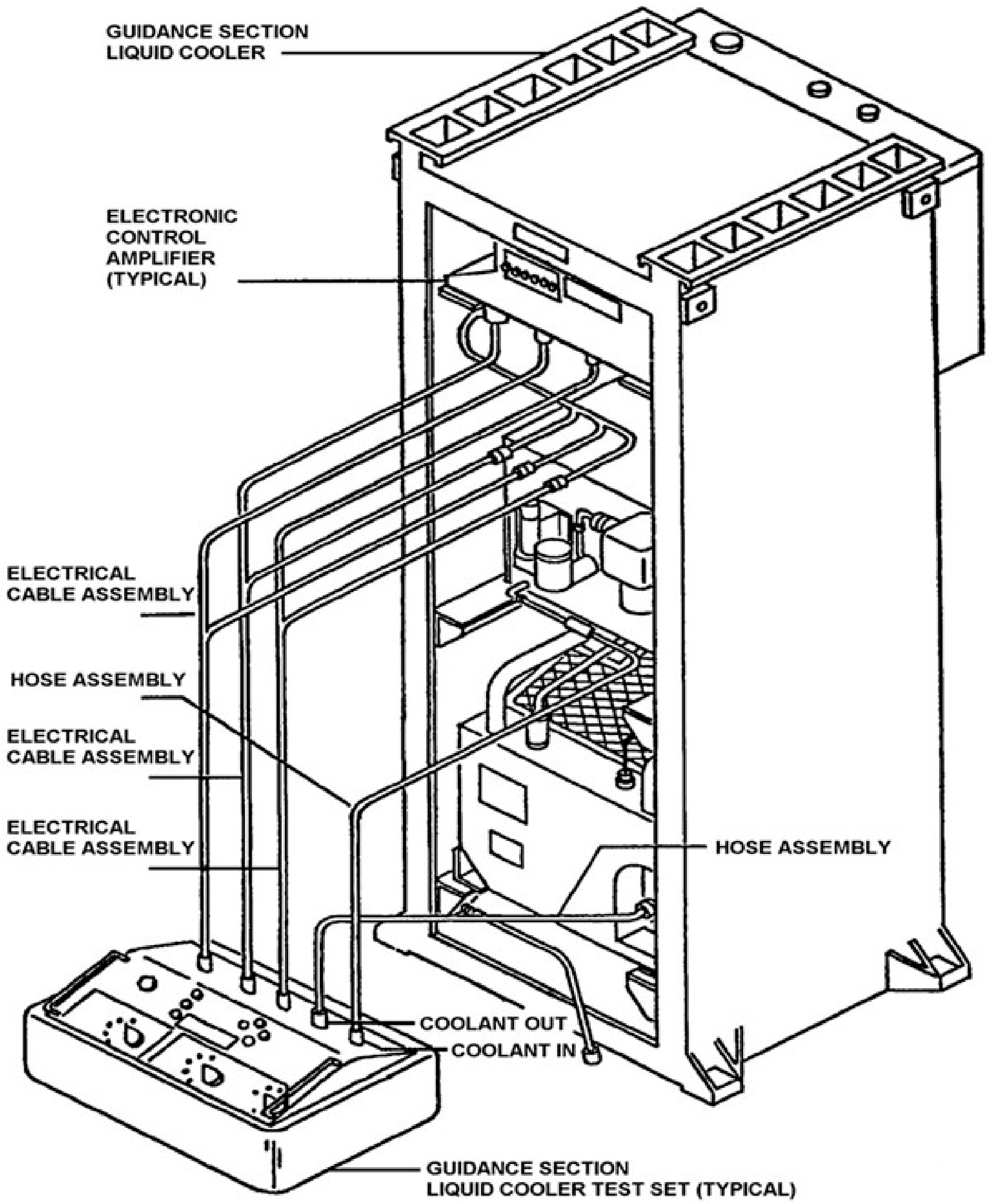


Figure 3–5. Power not applied test hookup.

Trouble analysis

Any time you receive abnormal indications during checkout, refer to the trouble analysis section of the technical order. The trouble analysis procedures are written for a "hard" fault, not a cycling one. Therefore, the troubleshooting section may not identify the actual fault. When troubleshooting a cycling fault, observe the chiller throughout at least one cycle of the fault to attempt to determine what is happening during the fault. Generally, if there is a problem with the G&C liquid cooler, then a GMR 25 will more than likely be reporting.

As a dispatching team, you will be troubleshooting a GMR 25 in accordance with the fault isolation TO 21M-LGM30G–2–1-X, *Maintenance Control, Minuteman Weapon Systems* (you read about this back in volume 2) and the 21M-LGM30G–2–6, *Ground Guidance and Control Liquid Cooling Assembly*. Typically, the most common faults are restrictions in the coolant lines and electrical component failure. However, as you may recall the troubleshooting techniques in volume 2, you should still perform a preliminary check when you first enter the LER.

Take a minute to use your senses and check for some obvious failure indicators. If all the breakers are pushed in, but the chiller, amplifier, or pump is not functioning, then you could have an obvious equipment failure. Even though you are going to inspect the coolant hoses, there is always the chance that the insulation surrounding the hose could be concealing a kink or a deformed hose clamp that could also pinch a hose. So take your time and thoroughly inspect the lines and clamps the best you can. If you discover an obvious fault, you could very well have saved yourself some time and a headache.

Hydraulic

Restrictions in the hydraulic system can be troublesome, especially when you replace components and the fault continues to recur. However, consider if the MGS was shut down due to a GMR 25 LFNG, then you will begin troubleshooting in the power not applied configuration. You do not want to apply power to the MGS if the restriction is preventing proper MGS cooling. Therefore, keep it in the back of your mind that the restriction could be somewhere in the MGS or the coolant lines leading to the MGS. The remainder of the GMR 25 LFNG troubleshooting, using a power not applied configuration, is focused on the G&C liquid cooler. Here is a list of chiller components that could possibly be creating the restriction:

- Hoses.
- Control valve.
- Coolant chiller unit.
- Coolant pump assembly.
- Filter cartridge assembly.

The procedures will step you through the process of isolating the components and replacing them as required. Eventually, you may be directed in the procedures to check the hoses leading to the MGS. To do this, you will have to get MMT to couple the hoses at the umbilical connector. The reason being, you will need to configure your test set in the power-applied configuration, and you still do not want to apply power to the MGS without sufficient cooling. If the lines checkout good, then the blockage is probably somewhere in the MGS.

Electrical and mechanical equipment

The faults associated with the G&C liquid cooler equipment maybe easy to solve or grueling to isolate. The reason being, if you were chasing a GMR 25, but the guidance section liquid cooler checked out properly, then you have to begin signal tracing to determine which drawer or relay maybe casing the alarm to report. For our purpose, we are going to focus on equipment and components that are more directly associated with the G&C liquid cooler.

The following are some equipment items and components that could cause an alarm condition if they were to fail:

- Control valve.
- Coolant chiller unit.
- Coolant pump assembly.
- Electronic control amplifier.

As stated earlier, we are going to focus on the equipment that is associated with the G&C liquid cooler. Therefore, if you were dispatched to troubleshoot a GMR 25 LFNG, there are some things you would want to look for:

- Obvious equipment failures. If you notice the chiller is running, but the pump is not, you may have discovered the problem—the chiller. Reason being, the chiller and the pump share the same power source. If one is working and the other is not, the fault could be the component or possibly wiring (unlikely).
- The control valve that will not open or close when commanded by the test set or the amplifier.
- Insufficient temperature changes in the coolant during testing.
- A locked rotor condition in the 400-Hz pump.

Like with any form of troubleshooting, you always want to be able to rule out the test equipment when you have a failure. To do this, always bring a spare test set with you. If you hook up your spare and end up with the same fault, you can be assured you are on the right path.

Self-Test Questions

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

314. Guidance and control liquid cooling system equipment

1. What is the function of the liquid cooling system?

2. What components make up the G&C liquid cooler?

3. What are the power requirements for the pump assembly?

4. What is the maximum flow rate for the control valve?

5. How much coolant is stored in the tank?

6. What voltage is supplied to the electronic control amplifier?

7. What amplifiers is the output of the bridge circuit used to drive?

315. Guidance and control liquid cooling system operation

1. What determines the rate of coolant flow through the guidance section?

2. What guidance section cooling system component completes vaporization of the refrigerant before it enters the compressor?

3. What happens to the thermistor’s resistance if the guidance section temperature increases?

4. How does the amplifier control the coolant flow rate?

5. What type of G&C cooling system checkout is performed when the MGS is *running*?

6. What should the ambient air temperature be as it is drawn into the G&C chiller?

7. What could a low coolant level indicate during the G&C power applied checkout?

8. What could a high coolant level indicate?

9. Why must the switch on the PG remain in the SET ALARM position while the test set is connected electrically to the G&C liquid cooler?

10. How do you remove MGS power if the GROSS TEMP indicator illuminates?

11. What is done with any excess coolant after a G&C checkout (power applied or not applied) is complete?

12. What are you checking for when using the G&C test set to simulate an operating MGS?

13. When do you refer to trouble analysis during G&C (power applied or not applied) checkout?

3–2. Missile Startup and Coding Operations Description

One of the most important and rewarding aspects of being a missile and space systems electronic maintenance journeyman is having the responsibility of putting an ICBM on strategic alert. However, start up and coding procedures must be accomplished first before you can actually put the missile on alert. In this section, you will learn about missile startup and coding operations for the Minuteman WS.

316. Minuteman missile startup

Several steps must be accomplish before performing a missile startup. One of them is to determine the status of the LF (i.e., is the OGE powered up or down). While you are performing these steps, you will also be coordinating with the MCC at the LCC, who will inform you of the LF's status. The next step depends upon the system status and type of maintenance to be performed. Whatever the case may be, you always coordinate with the MCC before taking any action, except when directed not to by the technical order procedures.

In this lesson, you will be learning about OGE startup in lieu of setting up for a tape load, establishing local control, and applying AVE power. This lesson will act as a lead in for Minuteman coding operations. Let's begin with OGE startup.

Operational ground equipment startup

At the LF, the OGE monitors missile functional performance, provides signals and ground power, maintains the liquid coolant, and the environmental control required to sustain missile operation until launch.

Starting the OGE consists of applying available LF power to electronic equipment cabinets located in the LER. This includes verifying the LF ECS is operating; energizing the LF power supply group, G&C liquid cooler, PG, and other OGE. Once the OGE is up and operating, the next step is to hookup equipment. A fault-locating indicator (FLI) (fig. 3–6) is used for observing GRMs while reading out LF status on the controller-monitor.

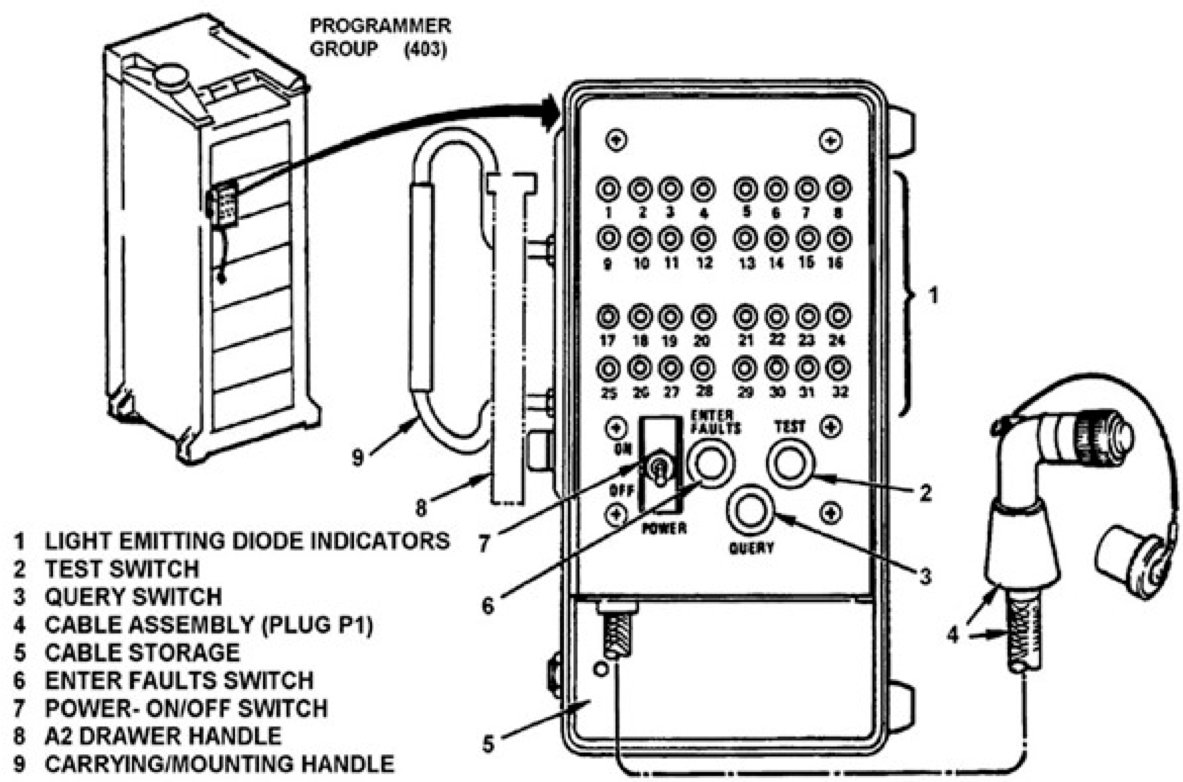


Figure 3–6. Fault-locating indicator.

Once you have the maintenance ground equipment (MGE) controller-monitor (fig. 3–7) and the cartridge tape unit (CTU) in front of the PG (fig. 3–8), establish local control. MCC coordination is required prior to taking local control. The CTU is used only when DCU program loading is to be accomplished.

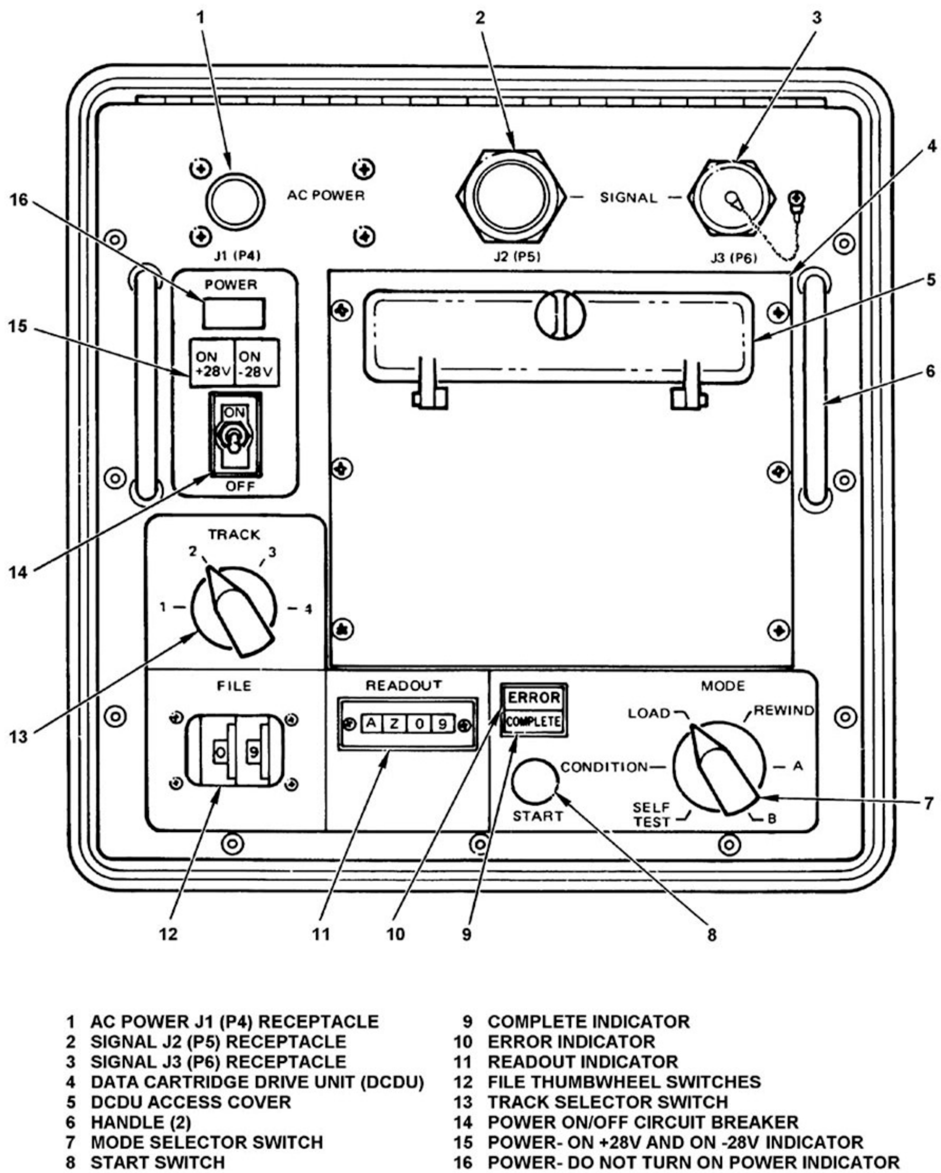


Figure 3–7. Controller-monitor.

Establishing local control

The controller-monitor operator initiates local control mode by pressing the MODE CONTROL switch. Entry into local control mode is required for loading the DCU program and for performing other maintenance tasks at the LF such as reading out MOSR words. Local control is available during all modes of operation, such as local data readout, IMU CAL 1 or 2, missile test, or Phi CAL.

Determining mode of operation

After you establish local control, follow the procedures and readout all LF and multiplexer status; circle the indications that you observed illuminated on the LF fault record. Once that is complete, refer back to the controller monitor figure 3–7 to determine the G&C system mode of operation. Using the LF fault record, look at figure 3–9 and determine which lights were illuminated.

For our purposes, the IDLE and G&C POWER ON lights on the coupler unit and the DRAWER CONTROL, ANY NO-GO, and 3 and 4 on the controller-monitor are illuminated. Follow the row over to the far right column (LF status and G&C system mode of operation). The LF is in critical NO-GO status. When you have determined the mode of operation, the next step is to determine the task requirements.

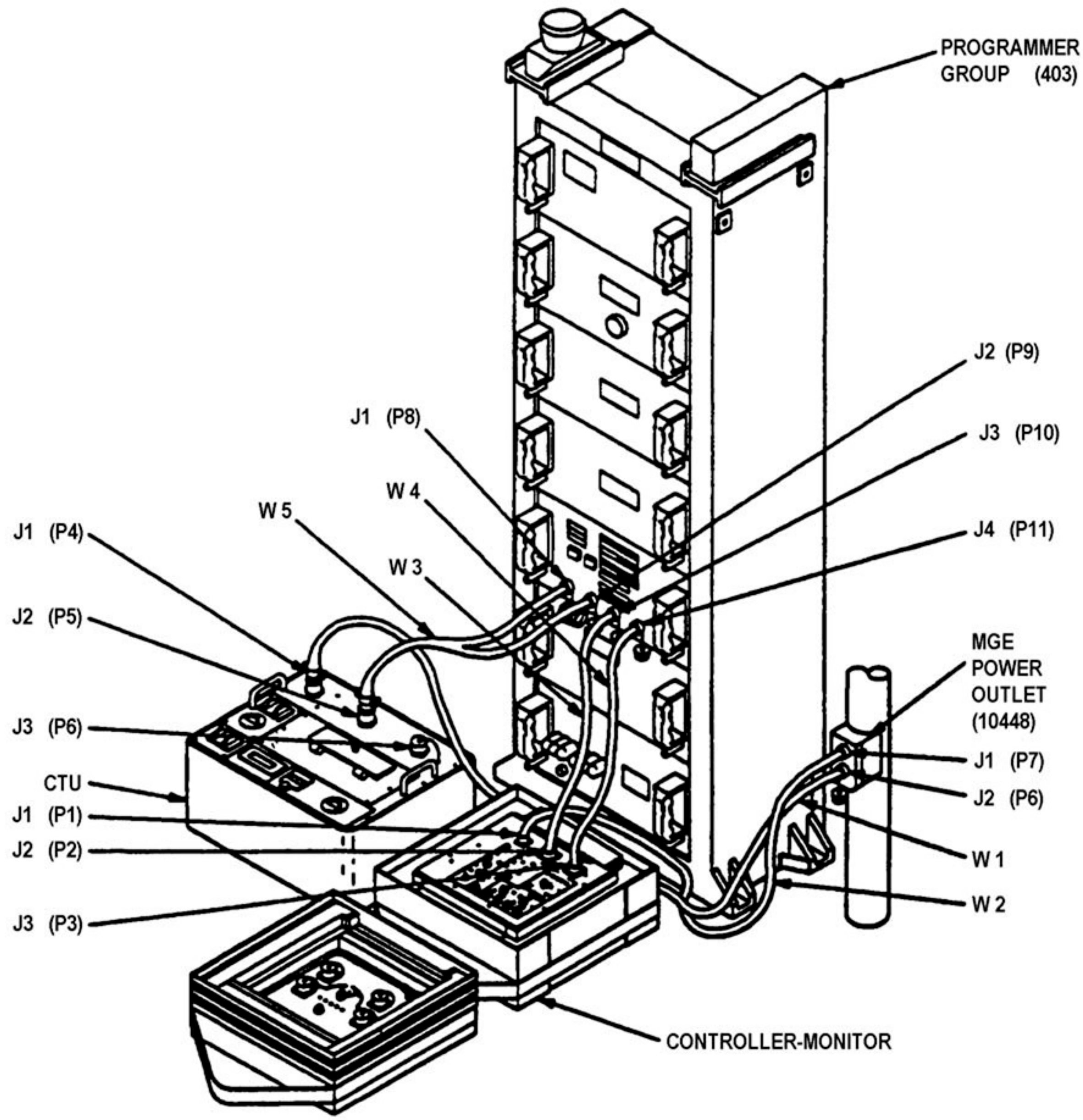


Figure 3–8. Cartridge tape unit in front of the PG.

