NONRESIDENT
TRAINING
COURSE

March 1991

Aviation Structural Mechanic E 1 & C

NAVEDTRA 14019

Although the words "he," "him," and "his" are used sparingly in this course to enhance communication, they are not intended to be gender driven or to affront or discriminate against anyone.

PREFACE

By enrolling in this self-study course, you have demonstrated a desire to improve yourself and the Navy. Remember, however, this self-study course is only one part of the total Navy training program. Practical experience, schools, selected reading, and your desire to succeed are also necessary to successfully round out a fully meaningful training program.

THE COURSE: This self-study course is organized into subject matter areas, each containing learning objectives to help you determine what you should learn along with text and illustrations to help you understand the information. The subject matter reflects day-to-day requirements and experiences of personnel in the rating or skill area. It also reflects guidance provided by Enlisted Community Managers (ECMs) and other senior personnel, technical references, instructions, etc., and either the occupational or naval standards, which are listed in the *Manual of Navy Enlisted Manpower Personnel Classifications and Occupational Standards*, NAVPERS 18068.

THE QUESTIONS: The questions that appear in this course are designed to help you understand the material in the text.

VALUE: In completing this course, you will improve your military and professional knowledge. Importantly, it can also help you study for the Navy-wide advancement in rate examination. If you are studying and discover a reference in the text to another publication for further information, look it up.

1991 Edition Prepared by
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Published by
NAVAL EDUCATION AND TRAINING
PROFESSIONAL DEVELOPMENT
AND TECHNOLOGY CENTER

NAVSUP Logistics Tracking Number
0504-LP-026-6960

Sailor's Creed

"I am a United States Sailor.

I will support and defend the Constitution of the United States of America and I will obey the orders of those appointed over me.

I represent the fighting spirit of the Navy and those who have gone before me to defend freedom and democracy around the world.

I proudly serve my country's Navy combat team with honor, courage and commitment.

I am committed to excellence and the fair treatment of all."

CONTENTS

INSTRUCTIONS FOR TAKING THE COURSE

ASSIGNMENTS

The text pages that you are to study are listed at the beginning of each assignment. Study these pages carefully before attempting to answer the questions. Pay close attention to tables and illustrations and read the learning objectives. The learning objectives state what you should be able to do after studying the material. Answering the questions correctly helps you accomplish the objectives.

SELECTING YOUR ANSWERS

Read each question carefully, then select the BEST answer. You may refer freely to the text. The answers must be the result of your own work and decisions. You are prohibited from referring to or copying the answers of others and from giving answers to anyone else taking the course.

SUBMITTING YOUR ASSIGNMENTS

To have your assignments graded, you must be enrolled in the course with the Nonresident Training Course Administration Branch at the Naval Education and Training Professional Development and Technology Center (NETPDTC). Following enrollment, there are two ways of having your assignments graded: (1) use the Internet to submit your assignments as you complete them, or (2) send all the assignments at one time by mail to NETPDTC.

Grading on the Internet: Advantages to Internet grading are:

- you may submit your answers as soon as you complete an assignment, and
- you get your results faster; usually by the next working day (approximately 24 hours).

In addition to receiving grade results for each assignment, you will receive course completion confirmation once you have completed all the assignments. To submit your assignment answers via the Internet, go to:

http://courses.cnet.navy.mil

Grading by Mail: When you submit answer sheets by mail, send all of your assignments at one time. Do NOT submit individual answer sheets for grading. Mail all of your assignments in an envelope, which you either provide yourself or obtain from your nearest Educational Services Officer (ESO). Submit answer sheets to:

COMMANDING OFFICER
NETPDTC N331
6490 SAUFLEY FIELD ROAD
PENSACOLA FL 32559-5000

Answer Sheets: All courses include one "scannable" answer sheet for each assignment. These answer sheets are preprinted with your SSN, name, assignment number, and course number. Explanations for completing the answer sheets are on the answer sheet.

Do not use answer sheet reproductions: Use only the original answer sheets that we provide—reproductions will not work with our scanning equipment and cannot be processed.

Follow the instructions for marking your answers on the answer sheet. Be sure that blocks 1, 2, and 3 are filled in correctly. This information is necessary for your course to be properly processed and for you to receive credit for your work.

COMPLETION TIME

Courses must be completed within 12 months from the date of enrollment. This includes time required to resubmit failed assignments.

PASS/FAIL ASSIGNMENT PROCEDURES

If your overall course score is 3.2 or higher, you will pass the course and will not be required to resubmit assignments. Once your assignments have been graded you will receive course completion confirmation.