COUPLER UNIT			CONTROLLER-MONITER														LF STATUS AND GUIDANCE-CONTROL SYSTEM MODE OF OPERATION
							STATUS GROUP SELECT / LF STATUS					DCU READOUT (FLUTTERING)					
COMPUTE	IDLE	G&C POWER ON	COMPUTE	DCU CONTROL	DRAWER CONTROL	ANY NO-GO	D 1	D 2	D 3	D 4	D 5	8	4	2	1	0	
	ON	*** ON			ON	ON			** ON	ON		MAY BE DISREGARDED					CRITICAL NO-GO
	ON				ON				ON	ON		MAY BE DISREGARDED					IDLE (AVE POWER OFF)
	ON	ON			ON				** ON	ON		**** MAY BE DISREGARDED					IDLE (AVE POWER ON)
ON		ON	ON	ON				ON				SEE NOTE	ON		ON		ALIGNMENT
ON		ON	ON	ON				ON					ON				STRATEGIC ALERT (BIASING)
ON		ON	ON	ON				ON						ON	ON		STRATEGIC ALERT (PIGA LEVELING) <
ON		ON	ON	ON				ON					* ON	* ON	* ON		MISSILE TEST
ON		ON	ON	ON				ON					ON	ON			IMU CALIBRATION / PHI CALIBRATION
ON		ON	ON	ON				ON						ON			[BGRP] SAT CALIBRATION / [AGRP] PSAT CALIBRATION
ON		ON	ON	ON				ON							ON		RESTART
ON		ON	ON	ON				ON								ON	STANDBY NO-GO
ON		ON	ON	ON				ON				ON					STANDBY NO-GO (WITH FAULT DATA CHANGE)
ON		ON	ON	ON				ON				ON	ON	ON	ON		STANDBY NO-GO OVERWRITE IN PROCESS <

* INDICATOR ON (STEADY STATE)
** INDICATOR MAY BE ON OR OFF
*** WHEN ON, INDICATES A G&C CRITICAL NO-GO IN LOCAL
**** [AGRP] INDICATORS 4 OR 4 AND 1 ON AFTER AVE POWER TURN-ON <

NOTE: (SOLID BLOCKS) REPRESENT DCU READOUT 8 (FAULT DATA CHANGE) INDICATION. WHEN OBSERVED ON, READOUT MOSR WORDS AND INTERPRETATION OF RESULTS ARE REQUIRED. MOSR WORDS CAN ONLY BE READ WHEN [BGRP] LOCAL COMMUNICATIONS ARE AUTHORIZED IN THE PROGRAM DATA BUFFER AND < THE SYSTEM MODE OF OPERATION IS ALINEMENT, STRATEGIC ALERT, [AGRP] IMU OR PHI CALIBRATION,< RESTART OR STANDBY NO-GO.

Figure 3–9. Maintenance ground equipment setup.

Task requirements

Task requirements are determined by locating on figure 3–10 the block intersected by the horizontal row for the respective TASK OBJECTIVE and the vertical column for LF STATUS AND GUIDANCE-CONTROL SYSTEM MODE OF OPERATION that you determined earlier while establishing local control. The letters with the block located at the juncture are keyed to STEP and TASK REQUIREMENTS. Having identified the TASK REQUIREMENTS, perform them in the order given. Let's say for our purposes, we are going to do a DCU program load with the LF in critical NO-GO status.

Looking at figure 3–10, under the task objective, locate load DCU program box. Then, find the critical NO-GO box and run your fingers down the page until you come to the load DCU program. The corresponding letters tell you what procedures to run in that order. For our purpose, we will follow A, B, E, F, and S. By looking at the graphic, you can see we have already accomplished step A. The next step is B: startup AVE (fig. 3–10, Task Requirements column, far right).

TASK OBJECTIVE	LF STATUS AND GUIDANCE-CONTROL SYSTEM MODE OF OPERATION											
	CRITICAL NO-GO	OGE POWER OFF	IDLE (AVE POWER OFF)	IDLE (AVE POWER ON)	ALIGN-MENT OR RESTART	STRATEGIC ALERT (BIASING)	STRATEGIC ALERT (PIGA LEVEL-ING)	MISSILE TEST	CALIBRATION PHI	CALIBRATION IMJ	CALIBRATION [BGRP] SAT< [AGRP] PSAT<	STAND BY NO-GO**
RESTART SYSTEM	A, B, F, S	A, B, F, S	B, F, S	F, S								D, J, S
RESTART SYS-TEM (WITHOUT CONTROLLER-MONITOR		A, B, S	B, S									
LOAD DCU PROGRAM	A, B, E, F, S	A, B, E, F, S	B, E, F, S	E, F, S	E, F, S	E, F, S	E, F, S	G(2), E, F, S	E, F, S	E, F, S	E, F, S	D, E, F, S
OVERWRITE DCU PROGRAM	A, B, H	A, B, H	B, H	H	H	H	H	G(2), H	H	H	H	D, H
INITIATE MISSILE TEST					G(1), I	I	N, I		G(3), I	G(4), I	G(5), I	I
[AGRP] INITIATE IMU CAL PHI CAL OR PSAT<					G(1), T	T	N, T	G(2), T	G(3), T	G(4), T	G(5), T	J, G(1), T
SHUT DOWN AVE AND/OR CGE	L		L	K, L	K, L	K, L	K, L	G(2), K, L	K, L	K, L	K, L	D*, K, L
CHANGE CODE IN CSD	M	M	M	M	M	M	M	M	M	M	M	M
EXIT STRATEGIC ALERT- PIGA LEVELING							N, S					
RESET MGS FOLLOWING G&C NO-GO IN LOCAL	C, B, F, S			C, F, S								
PREPARE LF FOR REMOTE OVERWRITE	A, B, F, P, Q, R	A, B, F, P, Q, R	B, F, P, Q, R	F, O, P, Q, R	O, P, Q, R	O, P, Q, R	O, P, Q, R	G(2), O, P, Q, R	O, P, Q, R	O, P, Q, R	O, P, Q, R	O, Q, R

STEP	TASK REQUIREMENTS
A	START UP OGE
B	START UP AVE
C	ISSUE RESET COMMAND CODE
D	READ OUT MOSR AND INTERPRET RESULT (S)
E	LOAD DCU MEMORY PROGRAM
F	INITIATE STRATEGIC ALERT-BIASING
G	WAIT FOR GUIDANCE-CONTROL SYSTEM TO RETURN TO STRATEGIC ALERT- BIASING: 1. ALIGNMENT 2. MISSILE TEST 3. PHI CALIBRATION 4. IMU CALIBRATION 5. [BGRP] SAT [AGRP] PSAT
H	OVERWRITE DCU MEMORY
I	COMMAND MISSILE TEST
J	EXIT STANDBY NO-GO MODE
K	SHUTDOWN AVE
L	SHUTDOWN OGE
M	CHANGE CSD CODE
N	EXIT PIGA LEVELING MODE
O	MEASURE G&C POWER VOLTAGE
P	SELECT AND ENTER COMMAND CODE 13 OR FORCE GUIDANCE-CONTROL TO STANDBY NO-GO
Q	TRANSFER TO REMOTE
R	NOTIFY JOB CONTROL AND MCC THAT REMOTE OVERWRITE IS TO BE PERFORMED, GUIDANCE CONTROL SYSTEM WILL SHUTDOWN AT TERMINATION COMMAND FOLLOWING THE REMOTE OVERWRITE COMMAND FROM LCC
S	NOTIFY JOB CONTROL OF GUIDANCE-CONTROL SYSTEM MODE OF OPERATION AND DETERMINE IF FURTHER MAINTENANCE IS REQUIRED
[AGRP] T	COMMAND CALIBRATION 1. IMU CALIBRATION 2. PSAT CALIBRATION 3. PHI CALIBRATION

* TASK REQUIREMENT D REQUIRED ONLY WHEN A CONTROLLER-MONITOR AS AVAILABLE
** WITH OR WITHOUT FAULT DATA CHANGE

Figure 3–10. Matrix for determining task requirements.

Aerospace vehicle equipment startup

The OGE must be on before performing AVE startup. The procedures will lead the technician back to accomplishing OGE start up. The controller-monitor will be used for AVE startup when any of the following is accomplished:

- G&C coupler drawer is replaced.
- Maintenance is performed on the D-box.

- MGS is replaced or removed and reinstalled.
- Cable/power signal distribution unit (PSDU) repair is accomplished.

Use of the controller-monitor for AVE startup is *not* required for the following actions:

- Following RS maintenance.
- Providing remote MGS overwrite.
- If a MGS replacement or complete or partial DCU program load (tape load) is not required.

AVE startup for other reasons does not require the use of the controller-monitor, but it may be used at the option of the missile maintenance operation center (MMOC).

Starting up the AVE consists of applying power to the missile and G&C liquid cooler from the power supply group, PG, and D-box. Any time abnormal indications are observed, refer to the corrective actions column to resolve the issue. Once the AVE is started up, refer back to the procedures, and determine the next step. For our purposes, the next step is loading the DCU memory program.

317. Minuteman coding operations

In this lesson, we will cover the Minuteman coding operations to include DCU memory loading, initiating strategic alert, and code-change operations. Computer program loading at the LF consists of transferring data from a launch facility load cartridge (LFLC) into the DCU memory to support ground monitoring, processing, and in flight functions. The following paragraphs explain the sequences of events during memory loading and strategic alert.

Digital computer unit memory loading

Computer program loading consists of transferring data from an LFLC cartridge into the DCU memory. The computer program data loaded into the DCU memory at the LF are contained on magnetic tape cartridge (fig. 3–11) and entered via the CTU. Whenever DCU program loading operations involve a code change loading only, OGE and AVE startup are not normally required since the G&C system will already be in a strategic alert.

DCU program loading requires use of a CTU, controller-monitor, cable set, and an LFLC. File loading requirements vary in accordance with the intent of DCU program loading task objective. A complete load of files (fixed and variable data) is required for the following tasks:

- Loading a DCU memory that has been overwritten.
- Initially loading the DCU memory of an emplaced or replaced MGS.
- Updating ground and flight data previously loaded into the DCU memory.
- A partial loading of files (variable data) is required whenever a squadron or LF code change is performed.

Digital computer unit tape load and verify sequence

The DCU tape load and verify begins when the DCU enters load mode processing and penetration codes are loaded in memory. A complete load cartridge is required to complete DCU tape load and verify operations. When tape loading begins, penetration codes are read from the tape and compared to the factory penetration codes stored in the dedicated memory. A match opens the DCU random access memory (RAM) to tape fill and verify operations.

If penetration codes do not match, DCU READOUT 11 (penetration code verify failure) is displayed and tape load is halted. Upon completion of tape fill and verify operations, factory penetration codes are replaced with secure penetration codes and computer memory security check (CMSC) processing is performed. During the tape load, the static random access memory (SRAM) battery is disconnected via a software switch during fill and verify operations and then reconnected prior to CMSC processing. DCU READOUT 0 through 12 and 15 indicates errors detected during DCU initialization (power turn-on) and tape loading.

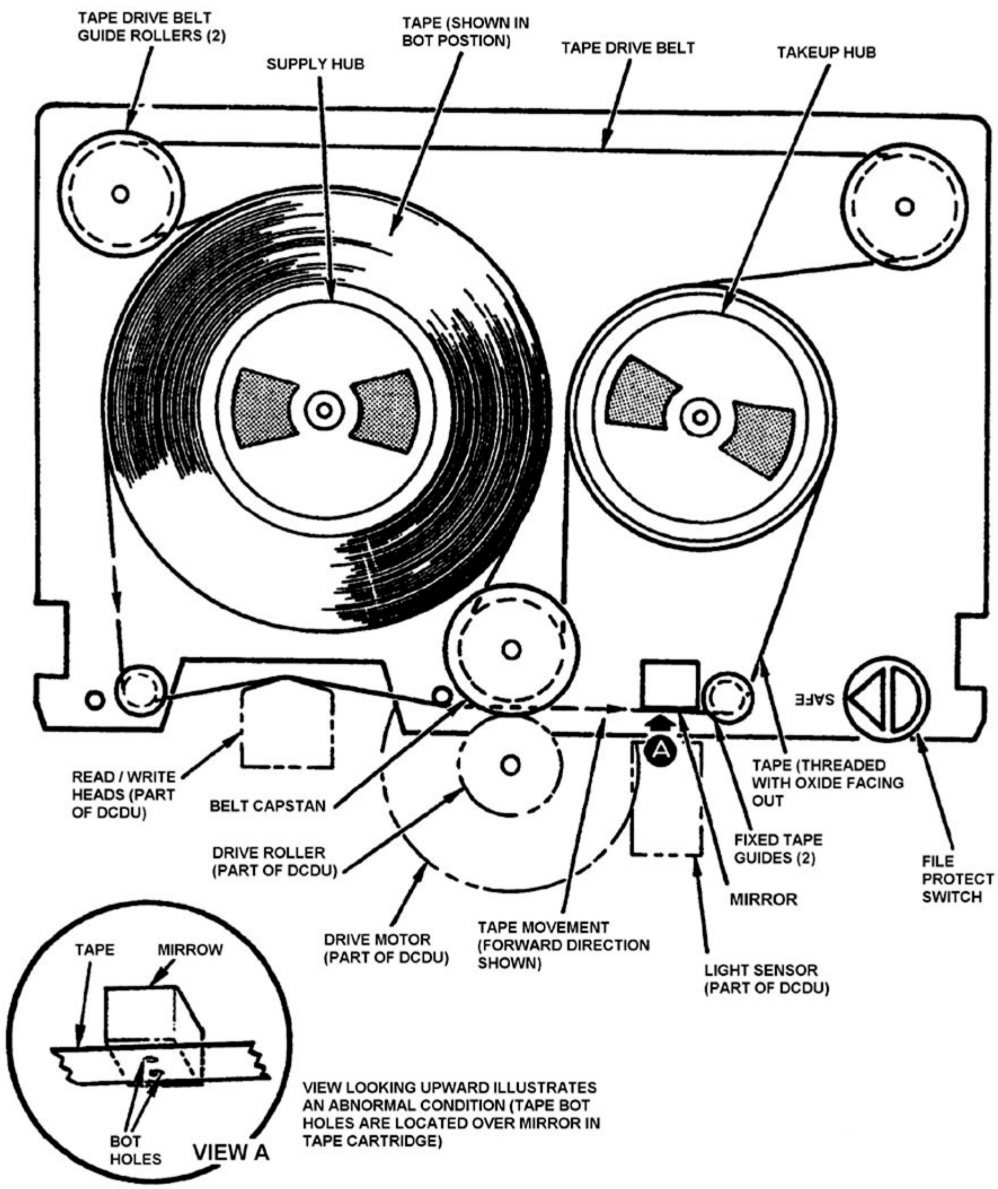


Figure 3–11. Magnetic tape cartridge.

Computer program tape cartridges and tapes

The computer program, contained on a MTC, provides the DCU with the software program necessary for ground monitoring, target and launch execution plan change, code processing, and in-flight control. Program information is provided as a number of files containing fixed and variable data recorded on a four-track magnetic tape cartridge. The Wing Code Processing System (WCPS) generates the three types of LFLCs using data from the MGS parameters tape, the operational ground program (OGP)/operational flight program (OFP) tape, the flight program constants tape, and the W data (LF unique data).

The following LFLCs are generated by the codes vault:

1. A complete load cartridge, allowing the SRAM to load in the DCU completely.
2. A code change LFLC for performing code change at the LF.

3. A penetration D LFLC for local overwrite at the LF, and may be used to disable the SRAM battery by setting the battery discrete flag to true purging the SRAM memory for long term system shutdown.

Cartridge tape unit self-test

The CTU self-test is a prerequisite to performing DCU program loading at the LF and, when successfully completed, ensures functional adequacy of the CTU for operations. Any subsequent self-testing of the CTU during a dispatch to the LF is initiated at the discretion of the team chief. A CTU self-test is initiated by the operator during DCU program loading preparations. This consists of applying power to the CTU, placing the MODE switch at SELF-TEST position, and pressing the START switch to execute the initial test sequence. While progressing through the self-test, the operator manually sets the appropriate switches per the procedure. Approximately three minutes are required to complete testing. On successful completion, the READOUT indicators on the CTU will display END and COMPLETE.

LFLC acclimation

Prior to performing DCU program loading at the LF, the LFLC may require a period of temperature stabilization if the cartridge inside the tape cartridge carrying case has been exposed to extremely cold (below –10 ºF) or extremely hot (above 100 ºF) temperatures for a period of more than 2½ hours. To accomplish the acclimation, open the tape cartridge carrying case and expose the MTC to the LF ambient temperature for at least 15 minutes.

LFLC conditioning cycle

An LFLC must be conditioned prior to initial use to ensure the adequacy of the tape cartridge drive belt tension on the tape. The CTU automatically performs the LFLC conditioning cycle after the operator places the MODE switch on the CTU to CONDITION and initiates the sequence by pressing the START switch. The conditioning process advances the tape at 90 inches per second until the early warning hole on the tape is detected.

LFLC tape track identification block readout

Each track of the four-track magnetic tape contained in an LFLC has a recorded tape track identification (ID) block. The tape track ID block is located at the beginning of each track and contains recorded identifier information. However, the CTU operator reads out only the ID block of tape track 1 prior to loading file data. Tape track 1 ID block information readout is displayed on the READOUT indicators of the CTU control panel. The information displayed identifies that the tape cartridge recorded file data is only valid for loading at a particular LF located in a certain flight within a designated squadron.

Prior to DCU program loading or overwrite, the CTU operator performs readout of tape track 1 ID block information when required by procedure. After initial readout of the tape track 1 ID block has been performed during a dispatch, subsequent readout of the tape track 1 ID block is not required. The purpose of tape track ID block data is to identify to the operator that the tape cartridge contains file data applicable for loading the DCU memory at the LF to which dispatched. The operator performs the readout by placing the MODE switch on the CTU at LOAD, TRACK switch at 1, setting the FILE switches for the pen D file, and then pressing the START switch on the CTU in order to initiate the readout. Selection of track results in a READOUT display of identifiers is read from left to right. Left indication (1 through 4) identifies squadron; next indication (1 through 5) identifies flight; and the remaining indication displayed (02 through 11) identifies LF number.

For example, the track ID reads 3204 for Wing 5. Using the information given, the “3” represents the third squadron, Kilo through Oscar. The “2” represents Lima flight and the 04 is LF–04. The LFLC then contains data for Lima–04. The DCU program loading must be discontinued whenever the tape track ID block identifiers displayed are incorrect or do not compare with the LFLC label information.

During DCU program loading, the CTU reads bits of recorded data on the magnetic tape and converts this data to electrical pulses for transmission to the DCU, via the coupler unit. A file search and file ID readout are initiated when the applicable track and file selections have been manually set, the MODE switch has been placed at LOAD, and the START switch has been pressed. The selected track is scanned for the desired file. When detected, the first data block ID is read and four identification characters are displayed, causing a READOUT display on the CTU in alpha or alphanumeric combination and identifying the program file data about to be loaded.

The operator (after determining that the READOUT display is correct) proceeds to load the selected file by pressing the TAPE START switch on the controller-monitor. At the same time, the tape start signal from the controller-monitor, via the coupler unit, places the coupler logic in the fill mode. This causes the ERROR or COMPLETE indicator on the CTU to go off, if on. When tape data is output, the first DCU fill code is read, resulting in entry to the conditional fill mode; then the penetration code, which follows, is stored in reserved locations in the DCU memory. The next code, enter, causes the DCU to make a bit-by-bit comparison of the DCU penetration code read from the data block with the DCU penetration code stored in other locations of the DCU memory. If the two codes match, the DCU enters the load mode true condition and the FILL indicator on the controller-monitor illuminates, signifying entry to fill sequence.

Fill sequence

When the fill sequence is entered, detection of the enable write on code by the coupler unit causes activation of DCU logic, which allows program data, recorded on the data block to be written into the DCU write protected SRAM. Entry to the fill sequence will be blocked whenever load mode signal is set false and will, instead, result in entry to a fill interlock condition (FILL INTERLOCK indicator on the controller-monitor illuminates). When the DCU detects a parity error during the fill sequence, it causes the enable write on signal to be reset, the CTU to stop, and the parity or verify (P/V) ERROR indicator on the controller-monitor to illuminate. When the CTU detects a parity error during fill, it causes the ERROR indicator on the CTU and TAPE PARITY ERROR indicator on the controller-monitor to illuminate.

Verify sequence

After the fill portion of the data file has been written into the DCU memory, the CTU reads the verify codes of the file and the coupler unit and DCU enter the verify mode. This causes the VERIFY indicator on the controller-monitor to illuminate. The enable write false code on the file prevents further writing into the DCU memory. The DCU starts to compare the file information following the verify code, with the information already stored in its memory. If the data on the verify portion of the file does not match the data loaded into the DCU memory during the fill sequence, the DCU issues a P/V error signal. This signal causes the P/V ERROR indicator on the controller-monitor to illuminate and the CTU to stop.

Compute sequence

A short compute routine, recorded on several of the LFLC files, is stored in the hot storage portion of the DCU memory. This routine enables the DCU to initiate a display of an identification number, via the DCU READOUT indicators on the controller-monitor. All files, except the pen D (track 1, file 01), IMU parameter (track 4, file 01), and a portion of the OGP (track 2, file 04) contain an identification number. Display of the ID number identifies that the selected file has been entered successfully into the DCU memory.

End-of-file

The CTU determines that end-of-file has been reached when a tape mark is detected. The tape is rewound automatically to the beginning of tape holes, the COMPLETE indicator on the CTU illuminates, and on the controller-monitor, the PROGRAMMED STOP indicator illuminates. This combination of events identifies to the operator that the selected file has been loaded successfully and the next selection may be made.

Computer memory security check routine

During the CMSC routine, the DCU operates on memory data associated with the G&C system to validate that the data, P-plug, and non-RDC words were filled properly into the DCU memory. A checksum of write-protected SRAM memory is performed during the CMSC routine. A checksum failure results in the display of a G&C NO-GO and DCU READOUT 0 indication and precludes continuing operations until corrective maintenance is performed.

During the CMSC routine, the DCU READOUT indicator displays DCU READOUT 15 (8, 4, 2, and 1 indicator lights) continually. The final display, a blinking DCU READOUT 15, informs the controller-monitor operator that CMSC processing is complete and the CMSC number is ready to be read out on the controller-monitor keyboard. The CMSC number, a 32-bit binary (8-digit hexadecimal) number, is read out four bits at a time by the operator and is recorded as eight hexadecimal digits.Verification with the base code controller that the number obtained agrees with the number recorded at the MSB, confirms that the DCU memory has been successfully loaded. If the recorded number disagrees then contact the MMOC. The next task to perform after the tape load is to initiate strategic alert.

Sequencing to strategic alert

Following successful readout of the CMSC number, the operator initiates system entry into the compute mode in order to begin execution of the OGP. The coupler unit exits idle and goes to compute after which the DCU enters the alignment mode for a specified period. On completion of alignment, the system exits to strategic alert.

Entry into the alignment routine, with startup indicator set true (LF STATUS D–3 on), is initially indicated by DCU READOUT 4 and 1 indicator display on the controller-monitor. If startup indicator was set false (LF STATUS D–3 off), entry to alignment is indicated by DCU READOUT 1 (restart) being displayed immediately. Alignment functions are delayed for 35 minutes whenever entry to alignment was not preceded by file 04 information DCU complete load file. This 35-minute delay ensures a sufficient time for warm-up of the PIGA before gyro stabilized platform (GSP) slewing and leveling is initiated.

Digital computer unit initialization sequence

The DCU initialization sequence is very fast, lasting only a few milliseconds. Initialization begins when 28 volts is applied to the G&C. The DCU enters self-test and displays DCU READOUT 1 (DCU initialization in process) on the controller-monitor. Self-test is a pass/fail test with a failure indicated by DCU READOUT 2 (DCU self-test failure) indicated on the controller-monitor along with a G&C NO-GO indication or an AVE NO-GO indication if no controller-monitor is present. Following a successful self-test, the SRAM battery voltage is checked. Low voltage causes a DCU READOUT 3 (backup battery voltage failure) with a G&C NO-GO or AVE NO-GO indication displayed.

The SRAM battery flag discrete is checked. If the flag is true, a software switch turns the battery on, the SRAM memory is purged, and factory penetration codes are loaded to unlock the memory and prepare it for program loading. DCU READOUT 4 (factory penetration codes loaded) indicates successful loading of factory penetration codes. DCU READOUT 11 (penetration code verify failure) displays if factory penetration codes are not loaded properly. A battery flag discrete set false indicates the battery has already been turned on and the SRAM memory contains stored data. Factory penetration codes are not required and a DCU READOUT 5 (successful ground power cycle) is displayed on the controller-monitor. DCU initialization is complete when either DCU READOUT 4 or 5 are displayed on the controller-monitor.

Alignment modes

Two alignment mode entries are available during ground initialization—initial and restart.

The initial alignment mode is a transitional mode of G&C system operation that occurs when the DCU enters compute following either an AVE startup, or a complete or partial load of the DCU memory.

The restart alignment mode of G&C system operation occurs when any of the following happen:

- The coupler unit issues a master reset with the startup indicator set false and a partial tape fill sequence was not performed.
- An IMU CAL 1 calibrate command is issued during standby no-go with no overwrite in process.
- A PSAT CAL command is issued during strategic alert biasing with MOSR 50 (gyrocompass assembly [GCA] failure No. 1) or MOSR 59 (GCA/platform indexing advised) set true.
- The coupler unit issues a master reset pulse following loss of keep-alive codes. Following a specified time in the initial or restart alignment mode, the guidance-control system exits to strategic alert biasing.

During ground initialization and alignment, operations are performed to index the GCA relative to the GSP, erect and align the downrange axis of the GSP to a specific target, fuze the RS, and conduct the necessary gyro/PIGA bias cycles. All MOSRs are reset, except MOSR 72 (IMU CAL advised), MOSR 53 (PSAT CAL advised) and MOSR 65 (Phi CAL advised). The DCU program data buffer is authorized and identification is set to missile test if a complete or partial loading of the DCU memory was performed. In performing these operations, the alignment portion of the OGP controls the following functions:

- Erection and leveling of the GSP.
- Referencing the GCA axis to the GSP axis.
- Application of power to the GCA (GCA rotor turn-on) during initial alignment.
- GSP alignment to the target azimuth and initial gyrocompass gyro input axis azimuth alignment to an east heading.
- Calculation of gyro and PIGA biases.
- Calculation of an initial azimuth misalignment angle.
- Calculation of missile roll attitude angle.

Timing requirements

An initial alignment routine normally requires approximately one hour and 45 minutes up to two hours and 30 minutes includes 35 minutes for PIGA warm-up, if applicable. Approximately 40 minutes is required to complete a restart alignment routine. Upon successful completion of the alignment routine, the system exits to strategic alert biasing. Detection of an absolute PIGA bias failure during initial bias cycles will result in system exit to the standby NO-GO mode.

Strategic alert is the launch readiness mode of the guidance-control system. Processing operations performed, while in this mode, are dependent on the environment condition that prevails. When the environment is determined to be non-hostile, the system operates in the strategic alert-biasing mode. In a hostile environment, the system operates in the strategic alert-PIGA leveling mode. Upon entry into either the biasing or PIGA leveling mode, the system remains in that mode indefinitely until a command code is received or a fault occurs that causes exit to another mode.

Strategic alert biasing

Strategic alert biasing is the mode of operation wherein processing operations are performed to ensure launch readiness in a non-hostile environment (seismic, DCU circumvention, and circumvention reset set false). During processing, the following operations are performed:

- Maintain the GSP level (level detector No. 1 reference) and aligned to a specific target azimuth (roll gimbal edge azimuth reference).
- Compute PIGA and gyro biases.
- Compute a precise azimuth heading for the GSP.
- Track missile attitude excursions from initial reference position.
- Check inertial instrument performance.
- Generate failure mode data whenever a failure occurs.

Strategic alert biasing is entered following successful completion of alignment, missile test, IMU CAL segment 1 or segment 2, PSAT CAL or Phi CAL or upon system acceptance of PSAT CAL command issued while in strategic alert-PIGA leveling. The system will remain in the strategic alert-biasing mode indefinitely until it receives a command or a fault occurs that causes exit to another mode of operation.

Strategic alert-PIGA leveling

Strategic alert-PIGA leveling is the mode of operation wherein processing operations are performed to ensure launch readiness in a hostile environment seismic; DCU circumvention or circumvention reset set true seismic, or DCU circumvention set true. The following are the processing operations performed in this mode:

- Maintain the GSP in level and aligned to a specific target azimuth (as determined from calculation of gyro bias and GSP attitude errors when the GSP is operating in the free inertial mode).
- Track missile attitude excursions from the initial reference position.
- Check inertial instruments for proper operation.

The G&C system enters PIGA leveling upon detection of a hostile environment. However, performance of PIGA leveling functions will be delayed if GCA slew is being performed during strategic alert biasing or whenever the system is operating in the alignment, IMU CAL, PSAT CAL, or Phi CAL mode. Since no indication is available in the local mode of operation for the operator to determine if the system is in strategic alert-PIGA leveling mode, communication with the LCC must be established to determine status. If the system is in strategic alert-PIGA leveling mode, the LCC may issue a PIGA leveling exit command to the DCU or a PSAT calibrate command may be issued in local mode. This will result in a guidance-control system exit from the PIGA leveling mode and re-entry to a strategic alert non-hostile environment status.

When the LF reaches strategic alert, record on the LF fault record the time the guidance-control system entered into strategic alert. Contact the MMOC to determine post maintenance requirements and then coordinate with the MCC to transfer the LF to remote control.

Code change operations

Each missile squadron normally performs a code change once a year. Changing the code components ensures the encryption of messages between the LCCs and LFs are authentic.

Three code change operations may be performed at the LF.

- Changing the LF unique (W-Tape It) data in the DCU.
- Changing the enable code in the command signal decoder-missile (CSD[M]).
- Loading the SDU keying variable in the message processor of the LF PG. Keying variable changes may be made independently of other code change activities.

Changing the LF unique data in the DCU was discussed in the previous lesson. Code changing at the LF includes loading the PG SDU keying variable and changing the CSD(M) code.

An authorized code handling team is required to load the SDU keying variable. The enable subsystem provides a link between the LCC and its LFs to authorize the launch of selected-missiles. Two units in the enable subsystem that contain secure codes are the LEP at the LCC and the CSD(M) in the missile between the first and second stages. When the enable codes are changed, a coordinated squadron wide code change is required.

Secure data unit keying variable

The LF keying variable is loaded into the SDU in the message processor (403A4) using a SKL. The SKL is a hand-held device that connects to the SDU fill port via a fill cable. Access to the SDU fill port is achieved by loosening eight captive fasteners on the SDU door on the front of the message processor drawer. The door is raised approximately 180 degrees and slid left until the locking bar engages a setscrew enabling the door to remain open. (Refer back to figure 2–42 in unit 2 of this volume.) By changing the keying variable in the SDU, two-way secure data may be passed between a LF and a LCC having identical keying variables. During code change, a loss of two-way secure data communications between the LF and its parent LCC is experienced until both have identical keying variables.

Command signal decoder-missile

The CSD(M) contains either a maintenance or test XYL code when the missile is initially installed in the LF. Any operational code contained in the CSD(M) must be changed to a maintenance or test code before the missile can be removed from the LF. The code changing procedures assume that required coordination and LF entry procedures have been completed. Upon completion of code changing operations, the electromechanical team (EMT) must have completed all applicable forms.

Changing the code in the CSD(M) is performed using a code change-verifier (CCV) set (consisting of a CCV test set and interconnecting cables). The CCV (fig. 3–12) contains secure codes and must be handled and transported accordingly.

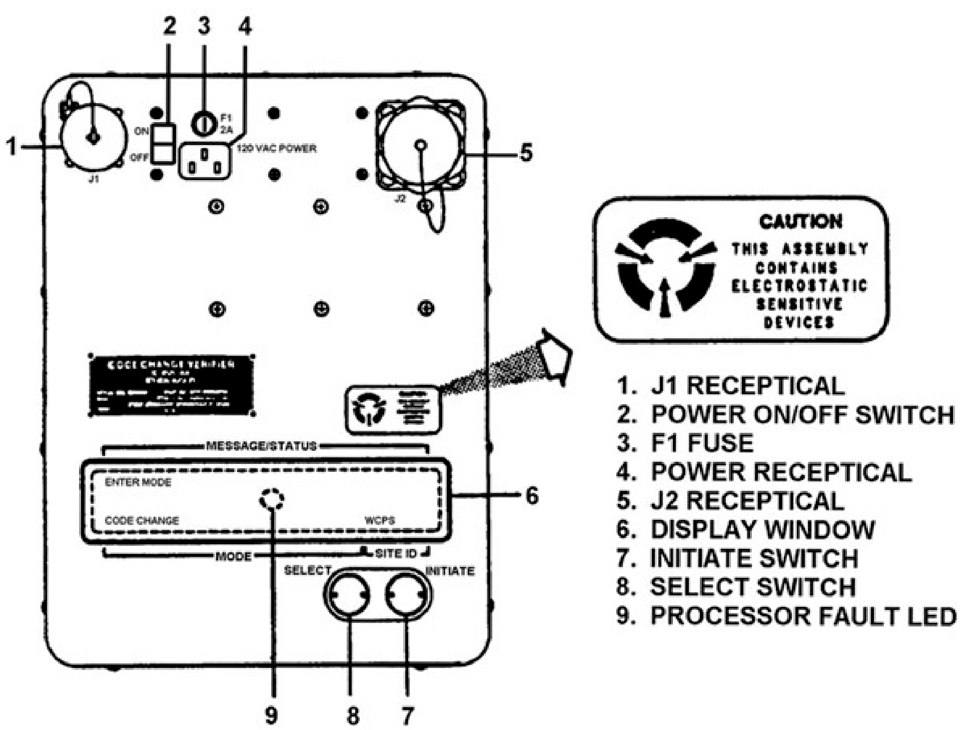


Figure 3–12. Code change verifier.

The code change sequence is divided into four cycles: penetrate (P), insert (I), verify (V), and re-verify (R). Each cycle consists of 32 timing intervals, numbered 1 to 32, thus a reference to P9 identifies the ninth interval of the penetrate cycle. During each interval of the P, I, V, and R cycles, the code device home, armed, 24th bit, and code change enabled status are sampled. Code change terminates when improper status is detected.

During code transmission, the mark and space outputs are sampled and compared bit for bit with the corresponding P, I, or V code in the code change data storage. Any discrepancy results in a code change fault and code change terminates.

For any code change fault, the CCV performs the following:

- Ensures that the step, mark, space, and code change enable (CCE) power outputs are false.
- Issues a code device reset.
- Displays a fault on the status screen, including the fault type, the interval number (when applicable), and where the failure occurred.
- Records the fault, including fault type and interval number (when applicable) in the trace events store.

Penetration cycle

On entry into the penetration cycle, the CCV indicates penetrate on the status display. It outputs the mark/space control signals in accordance with the 1s and 0s respectively of the P code in the sequence in which the WCPS originally loaded it.

Insert cycle

The CCV inserts the I code into the code device upon successful completion of the P cycle or upon sensing the initiate switch. On entry into the I cycle, the CCV indicates insert on the status display. It outputs mark/space control signals in accordance with the 1s and 0s respectively of the I code in the sequence in which the WCPS originally loaded it.

Verify cycle

On entry into the V cycle, the CCV indicates verify on the status display. It outputs mark/space control signals in accordance with the 1s and 0s respectively of the V code in the sequence in which the WCPS originally loaded it.

Re-verify cycle

On entry into the R cycle, the CCV indicates re-verify on the status display. It outputs mark/space control signals at 8 cycles per second in accordance with the 1s and 0s respectively of the P code in the sequence in which the WCPS originally loaded it. When the P, I, V, and R cycles of the code change sequence have been successfully completed, the CCV displays COMPLETE and the verification number received from the WCPS. Code change completion and the verification number are stored in the trace data store. Following the CSD(M) code change, EMT verifies the verification number with the base code controllers at the MSB.

Self-Test Questions

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

316. Minuteman missile startup

1. What piece of equipment is required for observing GMRs while reading out LF status on the controller-monitor?

2. What is required prior to taking local control?

3. What is a required prerequisite when preparing for DCU program loading?

4. What is the next step after you establish local control?

5. What piece of equipment is required for AVE startup whenever the G&C coupler drawer is replaced?

6. What does starting up the AVE primarily consist of?

317. Minuteman coding operations

1. What equipment is required for DCU program loading?

2. Where does the WCPS get the data from in order to generate LFLCs?

3. Why is the CTU self-test performed?

4. What actions are taken when the LFLC has been exposed to extremely cold or hot temperatures for more than 2½ hours?

5. What is the purpose of conditioning the LFLC tape?

6. What does the CTU do after it reads bits of recorded data on the MTC during DCU program loading?

7. During the fill sequence, what happens when the CTU detects a parity error?

8. What events tell the operator that the selected file has been loaded successfully and the next selection may be made?

9. Following successful readout of the CMSC number, why does the operator initiate system entry into the compute mode?

10. Why are the alignment functions delayed for 35 minutes whenever entry to alignment was not preceded by a file 04 information DCU complete load file?

11. What does a battery flag discrete set false indicate during DCU initialization sequence?

12. What two alignment mode entries are available during ground initialization?

13. How long does an initial alignment routine take?

14. What is strategic alert biasing?

15. What is strategic alert-PIGA leveling?

16. How many code change operations can be performed at the LF?

17. What does code changing at an LF include?

18. How is the LF keying variable loaded into the SDU in the message processor (403A4)?

19. During each interval of the penetrate, insert, verify, and re-verify cycles, what enabled statuses are sampled?

20. Following the CSD(M) code change, what does the maintenance team verify?

3–3. Launch Facility Security System

When dealing with nuclear weapons, especially the ones that are deployed to remote locations such as the LF, it is imperative to have secure measures in place to defend against unauthorized personnel from gaining access. The LF security system (LFSS) is divided into an OZ and IZ function. The OZ monitors the above ground area over the launcher and the LSB for detection of attempted intrusion. The IZ monitors the below ground area around the launcher for detection of attempted intrusion. The IZ also monitors the doors and accesses to the launcher for detection of sensitive switch disturbance. The LFSS provides alarm signals and system-test responses for monitoring at the LCC.

318. Security system description

The LFSS uses switches, a penetration detectors, vibration transducers, and radar to detect intruders. The switches and penetration detectors are located at key positions around the LF and cause an alarm when opened or shorted to ground. Vibration transducers in the launcher cause alarms when vibrations are sensed. The Doppler radar generates an alarm when movement in the radar field is detected.