If you receive less than a 3.2 on any assignment and your overall course score is below 3.2, you will be given the opportunity to resubmit failed assignments. **You may resubmit failed assignments only once.** Internet students will receive notification when they have failed an assignment--they may then resubmit failed assignments on the web site. Internet students may view and print results for failed assignments from the web site. Students who submit by mail will receive a failing result letter and a new answer sheet for resubmission of each failed assignment.

COMPLETION CONFIRMATION

After successfully completing this course, you will receive a letter of completion.

ERRATA

Errata are used to correct minor errors or delete obsolete information in a course. Errata may also be used to provide instructions to the student. If a course has an errata, it will be included as the first page(s) after the front cover. Errata for all courses can be accessed and viewed/downloaded at:

http://www.advancement.cnet.navy.mil

STUDENT FEEDBACK QUESTIONS

We value your suggestions, questions, and criticisms on our courses. If you would like to communicate with us regarding this course, we encourage you, if possible, to use e-mail. If you write or fax, please use a copy of the Student Comment form that follows this page.

For subject matter questions:

E-mail: n315.products@cnet.navy.mil
Phone: Comm: (850) 452-1001, Ext. 1713
DSN: 922-1001, Ext. 1713
FAX: (850) 452-1370
(Do not fax answer sheets.)
Address: COMMANDING OFFICER
NETPDTC (CODE N315)
6490 SAUFLEY FIELD ROAD
PENSACOLA FL 32509-5237

For enrollment, shipping, grading, or completion letter questions

E-mail: fleetservices@cnet.navy.mil
Phone: Toll Free: 877-264-8583
Comm: (850) 452-1511/1181/1859
DSN: 922-1511/1181/1859
FAX: (850) 452-1370
(Do not fax answer sheets.)
Address: COMMANDING OFFICER
NETPDTC (CODE N331)
6490 SAUFLEY FIELD ROAD
PENSACOLA FL 32559-5000

NAVAL RESERVE RETIREMENT CREDIT

If you are a member of the Naval Reserve, you will receive retirement points if you are authorized to receive them under current directives governing retirement of Naval Reserve personnel. For Naval Reserve retirement, this course is evaluated at 6 points. (Refer to *Administrative Procedures for Naval Reservists on Inactive Duty*, BUPERSINST 1001.39, for more information about retirement points.)

COURSE OBJECTIVES

In completing this nonresident training course, you will demonstrate a knowledge of the subject matter by correctly answering questions on the following: management safety and supervision; electrically operated canopy systems; utility systems; air-conditioning systems; and the Navy aircrew common ejection seat (NACES).

Student Comments

Course Title: *Aviation Structural Mechanic E 1 & C*

NAVEDTRA: 14019 **Date**: ____________________

We need some information about you:

Rate/Rank and Name: ____________________ SSN: ____________ Command/Unit ________________

Street Address: ________________________ City: ____________ State/FPO: ________ Zip ________

Your comments, suggestions, etc.:

Privacy Act Statement: Under authority of Title 5, USC 301, information regarding your military status is requested in processing your comments and in preparing a reply. This information will not be divulged without written authorization to anyone other than those within DOD for official use in determining performance.

NETPDTC 1550/41 (Rev 4-00)

CHAPTER 1

MANAGEMENT SAFETY AND SUPERVISION

Chapter Objective: *Upon completion of this chapter, you will have a working knowledge of the AME work center supervisor's responsibilities for a continuous safety program.*

The *Manual of Navy Enlisted Manpower and Personnel Classifications and Occupational Standards,* NAVPERS 18068 (series), states that the AME is responsible for the maintenance of many systems. Some of these systems are covered in this manual. Other areas that the AME1 and AMEC must be qualified in are maintaining work center records, preparing reports, and training and leadership. The training and leadership responsibilities are addressed in the *Aviation Maintenance Ratings Supervisor,* NAVEDTRA 10343-A1, which you should complete along with this training manual (TM).

Senior AME personnel, because of the inherent dangers involved in the duty, must be more concerned with personnel and equipment safety than senior petty officers in other aviation ratings. Because of this concern, management, safety and supervisory information is presented here as a separate chapter, as well as in other places throughout this training manual.

SAFETY

Learning Objective: *Identify safety precautions for working with hazardous substances and equipment.*

In the AME rating there are many ways for a careless or inexperienced worker to hurt himself or others and damage equipment. In fact, no other aviation ratings has more potential for loss of life or violent destruction of property than the AME rating. Because of the inherent dangers associated with survival equipment, AME supervisors must be able to recognize and correct dangerous conditions, avoid unsafe acts, and train others to recognize and respect the importance of safety.