Outer zone components

The OZ components of the LFSS are the antenna group and clutter monument, receiver-transmitter (R/T) alarm set, transducers, switch loops, a transmit filter and radio frequency (RF) ESA, and EFAs. Refer to figure 3–13 as the main components are covered.

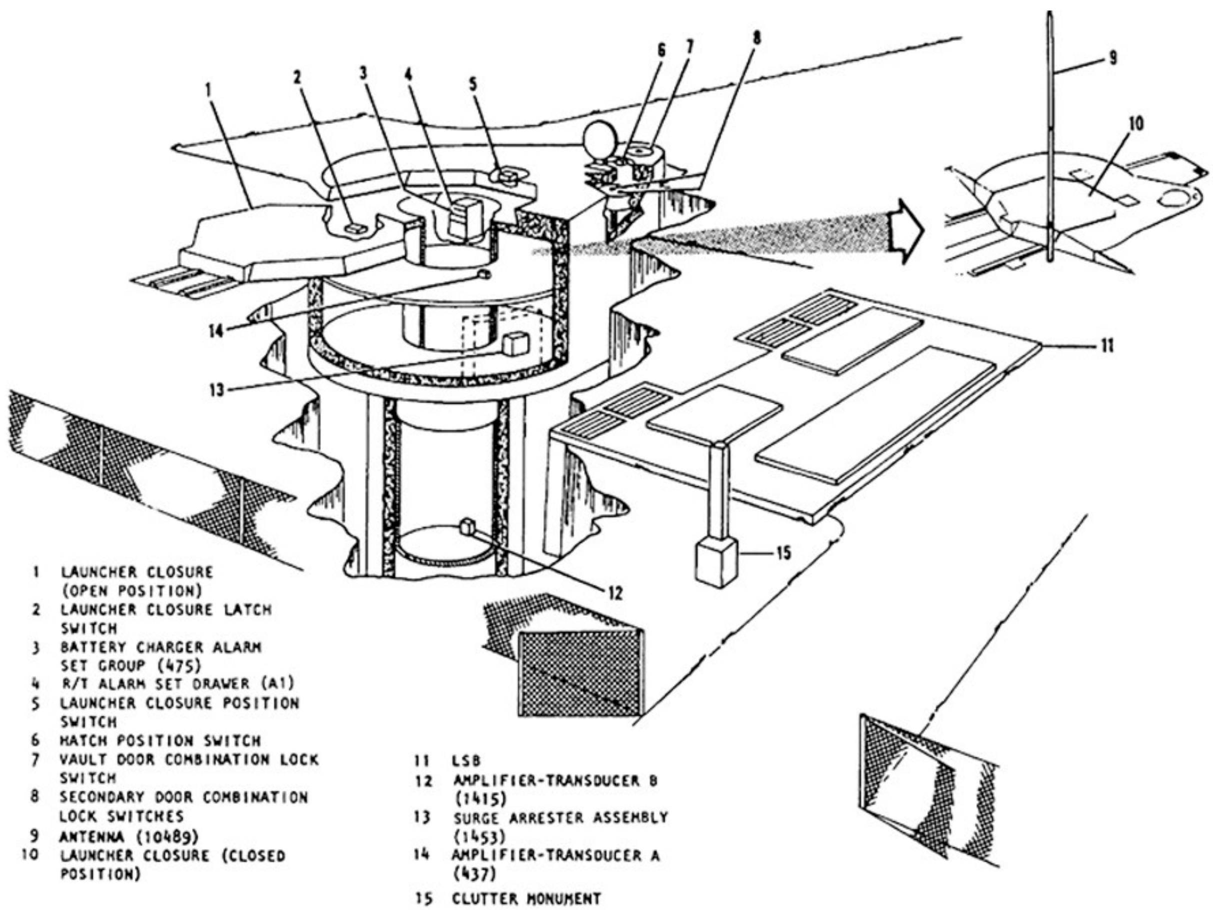


Figure 3–13. Launch facility security system.

Antenna group

The LFSS uses a single mono-static radar system. Figure 3–14 shows the typical location of the antenna on site. The antenna group (fig. 3–15) is approximately 22 feet long, high and mounted on a five-foot pedestal at the breakaway bolt junction. The transmitter antenna is near the top of the mast and the receiver-antenna is several feet below the transmitter antenna. Between the two antennas is an RF absorber assembly to control transmitter-to-receiver coupling. The radome is a fiberglass housing that shelters the antenna element assembly.

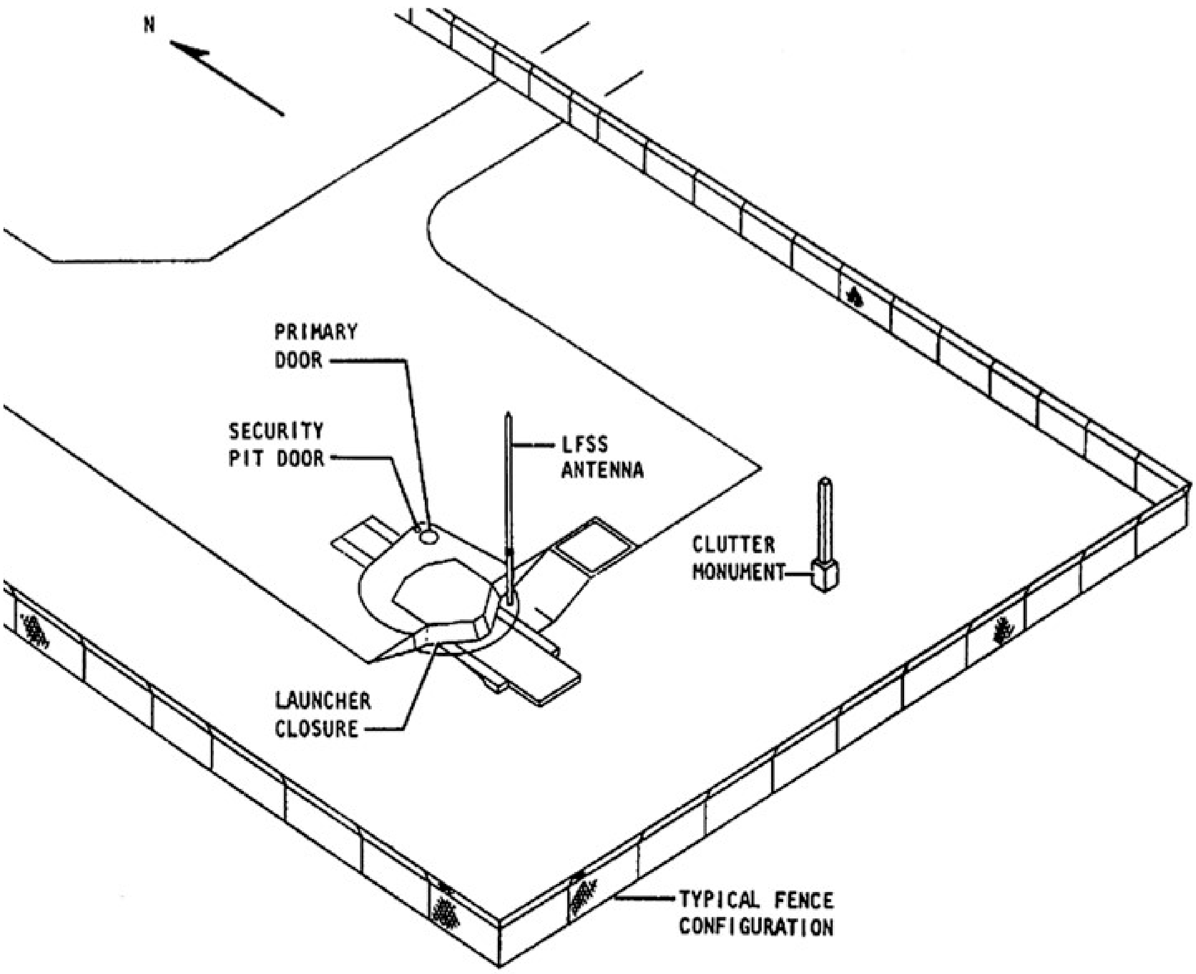


Figure 3–14. Typical antenna location.

Clutter monument

The clutter monument is just a steel square post that was left in place after the deactivation of a previous security system. Its purpose is to provide a clutter level for the OZ security system. This clutter lets the processor know the transmitter and receiver are working. It is a passive component that merely reflects some of the radar signal back to the receive antenna.

On certain sites with unique topographies, a clutter (steel) plate is affixed to the clutter monument to increase the clutter decibel level.

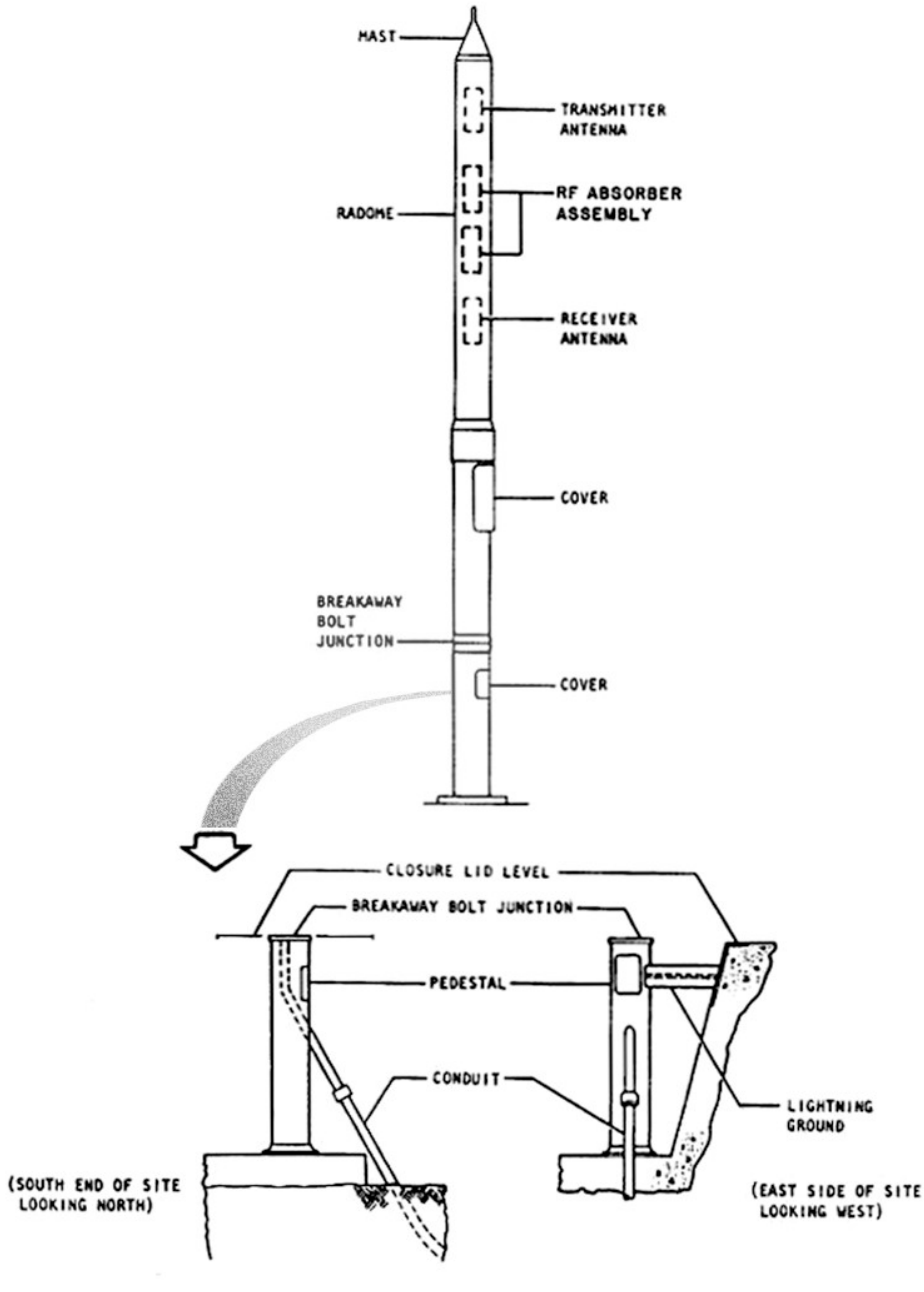


Figure 3–15. Antenna group.

Inner zone components

The IZ components of the LFSS are the R/T alarm set, transducers, switch loops, a transmit filter and RF ESA, and EFAs. (The main components are shown back in figure 3–13.)

Receiver-transmitter alarm set

The R/T alarm set drawer (fig. 3–16) houses the computer processor and firmware, receiver, transmitter, maintenance assist panel, power supplies, thumb-wheel switches, and circuits for command and status interface, transducer, and switch-loop functions. This drawer is classified secret and requires two-person control. The drawer also contains electrostatic discharge sensitive components that could be damaged by maintenance personnel touching electrical connectors. The R/T alarm set drawer is located in the A1 position of the battery charger-alarm set group.

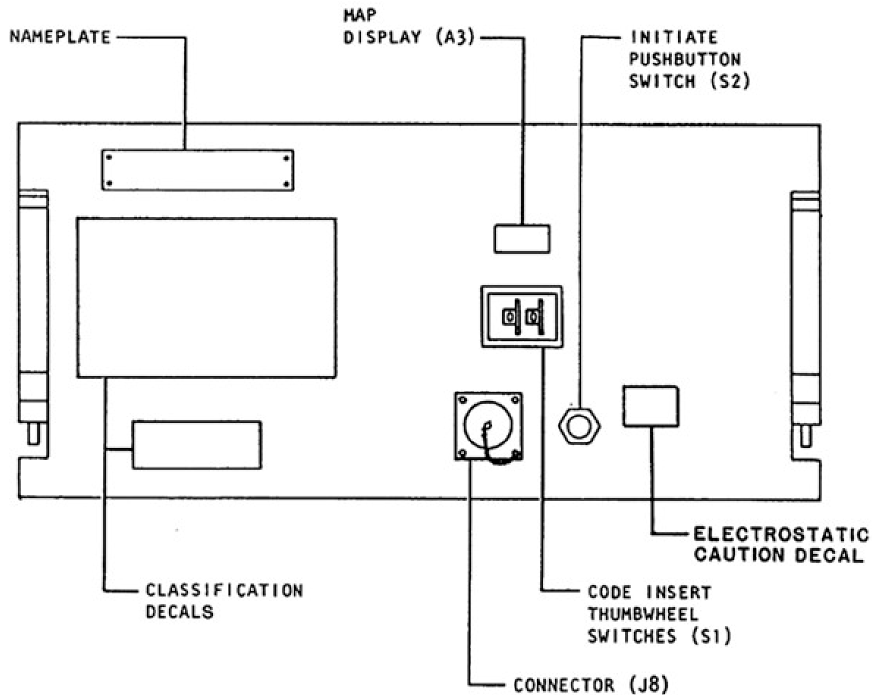


Figure 3–16. Receiver-transmitter alarm set.

Transducers

The Wing 1 LFs contain six transducers, while the Wings 3 and 5 LFs contain only two transducers each. These transducers detect vibrations in the LER and launch tube. Any vibration, such as that caused by hammering, produces an AC voltage from one or more transducers. These signals are processed in the security drawer so that either a heavy shock or a few light shocks in succession will cause an alarm. Light shocks occurring over a minute apart will not cause an alarm, thus eliminating many false alarms that could be caused by mechanical transients.

Switch loops

The LFSS uses an IZ switch loop made up of the following six switches:

- Two on the launcher closure (LC).
- One on the primary door.
- Two in the secondary door.
- One in the security pit vault door.

The system uses sensitive switches to detect movement of combination dials and the LC door latch; magnetic switches to detect movement of the primary door and LC, and an additional feature in the security pit vault door; and a penetration detector (Mylar grid) which detects any drilling attempts. The logic circuits of the R/T alarm set drawer monitors each closed contact of the IZ access switches using DC voltage. When any of the six switches are opened, or the penetration detector is grounded, the resulting DC voltage change is detected and processed in the R/T alarm set drawer. The DC voltage change is reported as an IZ alarm to the LCC. The software program monitors the IZ continuity loop discrete signals to detect attempts to open any launcher accesses.

At Wing 1 LFs, an OZ switch loop was installed because the LSB is further away from the antenna than at other wings. A magnetic switch monitors the position of the LSB door.

319. Security system electrical protection

The LFSS is protected from electrical surges and EMP. This protection comes from various components such as RF ESAs, transmitter filter, and electrical filter assembly.

Radio frequency electrical surge arresters

Two RF ESAs protect the LFSS from electrical surges caused by lightning and other induced voltages. The RF ESAs are installed in the ESA vault (fig. 3–17) and connect to the transmit and receive lines leading from the antenna. The other side of the RF ESAs connects to cables that lead to the R/T alarm set drawer. At Wing 1, the OZ switch loop line is connected to an ESA in the ESA vault. The other side of the connection is routed through an EFA and then to the battery charger alarm set group.

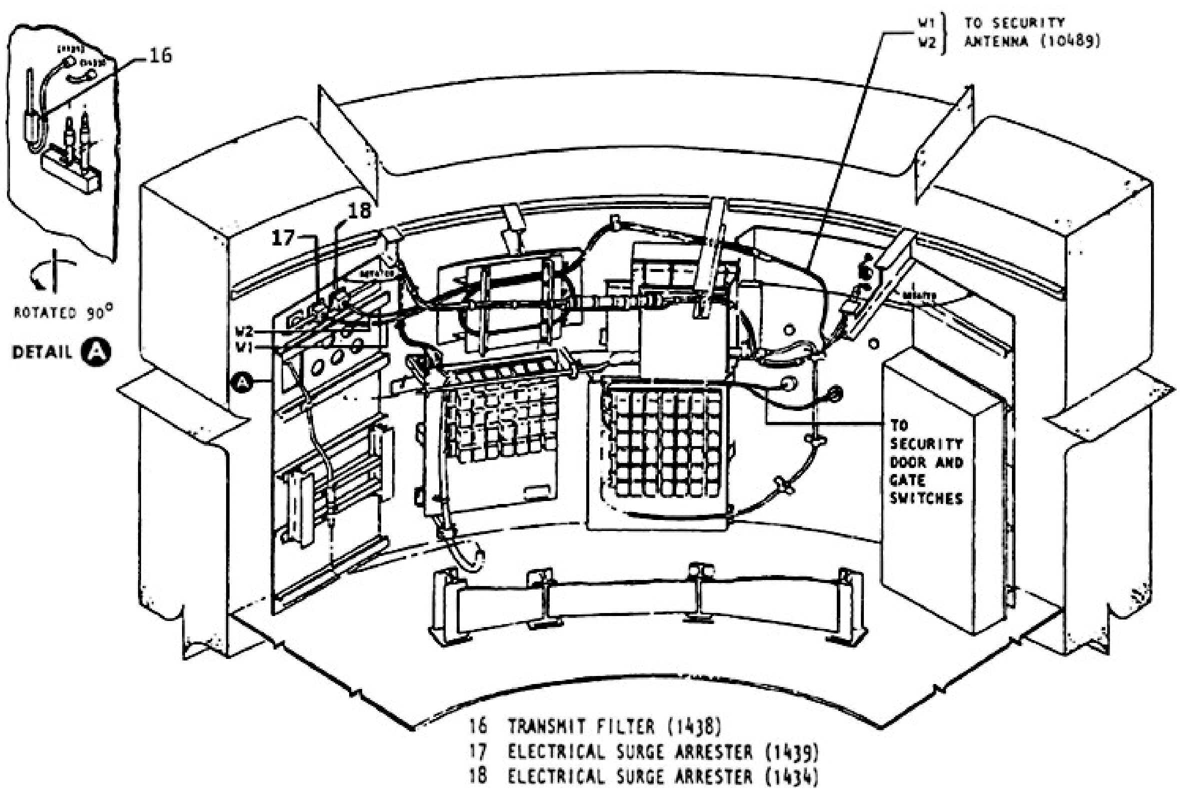


Figure 3–17. Electrical surge filter arrest vault.

Transmit filter

The transmit filter provides filtering to prevent interference with the operation of the UHF radio. The filter includes a pigtail cable that connects to one of the RF ESAs and to the R/T alarm set drawer. Both of these filters are used to protect the transmit line connected to the antenna group from electrical surges.

Electrical filter assembly

The EFA provides EMP protection for the IZ switch loop lines that penetrate the launcher. The assembly interfaces with the battery charger alarm set group, J-boxes, and transducers. At Wing 1, an additional EFA interfaces with the OZ switch loop line via an ESA and the battery charger alarm set group.

Self-Test Questions

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

318. Security system description

1. Match the item in column B to the description in column A. Each item in column B may be used only once.

Column A	Column B
____ (1) Houses the receiver, transmitter, and processor.	a. Transmitter antenna.
____ (2) Detects vibrations in the LER and launch tube.	b. Receiver-antenna.
____ (3) Several feet below the transmitter antenna.	c. RF absorber assembly.
____ (4) Monitors the wing 1 LSB door.	d. Transducer.
____ (5) Controls transmitter-to-receiver coupling.	e. Switch loop.
____ (6) Near the top of the mast above the RF absorber assembly.	f. Receiver-transmitter alarm set drawer.

2. What might be attached to the clutter monument and what is its purpose?

3. What is reported to the LCC when the receiver-transmitter alarm set drawer detects a change in DC voltage on the switch loop line?

319. Security system electrical protection

1. What protects the receive line coming from the antenna group from electrical surges?

2. What protects the switch loop lines that penetrate the launcher from electrical surges?

3. What provides EMP protection for the IZ switch loop lines that penetrate the launcher?

Answers to Self-Test Questions

314

1. Control the temperature of the MGS.
2. Plumbing set, coolant chiller unit, coolant pump assembly, control valve assembly, coolant tank, filter assembly, electronic control amplifier, and wiring harness.
3. 400-Hz, 120/208 VAC, three-phase power.
4. 4(±0.5) pounds per minute.
5. About seven gallons.
6. 36 VDC battery power.
7. ALARM, GROSS TEMP, NO-GO, and CONTROL.

315

1. The control valve setting.
2. The regenerative heat exchanger’s coils.
3. Decreases.
4. It evaluates the resistance change and if necessary, sends an open valve or close valve signal to make the control valve assembly adjust the flow rate.
5. Power applied checkout.
6. Between 60 and 80 °F.
7. A leak in the G&C cooling system or the MGS.
8. The old MGS was purged by MMT.
9. The MGS will shut down.
10. Press the G&C SHUTDOWN switch on the PG.
11. Label appropriately and return it to the MSB for neutralization and disposition.
12. To see if the guidance section of the liquid cooler will respond accordingly and adjust flow rates and temperature levels.
13. Any time you receive abnormal indications during checkout.

316

1. FLI.
2. MCC coordination.
3. Entry into local control mode.
4. Readout all LF status and multiplexer status and circle the indications that were observed to illuminate on the LF fault record.
5. The controller-monitor.
6. Applying power to the missile and G&C liquid cooler from the power supply group, PG, and D-box.

317

1. A CTU, controller-monitor, cable set, and an LFLC.
2. The MGS parameters tape, the OGP/OFP tape, the flight program constants tape and the W data.
3. It is a prerequisite to performing DCU program loading at the LF and, when successfully completed, ensures functional adequacy of the CTU for operations.
4. Open the tape cartridge carrying case and expose the MTC to the LF ambient temperature for at least 15 minutes.
5. To ensure adequacy of tape cartridge drive belt tension on the tape.
6. It converts this data to electrical pulses for transmission to the DCU, via the coupler unit.
7. It causes the ERROR indicator on the CTU and TAPE PARITY ERROR indicator on the controller-monitor to illuminate.

8. The end-of-file has been reached; afterwards, the tape is automatically rewound to beginning of tape holes, the COMPLETE indicator on the CTU illuminates and, on the controller-monitor, the PROGRAMMED STOP indicator illuminates.
9. To begin execution of the OGP.
10. This delay ensures a sufficient period for warm-up of the PIGA before GSP slewing and leveling is initiated.
11. The battery has been turned on and the SRAM memory contains stored data.
12. Initial and restart.
13. The routine normally requires approximately one hour and 45 minutes up to two hours and 30 minutes.
14. The mode of operation wherein processing operations are performed to ensure launch readiness in non-hostile environment (seismic, DCU circumvention, and circumvention reset set false).
15. The mode of operation where in-processing operations are performed to ensure launch readiness in a hostile environment seismic; DCU circumvention or circumvention reset set true seismic or DCU circumvention set true.
16. Three.
17. Loading the programmer group SDU keying variable and changing the CSD(M) code.
18. SKL.
19. The code device home, armed, 24th bit, and code change.
20. The verification number with the base code controllers at the MSB.

318

1. (1) i.
   (2) d.
   (3) b.
   (4) e.
   (5) c.
   (6) a.
2. A clutter plate; to increase the decibel level.
3. An IZ alarm.

319

1. RF ESAs.
2. Transmit filter and a RF ESA.
3. Electrical filter assembly.

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 ECI Form 34, Field Scoring Answer Sheet.

32. (314) About how many gallons of coolant does the guidance section liquid coolant tank store?
   a. 2.
   b. 7.
   c. 14.
   d. 20.

33. (315) Which is the last component in the guidance section liquid cooler the coolant flows through before entering the missile guidance set?
   a. Filter.
   b. Coolant tank.
   c. Control valve.
   d. Coolant pump.

34. (315) A decrease in the thermistor resistance would indicate a
   a. temperature increase in the missile guidance set.
   b. “close valve” signal is being sent to the control valve.
   c. ground maintenance reply (GMR) 25.
   d. temperature decrease in the missile guidance set.

35. (315) Identify the temperature, in degrees Fahrenheit, at which the GROSS TEMPERATURE warning light illuminates on the electronic control amplifier.
   a. 75.
   b. 80.
   c. 85.
   d. 90.

36. (315) Where should the graduated sight tube coolant level be during the guidance and control power applied checkout?
   a. Above the top mark.
   b. Below the last black mark.
   c. In the middle of the graduated sight tube.
   d. Between the top and second black mark.

37. (315) After the guidance and control checkout is complete and the coolant is in its proper container, the excess coolant must be labeled appropriately and
   a. returned to the missile support base for neutralization and disposition.
   b. returned to the missile support base for depot to analyze it.
   c. left on site for hazardous waste team to pick up.
   d. stored properly in your shop.

38. (316) Identify the Minuteman equipment that monitors missile functional performance, provides signals and ground power, and maintains the liquid coolant and environmental controls; all of which is required to sustain missile operation until launch.
   a. Aerospace vehicle equipment.
   b. Operational ground equipment.
   c. Operational support equipment.
   d. Maintenance support equipment.

39. (316) For which action is the controller-monitor *not* required for during aerospace vehicle equipment startup?
   a. Power signal distribution unit repair.
   b. Guidance and control coupler drawer replacement.
   c. Reentry system maintenance.
   d. Missile guidance set replacement.

40. (317) The tape identification block tells the operator that the tape cartridge is for a particular
   a. wing.
   b. flight.
   c. squadron.
   d. launch facility.

41. (317) If the tape track reads 1105 for Wing 5, to which launch facility is it referring?
   a. Alpha-05.
   b. Bravo-05.
   c. Fox-05.
   d. Kilo-05.

42. (317) When the fill sequence is entered, detection of the enable write on code by the coupler causes activation of digital computer unit logic that allows program data recorded on the data block to be written into the digital computer unit
   a. hot storage.
   b. cold storage.
   c. random access memory.
   d. write protected static random access memory.

43. (317) The computer memory security check number consists of how many hexadecimal digits?
   a. 4.
   b. 6.
   c. 8.
   d. 12.

44. (317) How many volts are applied to the guidance and control during the beginning of the digital computer unit initialization sequence?
   a. 37.
   b. 36.
   c. 32.
   d. 28.

45. (317) During digital computer unit initialization sequence, what indicates the battery is turned on and the static random access memory (SRAM) contains stored data?
   a. Battery/SRAM flag discrete set.
   b. Battery flag discrete set false.
   c. Battery flag discrete set true.
   d. Battery/SRAM discrete set.

46. (317) Identify the two alignment modes that are available during ground initialization of the Minuteman system.
   a. Cold and warm.
   b. Initial and restart.
   c. Initial and secondary.
   d. Primary and secondary.

47. (317) Which status indicates that the guidance and control system is in the launch readiness mode?
   a. Launch commanded.
   b. Strategic alert.
   c. Standby.
   d. Enable.

48. (317) Who is required to install or remove the operational keying variable?
   a. Security code handling team.
   b. Contractor code handling team.
   c. Authorized code handling team.
   d. Wing code processing personnel.

49. (318) The launch facility security transducers detect vibrations in the
   a. missile and launcher equipment room (LER).
   b. LER and launch tube.
   c. launcher closure, LER, and launch tube.
   d. launch support building, lunch tube, and missile.

50. (318) The launch facility security system uses an inner zone switch loop made up of two switches on the launcher closure, one on the primary door, two on the secondary door and one on the
   a. lower equipment room.
   b. upper equipment room.
   c. security pit vault door.
   d. weather cover.

51. (319) Which component provides electromagnetic pulse protection for the inner zone security switch loop lines that penetrate the launcher?
    a. Transmit pulse filter.
    b. Electrical filter assembly.
    c. Electromagnetic pulse arrester.
    d. Electromagnetic pulse to ground filters.

Please read the unit menu for unit 4 and continue ➔

Unit 4. Missile Communications

THIS UNIT IS A GENERAL OVERVIEW of the three main divisions of missile communications equipment. These three divisions include strategic communications (STRATCOM), satellite communications (SATCOM), and missile radio. The unique organizational setup that each wing may have for the respective shops will not be addressed. However, the description and function of the equipment should be common throughout each wing. Some of the equipment you will learn about will be installed at the MAF, LF, and MSB.

4–1. Strategic Communications

The area of responsibility known as STRATCOM is divided into three areas:

1. Strategic Automated Command and Control System (SACCS).
2. Missile control communications systems (MCCS).
3. REACT.

Let's begin with the SACCS system.

320. Strategic Automated Command and Control System

SACCS is also known as the strategic air command digital information network (SACDIN), and both terms are used synonymously (fig. 4–1).

SACCS provides C2 capability from national command authorities to and from STRATCOM, the ICBM fleet, bomber, tanker, and reconnaissance forces (fig. 4–2). SACCS is the primary medium for transmitting and receiving secure EAM, force direction message (FDM), and non-action message (NAM) traffic. SACCS is a high-speed, secure, data transmission, processing, and display system that links together the selected wing command posts in the CONUS. It has external interfaces with a triad computer system, a force management information system, a command center processing and dissemination system, Air Force global weather central, and weapons system control (WSC) consoles at LCCs.

The hierarchy of the SACCS consists of utilizing the dedicated line network (DLN) as the primary means of transmission, and interconnecting DLN to SACCS with full-duplex (two-way) encrypted circuits. The SACCS consists of various functional areas (FA) which are a combination of hardware and software used to perform system functions at various sites. The DLN connects to the subnet communications processor/FA (SCP/FA), which is located at Offutt Air Force Base (AFB). Offutt AFB is home of the United States Strategic Command (USSTRATCOM), which connects to the wing base communications processor (BCP) FAs. The wing BCPs interface with the missile BCP (MBCP)/FAs located at each squadron command post. The MBCP/FAs connect to subordinate hardened user terminal elements (HUTE).

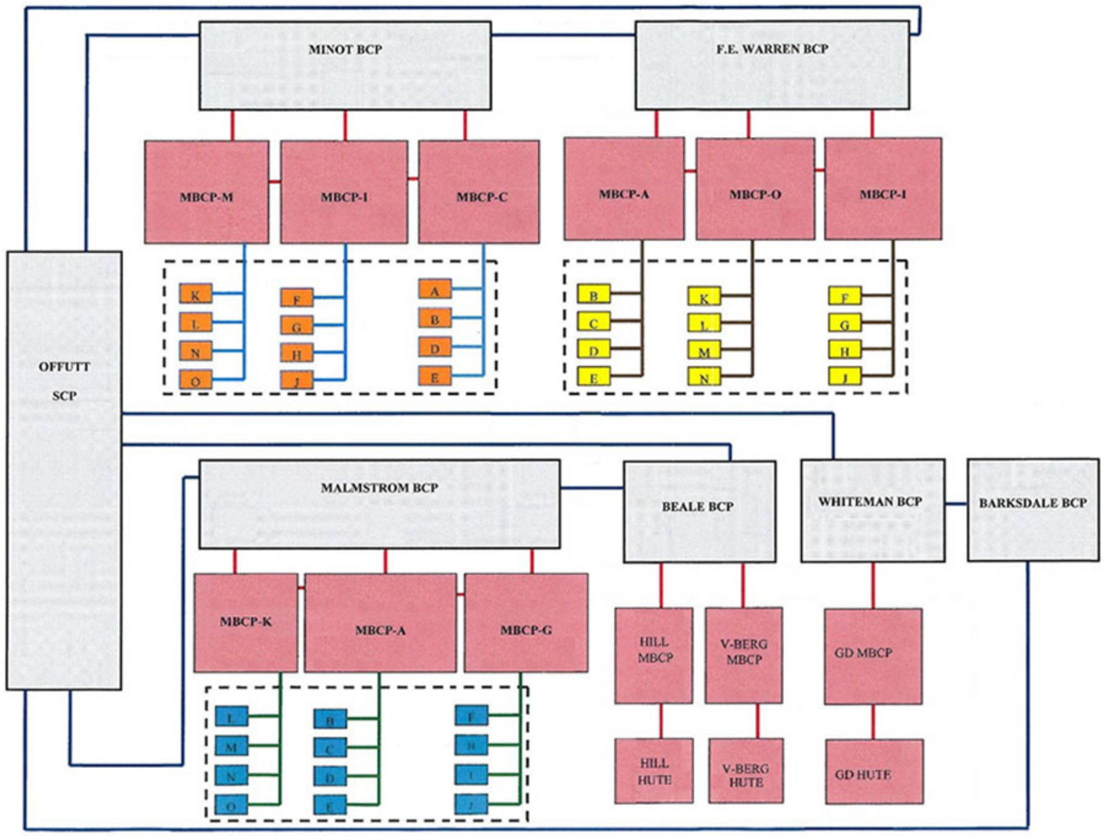


Figure 4–1. SACCS functional diagram.

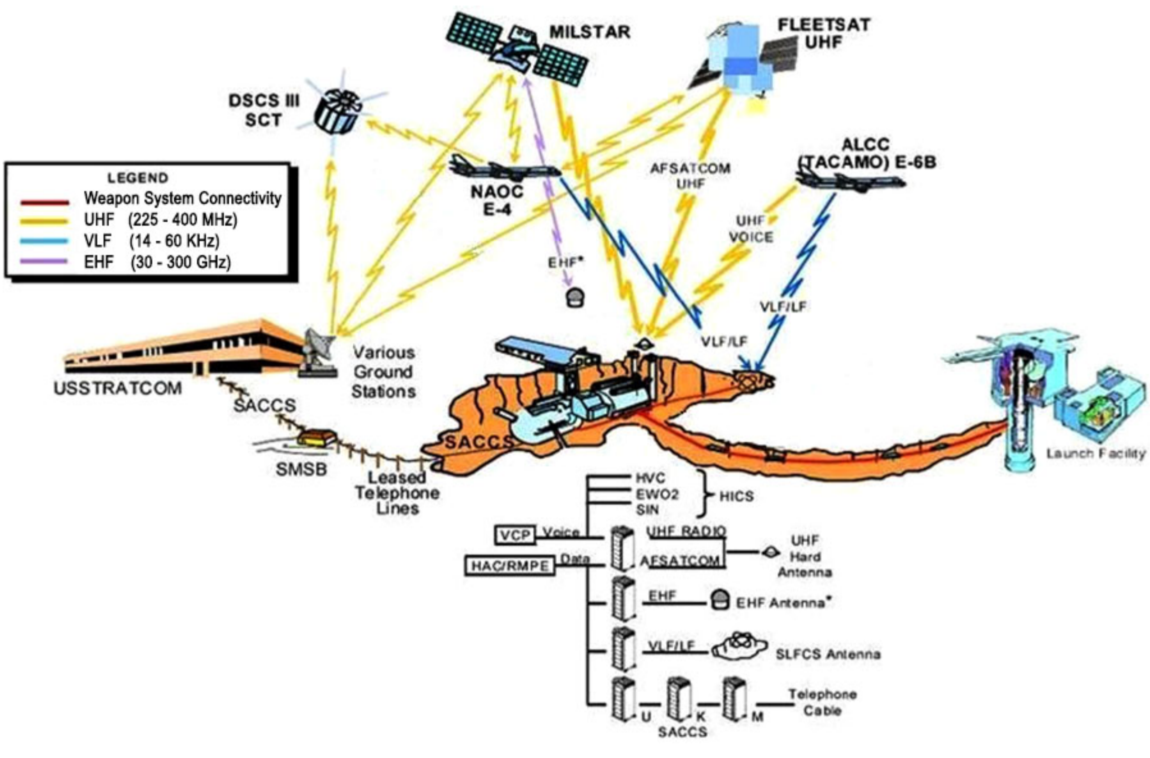


Figure 4–2. Communication networks.

The SACCS desktop terminal (SDT) is the primary input/output terminal that provides message entry and delivery. The BCP/FA functions as a message switching and data center and connects to the SCP/FA that provides packet switching. Messages originating at the local SDTs are assembled, validated, and journaled at the BCP. After transforming each block into a packet by adding the packet header information, the packets are routed as segments to the DLN. Each BCP consists of three soft cabinets: (S, K, and M), up to two SDTs, and a keyboard send receive (KSR) switch operator station (fig. 4–3).

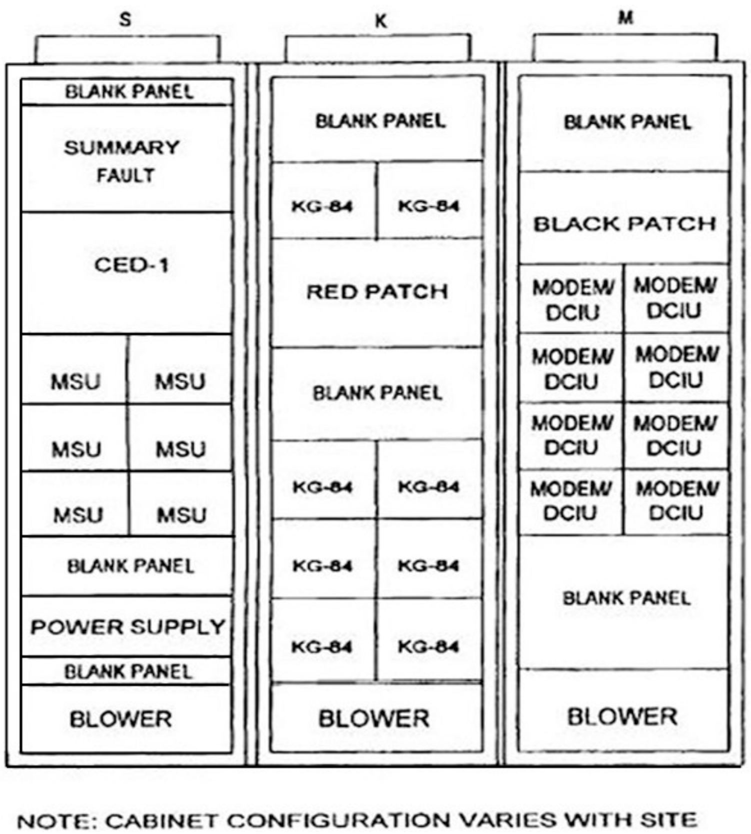


Figure 4–3. Base communications processor/functional area equipment diagram.

S-cabinet

The following table lists and describes the drawers of the S-cabinet.

S-Cabinet Drawers	
Drawer	**Description**
Summary fault unit (SFU)	Alerts the operator to equipment malfunctions. It has an audio alarm and several error indicators that identify the malfunction.
Control electronics drawer (CED)	Provides the data processing and control functions for the BCP/FA.
Six mass storage units (MSU)	They are secure digital data memory card units used for journaling, preformatted messages, initial program load (IPL), diagnostics, and so on.
Power supply drawer (PSD)	Provides DC power to equipment in all three cabinets. It requires a 120 VAC, 60-Hz, single-phase power. It produces DC power for red and black applications.
Blower assembly	Cools the electrical equipment drawers housed in the cabinet by circulating air through the cabinet.

K-cabinet

The K-cabinet at the BCP/FAs contains KG–84A crypto units and a *red patch* (plain text, non-encrypted) panel drawer. The KIV–7M is the standard crypto in the SACCS and is used for all SACCS communication links. The KIV–7M provides encryption (coding) and decryption (decoding) of messages and can be remotely or locally controlled through the front panel.

M-cabinet

The M-cabinet at the BCP/FA contains modem units and a *black patch* (encrypted text) panel drawer. Some of the modem units on the M-cabinet are the standard SACCS modems, equipped with a remote loopback feature and automatic answering capability. Each modem provides a single communication line interface performing received signals. The modem is fully automatic and its data transmission rate can be either 4,800 or 2,400 bits per second.

Port expansion processor description

Connected either directly or remotely to a BCP or the SCP, the port expansion processor (PEP) is a rack-mounted personal computer containing a modified high-level data link control (HDLC) interface card connected to a crypto device. The PEP extends the rapid and reliable message delivery capabilities of SACCS to up to six SACCS desktop or SACCS portable terminals. The PEP is also equipped with a removable hard drive kit for easy removal and storage.

SACCS desktop terminal description

The SDT provides the operator interface to compose, store, edit, and transmit outgoing messages. The communications program provides communications with the SACCS network by emulating the SACCS message handling protocols within the SDT.

Keyboard send receive description

The KSR allows system operators and maintainers to input commands into the SCP, BCP, and other processors. Online, the KSR is the only device that inputs the date/time group upon IPL. The KSR allows system operators to call communication lines up and down, request system reports, system configuration, and test on-line equipment.

MBCP and HUTE description

Each missile squadron contains one squadron command post, which is called the SACDIN MBCP, and four LCC HUTEs.

The MBCPs consist of three component racks similar to the BCP layout, while the HUTEs have one component end terminal rack.

The HUTEs are connected to the MBCP by the HICS. Because of the HICS routing, some of the HUTE lines pass through a relay site. A relay site may provide line amplification if the total HICS line length requires signal boosting. Additionally, one or two other MBCPs may also be connected to the MBCP to provide an alternate communication path.

The intersite connections for the other MBCPs are similar to the HUTE-to-MBCP paths. At the squadron MBCP, the M and K racks contain a modem and a crypto unit for each incoming line.

The signals from the HUTEs then feed through the MBCP control electronics drawer that prioritizes and feeds the signals to, or accepts signals from, the wing command post.

It should be noted that an MBCP operator does not communicate directly with squadron HUTEs or directly connected MBCPs; the squadron MBCP serves merely as a relay.

321. Missile control communications systems

The MCCS is a soft system not designed to withstand a nuclear attack. It consists of five separate subsystems and is responsible for the largest portion of communication in a MAF. It allows communication between the LCC and the security control center (SCC), the MAF and the LF, and internally in a MAF or LF. MCCS's five subsystems operate independently of each other but in certain instances, they can interconnect.

Missile alert facility-launch facility telephone

The MAF-LF phone connects each MAF to its 10 subordinate LFs. The MAF-LF phone communicates between the MCCMs and maintenance crews performing maintenance at LFs. When its function is impaired, it also slows down maintenance at the LF due to difficulty in coordinating system tests and status between the MCCM and maintenance teams. Without the MAF-LF phone working correctly, maintenance crews must communicate indirectly through the radio to the flight SCC. The SCC then informs the capsule of developments. With the MAF-LF phone functioning correctly, time is saved because the capsule can be contacted directly.

Missile alert facility interphone

The MAF interphone is a system that allows communication throughout the MAF with jackboxes at different places across the facility. The MAF interphone can maintain communication if the commercial telephone lines should fail. Maintenance teams also use it to maintain voice communication between maintenance personnel and the MCCM while performing maintenance that may blackout other communication systems (fig. 4–4).

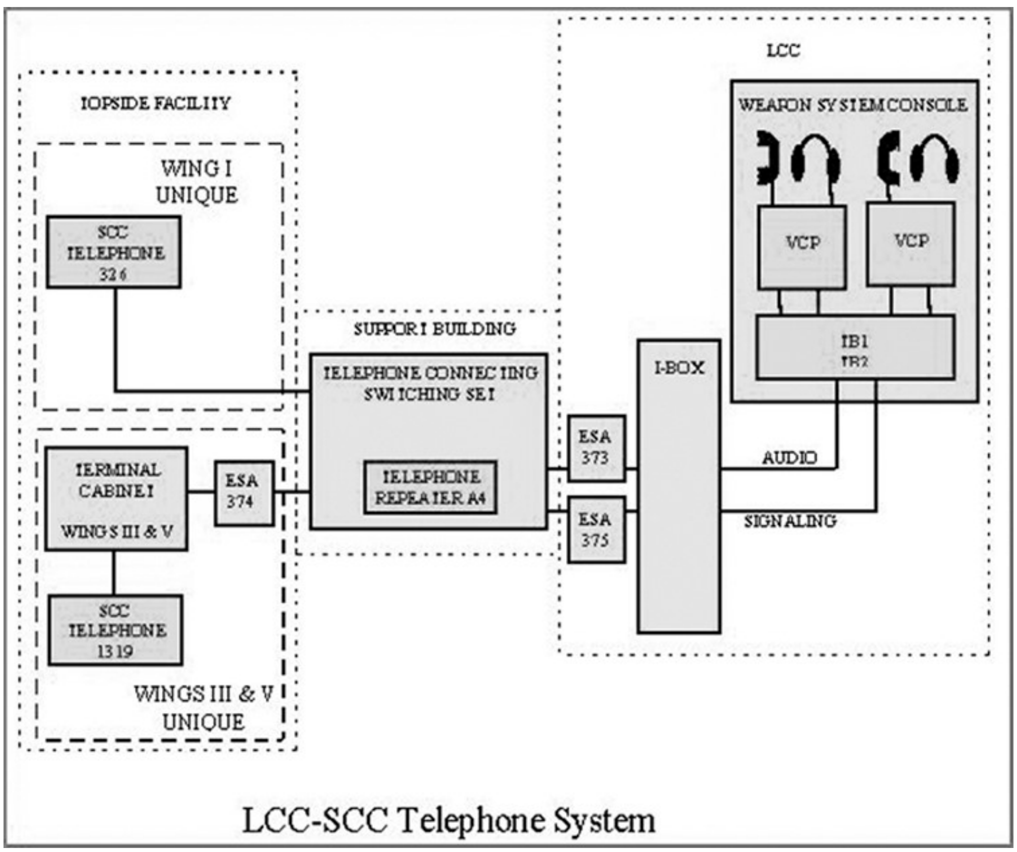


Figure 4–4. Launch control center interphone.

Launch facility interphone

The LF interphone circuit provides communication capability from the LSB wallphone to the LER's via a series of jackboxes located throughout each location. This circuit also has the ability to connect to the MAF-to-LF telephone circuit. This allows communication from the team on site to the MCCM located in the LCC. Figure 4–5 shows a typical LF wall phone (TA–466).

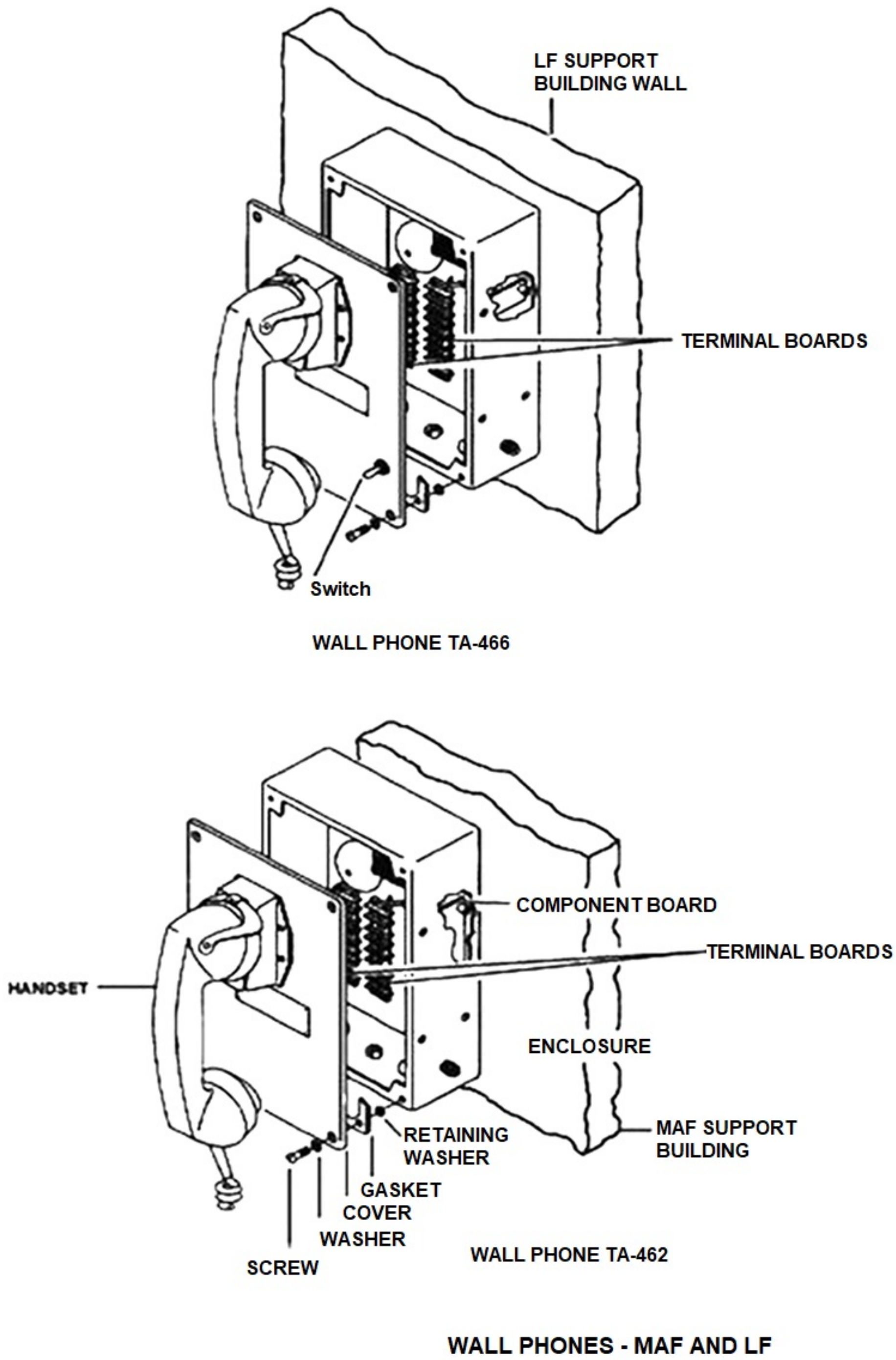


Figure 4–5. Typical wall phone.

Launch control center-security control center telephone

The LCC-SCC telephone is a hard-wired communications circuit that connects the LCC to the SCC. Security forces use it to communicate with the MCCM for security issues, the status of the LFs, weather conditions, and daily changeover procedures. The backup for the LCC-SCC line is the dial line 1 and 2. Common problems with the LCC-SCC line are “no ring at LCC”, “no ring at SCC”, “no voice at LCC”, “no voice at SCC”, “constant ring at LCC,” and “constant ring at SCC.” Generally, these problems are caused by a malfunction of the wall phone.

Dial lines 1 and 2

The dial lines 1 and 2 are telephone company circuits that provide commercial service in and out of a MAF. Dial line 1 is dedicated to the LCC and cannot be used by anyone other than a MCCM. Dial line 2 is exactly the same as dial line 1 (fig. 4–6, phone icons attached to the VCPs). Dial lines 3, 5, 6, and 8–12 are divided between the facility manager, culinary chef, fire crews, the flight security controller, and on-site personnel. Dial line 4 is a line for the fax machine and dial line 7 is a line used by the pressure monitor receiver-transmitter only.

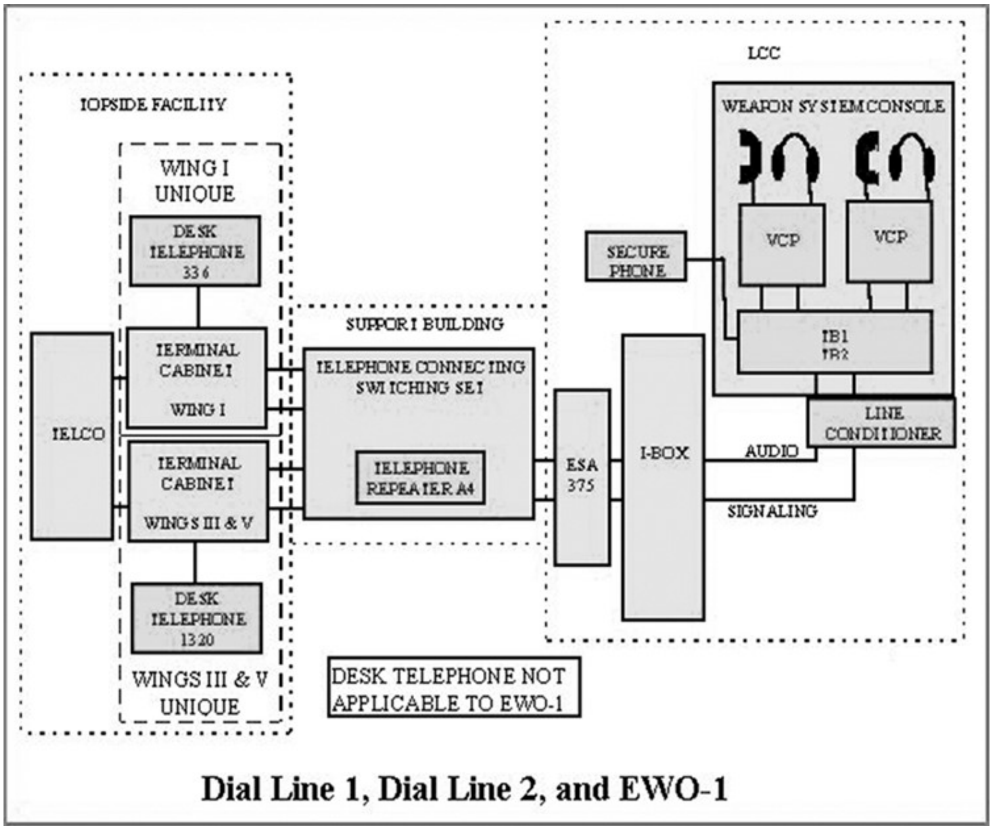


Figure 4–6. Dial lines 1, 2, emergency war order–1.

Hardened voice channel

The HVC is a hardened telephone network providing voice communication between the MAFs in a squadron. The HVC is for general communication, as well as verification of launch commands, and for notification of gross faults. The HVC can also be a backup system for MCCS. If MCCS equipment goes down at any MAF, the affected MAF can contact another MAF in their squadron over the HVC and have the necessary outage information relayed to MMOC (fig. 4–7).

The HVC is a hard communications system (the system is shielded from an EMP) and when commercial power is lost, backup batteries maintain system integrity in the LCC until the diesel electric generator is activated. This system connects the five MAFs in a squadron through the HICS. The MAFs can ring (selectively or collectively) the other four MAFs. This system is considered hardened because at no time does it interface with an equipment rack connected to a soft system. The HVC becomes the primary relay mechanism if all C2 communication systems are down in an LCC, unless the problem is a bad pair of VCPs.

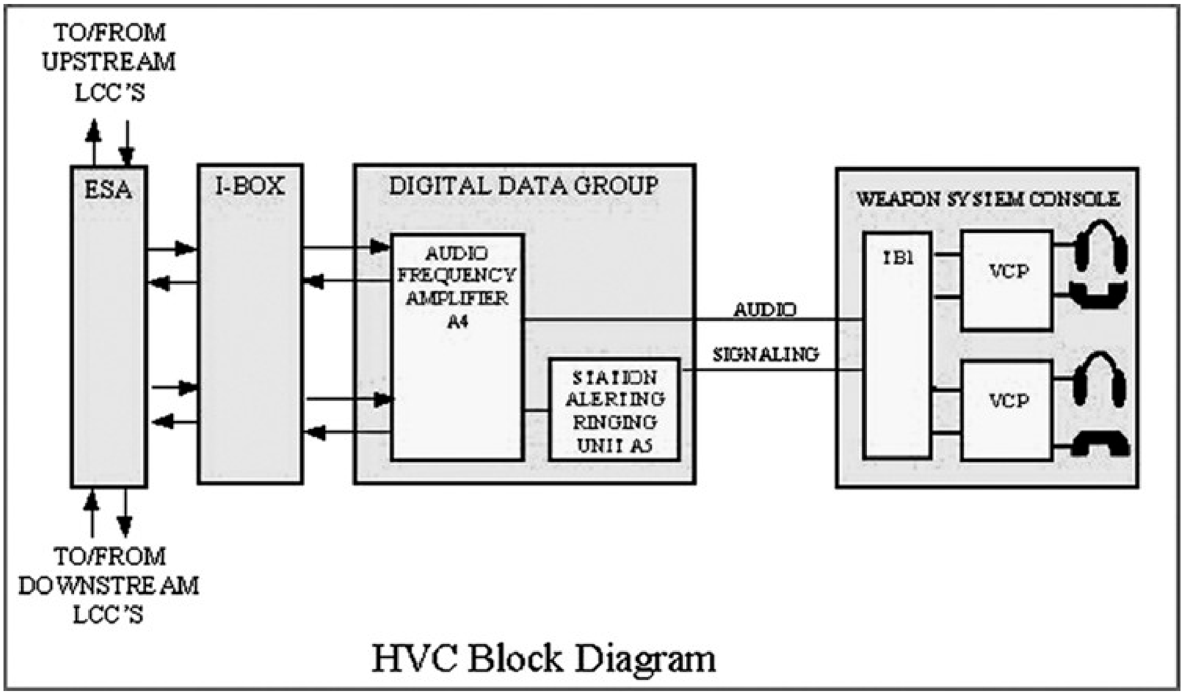


Figure 4–7. Hardened voice channel block diagram.

Voice control panel

The REACT console subassembly (RCS) contains two VCPs, one for each operator position. Both provide the same functions (fig. 4–8). The VCP controls the voice communications between the LCC and the other LCCs using HVC and LFs. In addition, the VCP provides connectivity to commercial telephone lines. The VCPs provide communications between capsule and interphone communications, SCC, very-high frequency (VHF), UHF, and Secure Phone.

At the MBCP, the VCP provides the capsule with emergency war order (EWO) 1, and EWO–2. It allows for the manual input of telephone numbers (connected to existing telephone systems) and for specific functions (e.g., redial, memory, hold, and conferencing) to be used individually or in combination with other keys. The VCP front panel contains necessary controls and indicators for the operator to select the communication mode and destination. The VCP is partitioned electrically and mechanically into the hard and soft sections. Each VCP has a separate power supply and circuit breaker.

Emergency War Order 1

The EWO–1 is a dedicated phone line that provides voice communication between the three MBCP sites in the missile field and the wing command post. EWO–1 is a soft commercial telephone communication system similar to dial lines 1 and 2, except that the EWO–1 network is set up as a hotline instead of a typical phone line. The capsule crewmember in the LCC initiates an EWO–1 call by pressing the EWO–1 push button on the VCP, which rings the EWO–1 line at the wing command post. The BCP initiates an EWO–1 call to a MBCP by picking up a phone dedicated solely to the EWO–1 line (fig. 4–9).

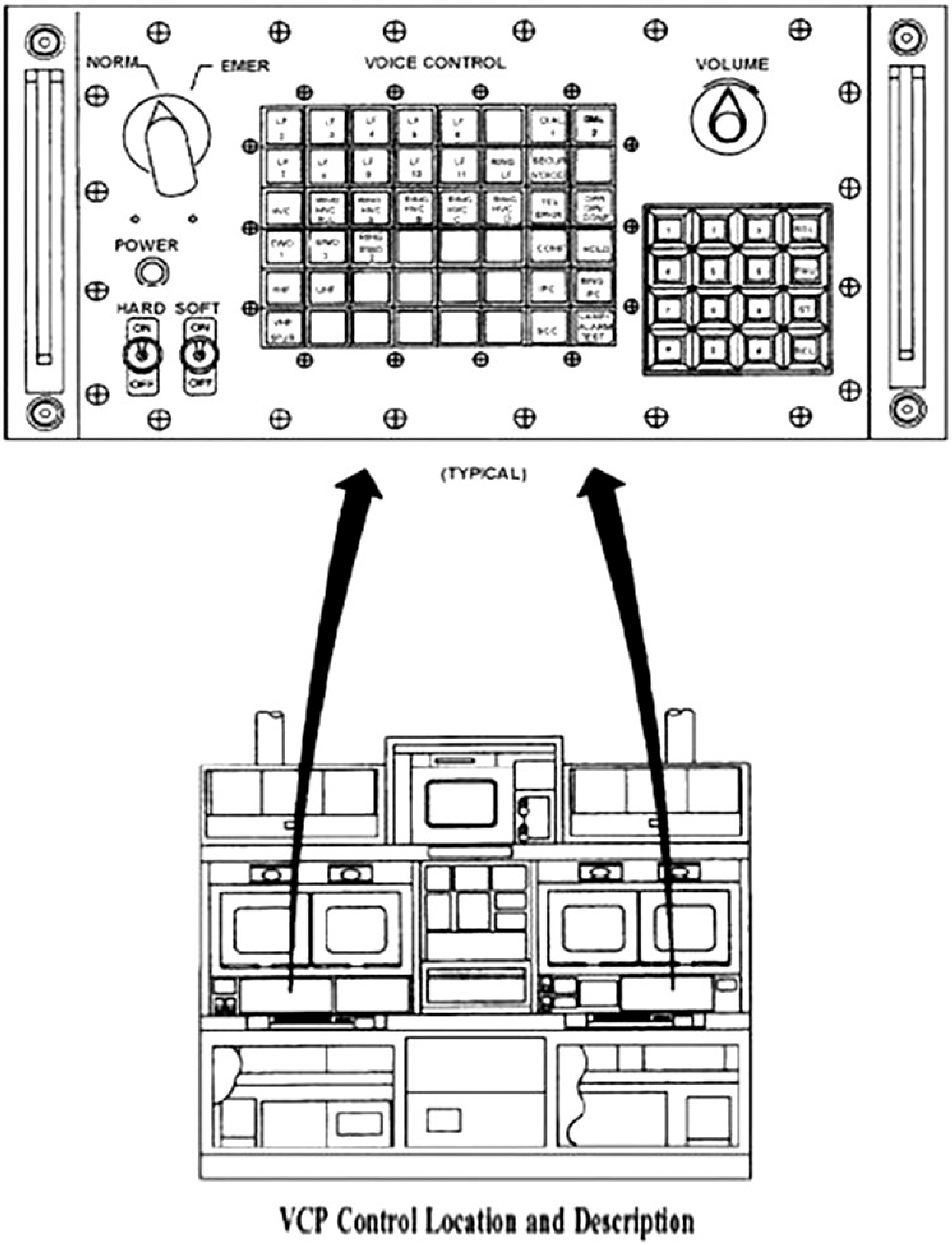


Figure 4–8. Voice control panel.

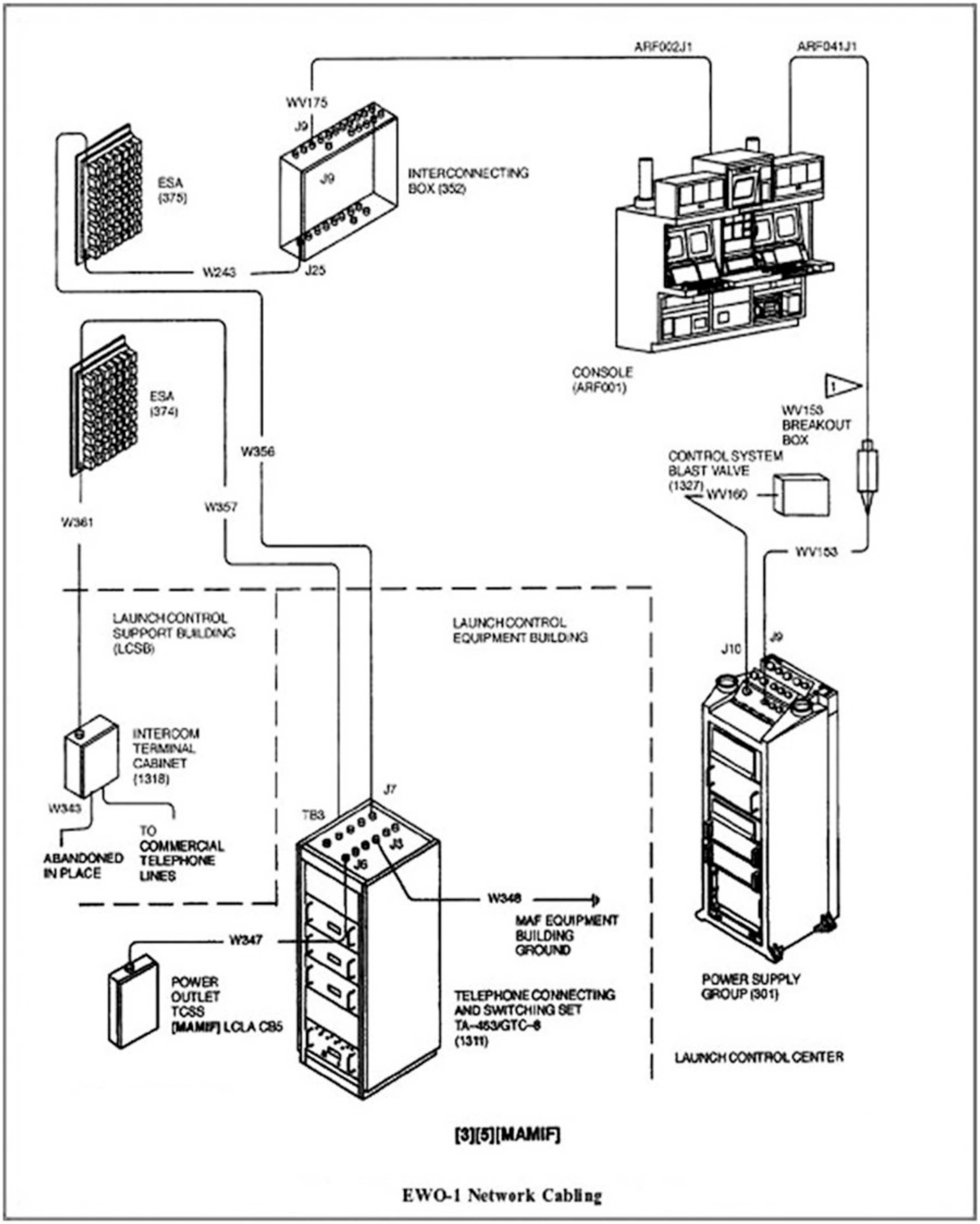


Figure 4–9. Emergency war order–1 cabling.

Emergency War Order 2

The EWO–2 is a voice network for communication between the SCP and ACP within the missile wing. The SCP is the source for lawful orders to be handed down to other MAFs in their squadrons. In the event the MSB is destroyed, depending on their designation, one of the SCPs will assume command. In the event an SCP is destroyed, the ACP for that squadron will assume command. The EWO–2 circuit connects all SCPs in a missile wing together through the HICS.

The SCPs can selectively or collectively ring and communicate with other SCPs. This circuit acts as a party line. Four MAFs in a wing have this capability. Because the SCP and ACP are a great distance apart, it is required to have some MAFs along the way to act as repeater stations. The MAFs used as repeater stations vary from wing to wing. For instance, at Wing 3, repeaters for EWO–2 are located at K–01, J–01, F–01, G–01, and D–01.

322. Rapid execution and combat targeting

The HA side of the REACT console is controlled by the RMP subsystem equipment. The RMP subsystem is housed in two drawers—RMP and RMPB. They are the major elements of a subsystem that controls HA communication systems installed in the LCC. Besides the RMP and the RMPB, the console is equipped with two HA VDUs, two keyboards, and two trackball assemblies for communication operations (fig. 4–10).

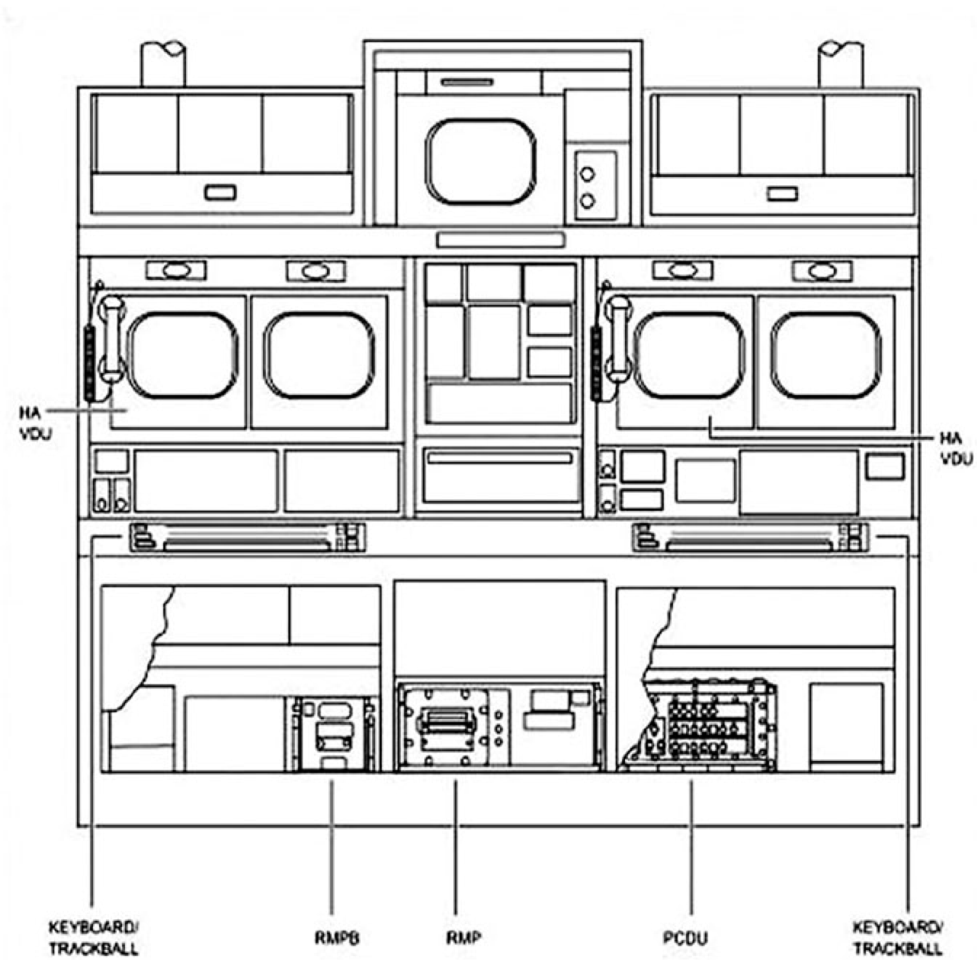


Figure 4–10. Weapon system console.

The HA VDUs are dedicated to the subsystem. The keyboard and trackball assemblies are shared between the weapon system and the HA. A toggle switch on each of the keyboards enables the operators to switch from the WSP to the RMP for communications operations. The RMP subsystem provides centralized monitoring and control of the HA communication systems by the MCCM. Outgoing messages can be composed, stored, and transmitted over multiple communications systems. Messages received over more than one communications system are processed, duplicate messages are suppressed, and the remaining messages are displayed to the MCCMs on the HA VDU.

The RMP subsystem processes EAMs, FDMs, and NAMs and signals the crew when a message is received. When commanded, it displays them on the HA VDU or prints them on the weapon system printer. Communications alarms are displayed on the console and most operator actions are initiated from the console. The equipment operates in existing Minuteman LCCs. It may be used to control communication systems planned for the future. The subsystem interfaces with AFSATCOM, SACCS, and extra-high frequency (EHF) MILSTAR communication systems.

The three operational computer programs that control the major functions of the RMP include:

1. Communications integrator (CI) computer program.
2. Transmission integrator (TI) computer program.
3. Message processor (MP) computer program.

The CI computer program also controls the CI function in the RMPB. The CI computer program and TI computer program are provided as firmware.

Self-Test Questions

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

320. Strategic Automated Command and Control System

1. What is SACCS the primary medium for?

2. What piece of equipment provides message entry and delivery in SACCS?

321. Missile control communications systems

1. What three types of communication does the MCCS provide?

2. Which dial lines are commercial telephone circuits in and out of a MAF?

3. What hardened system provides voice communication between the MAFs of a squadron?

4. Which voice network is used for communications between the SCP and ACP within the missile wing?

322. Rapid execution and combat targeting

1. What REACT console subsystem provides centralized monitoring and control of the HA communication systems?

2. What are the three communication systems that interface with the RMP?

4–2. Satellite Communications

The SATCOM is divided into two main sections—the EHF MILSTAR system and AFSATCOM. Let’s begin by covering the EHF MILSTAR system.

323. Extremely-high frequency military strategic tactical relay

The EHF MILSTAR communications system provides a reliable communications link that interfaces with the MILSTAR satellite constellation. The EHF equipment functions as a communications link that is capable of simultaneous participation in the EAM network (by receiving EAMs) and an Air Force status report back network. The EHF system functions as a communications link between the MAFs and remotely located command posts. It is designed to operate during most pre-, trans-, and post-attack nuclear conditions and EMP events that threaten operations. The EHF radio is capable of transmitting encrypted Air Force report back messages independent from receiving messages. Received information is displayed on the HA VDU on the console or hard copy printout. Incoming EHF messages are stored in survivable memory in the RMP equipment. This is located on the combat crew console and may be printed out.

Communications over EHF can be secure-coded or in clear text. Nonsecure messages are authenticated by procedural means. The EHF consists of an antenna system, a terminal electronics unit, portions of an electronics drawer, and an AC-to-DC converter. The antenna system consists of a receive/transmit antenna and associated antenna electronics located topside at a MAF in an antenna shelter. Remaining EHF equipment is housed in the EHF and very-low frequency (VLF)/low frequency (LF) higher authority command systems equipment rack in the LCC.

Topside equipment

The topside equipment consists of an above ground EHF antenna, pedestal assembly, shelter, and associated electrical equipment. This equipment is designed to survive nearest neighbor nuclear attack and high-altitude electromagnetic pulse. The shelter is comprised of two concentric steel cylindrical enclosures, approximately nine feet tall and five feet in diameter. Atop the shelter is a six-foot tall radome. An EHF antenna/pedestal assembly is mounted inside the radome, along with a radome heater and antenna control servos. Cables from antenna are routed underground to an ESA mounted on the wall of the LCC (fig. 4–11).

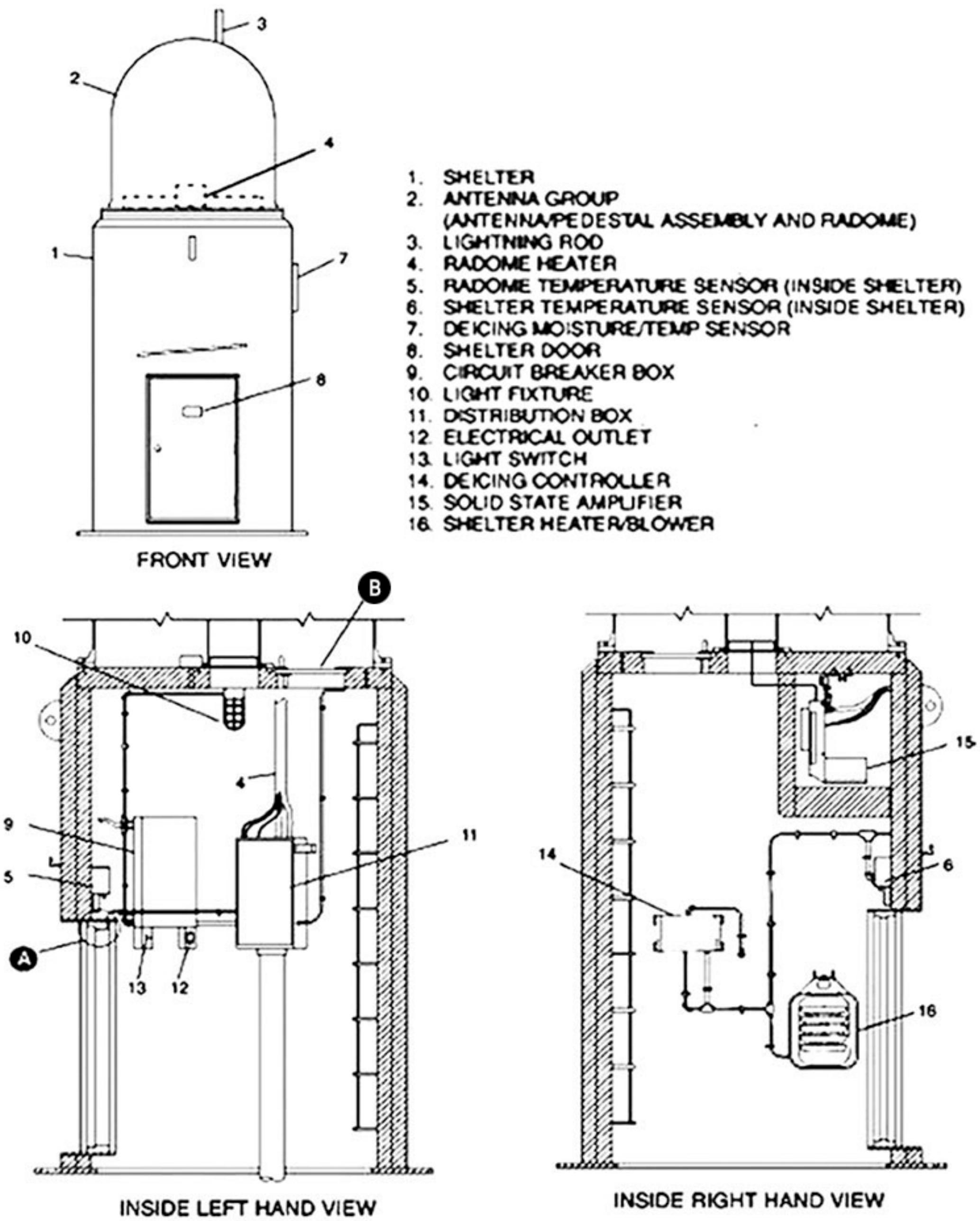


Figure 4–11. Antenna shelter.

Extra-high frequency electrical surge arrester set

In the LCC, four units for EHF provide protection to electronic circuits, equipment, and personnel from voltage or current surges induced by lightning or other electromagnetic pulses in circuits entering the LCC. Unit 1, 2, and 3 of URD 16720 use ESAs to provide protection. Unit 4 of URD 16720 consists of 14 circuit cards and nine MOVs.

324. Air Force satellite communications

The AFSATCOM system is a UHF radio system that uses orbiting satellite repeaters for long-distance, two-way message handling (fig. 4–12).

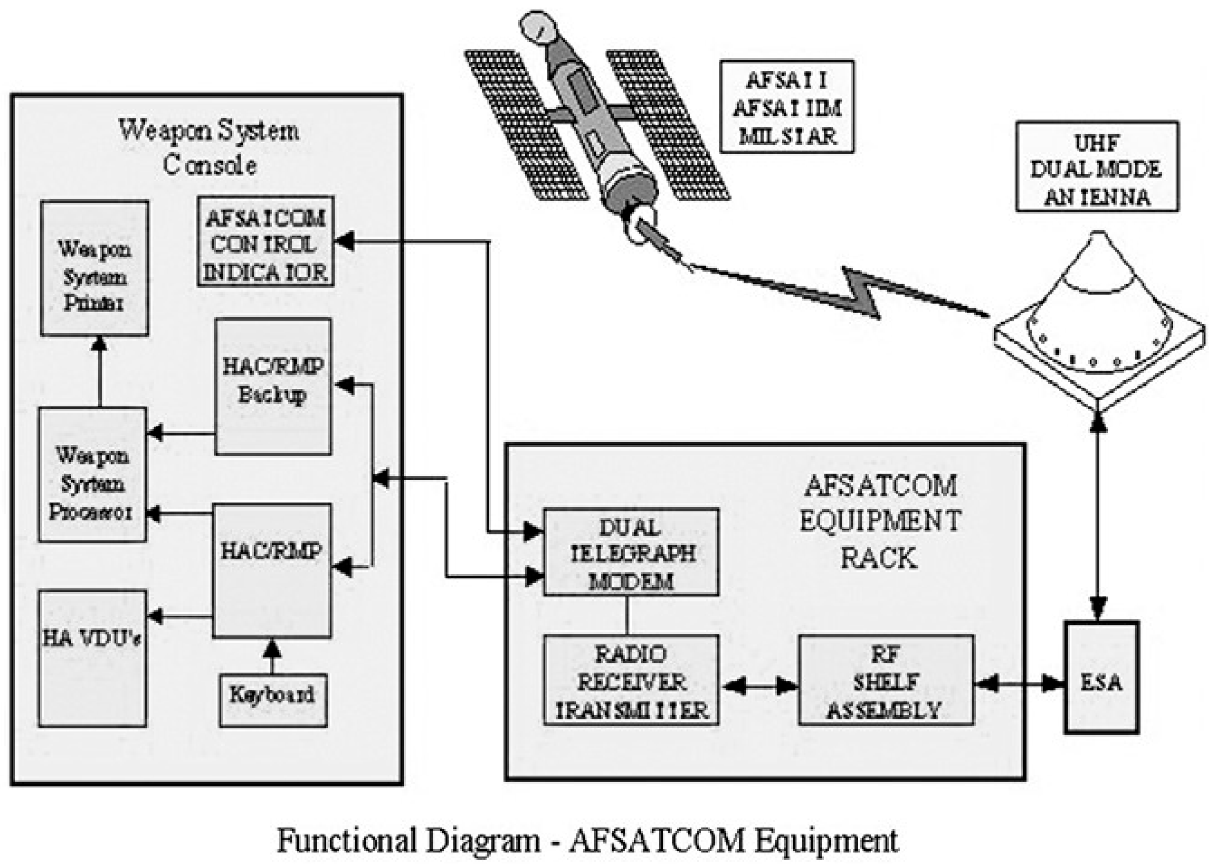


Figure 4–12. AFSATCOM equipment diagram.

An AFSATCOM station copies all messages that are addressed to a group of which it is a part. Messages are composed and sent from the console. When a priority or an EAM is received, audible and visual signaling devices (fig. 4–13) alert operators.

The dual-mode UHF antenna is used by both the AFSATCOM system and the UHF (voice) radio system (fig. 4–13). The antenna actually contains two antenna elements, one for AFSATCOM, the other for UHF radio. The antenna is joined to the respective system cables through a hybrid assembly at the base of the antenna elements. The hybrid assembly matches the antenna impedances to the respective cable impedances, and provides isolation between systems. The antenna is a low profile, hardened structure.

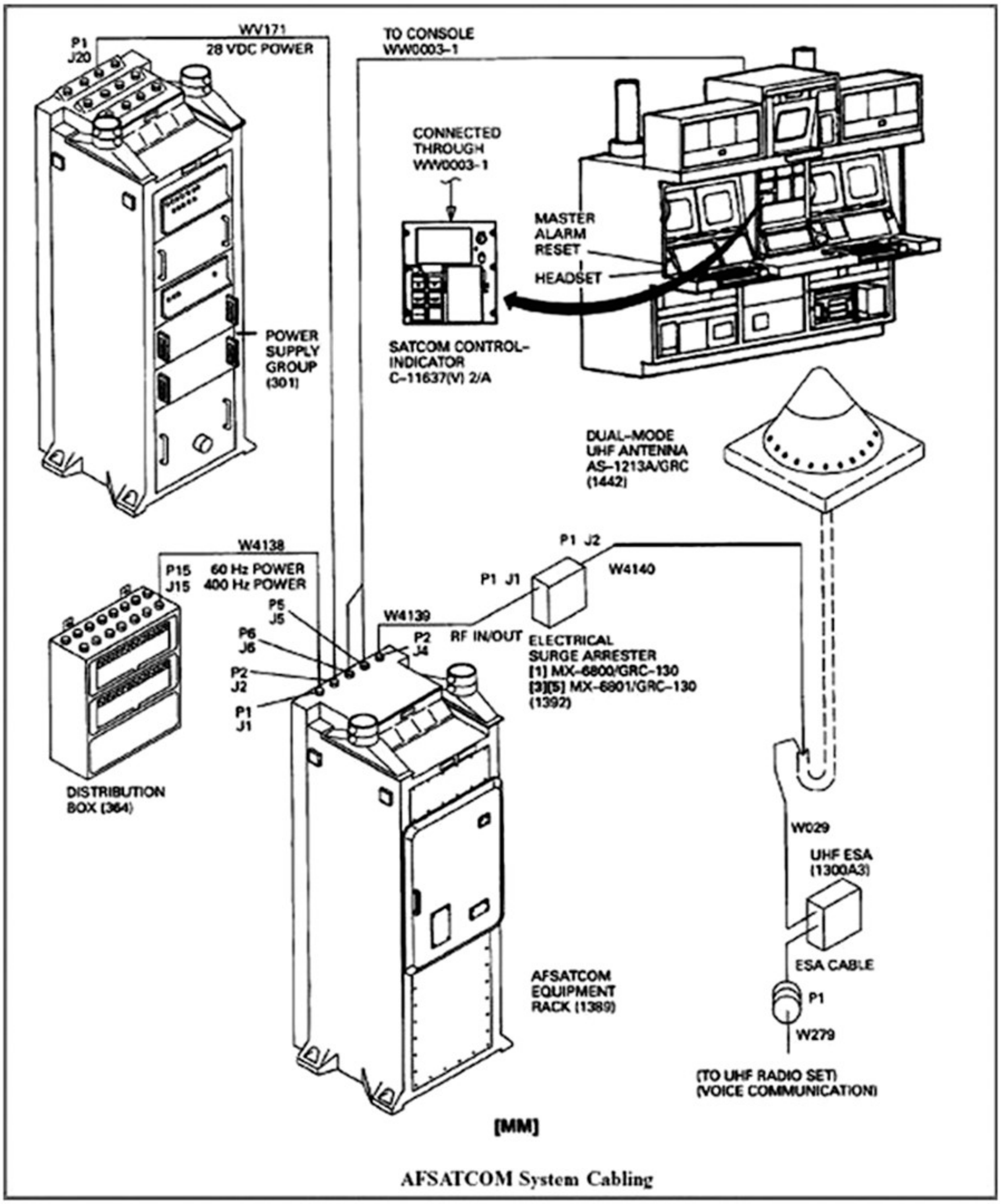


Figure 4–13. AFSATCOM system cabling.

Self-Test Questions

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

323. Extremely-high frequency military strategic tactical relay

1. Which system is designed to operate during nuclear conditions and EMP events?

2. What provides EHF circuit protection?

324. Air Force satellite communications

1. What UHF radio system uses orbiting satellite repeaters for long-distance, two-way message handling?

2. What two systems use the dual-mode UHF antenna?

4–3. Missile Radio

The missile radio system is divided into two categories—VLF/LF and UHF communications. As you will see, this system has several components, each with a unique role to play. We will begin the description of the VLF/LF system.

325. Very-low frequency/low-frequency communications

Communications over the VLF/LF can be secure-coded or delivered in clear text. Nonsecure messages are authenticated by procedural means. To better help understand this process, in this lesson we will cover the components of the VLF/LF system; namely, the Survivable Low-Frequency Communication System (SLFCS) antenna assembly, a VLF/LF receiver, components within an electronics drawer, and VLF radio control assembly. The SLFCS antenna assembly group consists of a receiving antenna and an EMP suppressor. VLF/LF receiver components reside in three drawers/chassis of the EHF and VLF/LF higher authority command systems equipment rack.

The VLF radio control assembly, mounted in the console, enables the operator to choose one of five primary operating channels configured in the receiver. The VLF/LF receiver provides the following five electrical antenna steering modes:

1. Omni-directional.
2. North-south.
3. Northeast-southwest.
4. East-west.
5. Southeast-northwest.

The SLFCS antenna assembly consists of a receiving antenna and an EMP suppressor and cabling. The receiving antenna, consisting of two interlocked vertical loops, is installed underground to ensure survivability. The antenna is installed so that one loop is oriented in the north-south direction with the other loop in the east-west direction. An ESA is permanently attached to each loop to protect the equipment from lightning and EMP surges. The EMP suppressor is mounted on the wall of the LCC ESA vault and is connected to the antenna via an underground cable. Signals received at the antenna in the 14 to 60 kilohertz range are fed to the receiver group equipment in the LCC via the underground cable and the EMP suppressor. The EMP suppressor protects the receiver group equipment from transient overvoltage's and currents.

326. Ultra-high frequency communications

The primary components of the UHF radio system include the power amplifier AM–6987/GR, the radio R/T–980/GRC–171, the electronic frequency converter CV–3450/GRC–171, and the UHF antenna. The power amplifier amplifies the output signal of the radio receiver-transmitter before it is sent to the antenna. The radio receiver-transmitter receives and transmits the UHF signal. The electronic frequency converter sets the frequency for the transmitter.

The UHF radio system is a hardened radio system for voice communications from the LCC. The system is designed for remote operation using the VCP and the UCP. The system transmits and receives an amplitude-modulated signal in the 225 to 400 megahertz range with 19 preset frequencies. Minimum modulated power output is 100 watts. The UHF radio system shares its antenna system with the AFSATCOM UHF communication system.

Self-Test Questions

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

325. Very-low frequency/low-frequency communications

1. The VLF radio control assembly allows the operator to choose how many primary operating channels?

2. The SLFCS antenna assembly consists of what three major assemblies?

326. Ultra-high frequency communications

1. What is the hardened UHF radio system used for?

2. What is the power output of the UHF radio system?

Answers to Self-Test Questions

320

1. Transmitting and receiving secure EAM, FDM, and NAM traffic.
2. The SDT.

321

1. Between the LCC and SCC, the MAF and LF and internally in a MAF of LF.
2. Dial lines 1 and 2.
3. The HVC.
4. The EWO–2.

322

1. RMP.
2. AFSATCOM, SACCS, and EHF MILSTAR.

323

1. The EHF equipment.
2. ESAs, MOVs, and circuit cards.

324

1. AFSATCOM.
2. AFSATCOM system and the UHF (voice) radio system.

325

1. Five.
2. A receiving antenna, EMP suppressor, and cabling.

326

1. Voice communications from the LCC.
2. 100 watts.

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.

52. (320) Identify the division of strategic communications that is the primary median for transmitting emergency action messages.
    a. Rapid execution and combat targeting.
    b. Missile control communications systems.
    c. Strategic missile intelligence communications.
    d. Strategic automated command and control system.

53. (320) The Strategic Automated Command and Control System desktop terminal is the primary input/output terminal that
    a. provides message entry and delivery.
    b. alerts the operator to equipment malfunctions.
    c. provides a single communication line interface.
    d. provides encryption and decryption of messages.

54. (321) The hardened voice channel is a hard communications system, meaning the system is
    a. highly encrypted.
    b. difficult to maintain.
    c. encased in concrete.
    d. shielded from electromagnetic pulse.

55. (322) Which is *not* one of the operational computer programs of the rapid message processor?
    a. Communications integrator.
    b. Transmission integrator.
    c. Message formatting.
    d. Message processor.

56. (323) The extremely-high frequency system functions as a communications link between missile
    a. alert facilities and remote command posts.
    b. combat crew and maintenance teams.
    c. alert facilities and launch facilities.
    d. combat crew and flight security controller.

57. (323) In which combat crew console equipment component, are incoming extremely-high frequency messages stored in survivable memory?
    a. Weapon system processor.
    b. Rapid message processor.
    c. Voice control panel.
    d. Message control.

58. (324) Which communication system is ultra-high frequency radio based and uses satellite repeaters for long distance, two-way message handling?
    a. Extra-high frequency military strategic and tactical relay.
    b. Missile control communications.
    c. Air Force satellite communication.
    d. Hardened intrasite cable.

59. (324) The dual-mode ultra-high frequency antenna element is used by the ultra-high frequency radio system and
    a. Air Force Satellite Communication System.
    b. Missile Control Communications System.
    c. voice control panel.
    d. site phone.

60. (325) How many primary operating channels are available on the very-low frequency radio control assembly?
    a. 1.
    b. 3.
    c. 5.
    d. 7.

61. (325) The Survivable Low-Frequency Communication System receiving antenna is installed underground to
    a. ensure survivability.
    b. reduce the risk from terrorist threats.
    c. maintain a constant operating temperature.
    d. prevent interference with other communication equipment.

62. (326) Identify the system that transmits and receives an amplitude-modulated signal in the 225 to 400 megahertz range.
    a. Ultra-high frequency.
    b. Extra-high frequency.
    c. Very-low frequency.
    d. High frequency.

Glossary of Abbreviations and Acronyms

π	pi
°F	degree Fahrenheit
AAP	auxiliary alarm panel
AC	alternating current
AF	Air Force
AFB	Air Force base
AFH	Air Force handbook
AFI	Air Force instruction
AFMAN	Air Force manual
AFREP	Air Force enhancement repair program
AFSATCOM	Air Force satellite communication
AHC	airborne launch control center hold off command
ALCC	airborne launch control center
amp	amperage or ampere
AR	as required
ASU	automatic switching unit
AVE	aerospace vehicle equipment
BCP	base communications processor
BS/L	bulk storage/loader
C2	command and control
CAGE	commercial and government entity
CCE	code change enable
CCV	code change verifier
CDA	coder-decoder assembly
CDC	career development course
CED	control electronics drawer
CEIU	communication equipment interface unit
CEM	civil engineering manual
CI	communications integrator

CLS	cooperative launch switch
CMPG	command message processing group
CMSC	computer memory security check
CMVC	computer memory verification check
CONUS	continental United States
CSD(G)	command signals decoder-ground
CSD(M)	command signal decoder-missile
CSR	command summary report
CTU	cartridge tape unit
D-box	distribution box
DC	direct current
DCU	digital computer unit
DD	Department of Defense (form or tag)
DDG	digital data group
DDRT	digital data receiver-transmitter
DEU	diesel electric unit
DFMR	dual frequency minimum essential emergency communications network receiver
DIFM	due-in from maintenance
DLADS	Defense Logistics Agency Disposition Services
DLN	dedicated line network
DOD	Department of Defense
DRMS	Defense Reutilization and Marketing Service
EAM	emergency action message
ECS	environmental control system
EFA	electrical filter assembly
EHF	extra-high frequency
ELC	execute launch command
EMI	electromagnetic interference
EMP	electromagnetic pulse
EMT	electromechanical team

ENC	enable command
ENT	enable test
ERRC	expendability, recoverability, reparability, category
ESA	electrical surge arrester
EWO	emergency war order
FA	functional area
FAD	force activity designator
FAPA	facility alarm protection assembly
FDD	floppy disk drive
FDM	force direction message
FEDLOG	federal logistics
FLI	fault locating indicator
FSC	federal supply classification
FSG	federal supply group
G&C	guidance and control
GCA	gyrocompass assembly
GMI	ground maintenance interrogation
GMR	ground maintenance response
GSP	gyro stabilized platform
GWEN	ground wave effect network
HA	higher authority
HDLC	high-level data link control
HESG	high-energy spark gap
HF	high frequency
HICS	hardened intrasite cable system
HUTE	hardened user terminal element
HVC	hardened voice channel
Hz	hertz
I	insert
I-box	interconnecting box
ICBM	intercontinental ballistic missile

ID	identification
ILC	inhibit launch command
IMDS	Integrated Maintenance Data System
IMU	inertial measurement unit
IMU CAL	inertial measurement unit calibration
INT	inhibit test
IPB	illustrated parts breakdown
IPD	inertial measurement unit performance data
IPDC	inertial measurement unit performance data command
IPDH	inertial measurement unit performance data halt
IPDR	inertial measurement unit performance data response
IPL	initial program load
IZ	inner zone
J-box	junction box
JCN	job control number
JML	journal memory loader
KSR	keyboard send receive
LA	lighting panel A
LC	launcher closer
LCC	launch control center
LCDN	launch control distribution-normal bus
LCDS	launch control distribution-standby bus
LCEB	launch control equipment building
LCP	launch control panel
LCPA	launch control power-A
LDA	launcher distribution-A
LDB	launcher distribution-B
LDC	launcher distribution-C
LEP	launch enable panel
LER	launcher equipment room

LES	launch enable switch
LF	launch facility; low frequency
LFLC	launch facility load cartridge
LFNG	launch facility no-go
LFSB	launch facility support building
LFSS	launch facility security system
LSB	launch support building
MAF	missile alert facility
MAJCOM	major command
MAR	master alarm reset
MBCP	missile base communications processor
MCC	missile combat crew
MCCC	missile combat crew commander
MCCM	missile combat crew member
MCCS	missile control communications system
MCRL	master cross-reference list
MCU	mechanical code unit
MEECN	minimum essential emergency communications network
MG	motor generator
MGE	maintenance ground equipment
MGS	missile guidance section
MILSTAR	military strategic and tactical relay
MIS	maintenance information system
MMOC	missile maintenance operation center
MMT	missile maintenance team
MOSI	missile operational status interrogation
MOSR	missile operational status reply
MOV	metal oxide varistor
MP	message processor
MPL	maintenance parts list
MPP	Minuteman power processor

MRT	miniature receive terminal
MSB	missile support base
MSU	mass storage unit
MXG	maintenance group
NAM	non-action message
NATO	North Atlantic Treaty Organization
NCB	National Codification Bureau
NIIN	national item identification number
NRTS	not repairable this station
NRZ	non-return-to-zero
NSN	national stock number
OFP	operational flight program
OGE	operational ground equipment
OGP	operational ground program
OID	operator input device
OSI	operational status interrogation
OSR	operational status response
OWC	overwrite command
OWT	overwrite terminate command
OZ	outer zone
P	penetrate
PBR	percentage of base repair
PEP	port expansion processor
PG	programmer group
PHI CAL	phi calibration
PIGA	pendulous integrating gyroscope accelerometer
PLC-A	preparatory launch command-A
PLC-B	preparatory launch command-B
PLCC	primary launch control center
PLPA	power line protection assembly

PMI	periodic maintenance inspection
POL	petroleum, oil and lubricants
PSAT CAL	perturbation self-alignment technique calibration
PSD	power supply drawer
PSDU	power signal distribution unit
PSG	power supply group
P/V	parity/verify
R	reverify
RAM	random access memory
RCS	rapid execution and combat targeting console subassembly
RDA	remote data authorized
RDC	remote data change
RDCP	remote data change program
RDCT	remote data change target
RDH	remote data halt
RDI	remote data interrogation
RDR	remote data response
RDT	remote data terminate
RDW	remote data word
REACT	rapid execution and combat targeting
REF	reference
REMIS	Reliability And Maintainability Information System
RF	radio frequency
RFI	radio frequency interference
RMP	rapid message processor
RMPB	rapid message processor backup
RPM	revolutions per minute
RS	reentry system
RSI	resync inquiry
RSR	resync response
R/T	receiver-transmitter

SACCS	Strategic Automated Command and Control System
SACDIN	strategic air command digital information network
SAHC	short airborne launch control center hold off command
SARC	site activation remote controller
SATCOM	satellite communications
SBSS	Standard Base Supply System
SCC	security control center
SCNT	sensitive command network test
SCP	subnet communications processor
SCS	safety control switch
SDCA	secondary door control assembly
SDT	Strategic Automated Command and Control System desktop terminal
SDU	secure data unit
SFU	summary fault unit
SIN	support information network
SKL	simple key loader
SLFCS	Survivable Low Frequency Communication System
SMR	source, maintenance, and recoverability
SRAM	static random access memory
SRD	standard reporting designator
STRATCOM	strategic communications
TDR	target data response
TI	transmission integrator
TIN	turn in
TO	technical order
TODC	time-of-day clock
TV	television
TVI	target verification interrogation
TVR	target verification response
UCP	ultra-high frequency control panel

UHF	ultra-high frequency
UII	unique item identifier
UMMIPS	Uniform Materiel Movement and Issue Priority System
UND	urgency of need designator
URD	unit reference designator
US	United States
USSTRATCOM	United States Strategic Command
V	verify
VAC	volts alternating current
VCP	voice control panel
VDC	volts direct current
VDU	visual display unit
VHF	very-high frequency
VLF	very-low frequency
WCPS	Wing Code Processing System
WebFLIS	Web Federal Logistics Information System
WSC	weapons system control
WSCC	weapon system control console
WSP	weapon system processor
WUC	work unit code

Student Notes

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