Each year Navy personnel operating and maintaining safety and survival equipment are involved in accidents. These accidents result in excessive repair and/or replacement cost amounting to millions of dollars and reduced operational readiness. The magnitude of this recurring loss emphasizes the necessity for preventing accidents, and the associated human suffering. Investigations have revealed two major reasons for most accidents with and around safety and survival equipment; (1) lack of effective training, (2) lack of supervision and leadership. The supervision, leadership, and training required for the proper operation and maintenance of safety and survival equipment are provided by the AME1 and the AMEC.

The term *safety,* as discussed in this course, is defined as *freedom from danger.* This definition covers both personnel and equipment. It does not mean that hazards will not exist (they will); but it does mean that if the hazards are known, safety awareness can and will help prevent accidents.

Safety is everybody's responsibility, and all hands are required to promote and adhere to safety rules and regulations. This is easy to say, and it is the ultimate aim of all supervisory personnel, but it is not easy to achieve.

The AME's interest in safety is personal. Ask anyone about safety and they will agree it's very important. This means everyone wants to be safe, but may feel that observing safety precautions slows down their work. Some feel they know the job so well that they don't have to be cautious. Still others think "there will be accidents, but to the other guy, not me."

It is these attitudes toward safety that place the burden of responsibility for safety on AME supervisory personnel. They must realize that accidents can happen anywhere, anytime, and to anyone. The AME1 and AMEC must, where possible, ensure "freedom from danger" for his personnel and equipment.

The best method for the supervisor to meet his responsibility for safety is by a continuous safety program. This program should include inspection of work areas, equipment, and tools; interpretation of safety directives and precautions; and personal attention to personnel problems and differences.

The main objective of this chapter is to discuss the parts of a **SAFETY PROGRAM** that will reduce the human suffering and operational readiness losses due to aviation safety and survival equipment accidents.

ORGANIZATION AND ADMINISTRATION OF A SAFETY PROGRAM

Many supervisors feel that it is only necessary to provide safeguards, and safety will take care of itself. Safeguards are a step in the right direction, but they alone will not get good results. To establish a good safety record requires the establishment of a good safety program. Navy directives require all organizations to have an active safety training program. The safety program discussed in this manual is built around **EDUCATION, ENVIRONMENT, and ENFORCEMENT.**

ENVIRONMENTAL CONDITIONS

Environment, as it applies to safety, can be defined as the improvement or redesign of equipment, machinery, work area, or procedures. The objective of the environment is the elimination of hazards or providing adequate safeguards to prevent accidents. The objectives are the responsibilities of the supervisor. Briefly, the objectives of supervision are as follows:

1. To operate with maximum efficiency and safety
2. To operate with minimum efficiency and waste
3. To operate free from interruption and difficulty

While these are the primary objectives of supervision, it is important for you to remember that your new assignment is important to you personally. It gives you an excellent opportunity to gain practical experience toward eventual promotions to AMCS and AFCM.

WORK AREAS

Supervisory personnel should be especially aware of shop cleanliness. A cluttered, dirty shop may cause personnel to become careless and inefficient. Look for spilled grease and oil. An otherwise "heads-up" man could become a "tails-up" man if spilled grease and oil is not cleaned up promptly. Notice rag storage. Oily rags should be kept in a closed metal container. Notice obstructions protruding from work benches and lying on decks, or items stowed on top of lockers. These are obvious dangers.

Less obvious hazards are poor work habits. Are the proper tools used for the tasks assigned? Are the established safety rules and regulations being followed? Is the shop lighting and ventilation adequate?

The hazardous conditions noticed by the AME during inspections should be corrected now, either by immediate action or training. General work center safety is covered more in the Aviation *Maintenance Ratings Supervisor* manual.

TOOLS

The inspection of tools should include type, condition, and use. As a general precaution, be sure that all tools conform to navy standards of quality and type. Remember that each tool has a place and should be in use or in that place. Each tool has a purpose and should be used only for that purpose.

If hand tools are dull, broken, bent, or dirty, corrective action is necessary. Tools that cannot be repaired should be replaced. Tools should be cleaned and kept clean. Portable tools should be inspected prior to each use to ensure they are clean and in the proper state of repair. The AME supervisor should be very critical of the tools within the work center. For more information on tools and their uses, refer to the *Aviation Maintenance Ratings Supervisor* manual.

EQUIPMENT

The AME supervisor will have many different kinds of equipment in his work center. The inspection of shop equipment should include checking for posted operational requirements and for safeguards such as goggles, hearing protectors, and protective clothing. Always check for leaks, frayed electrical cords, proper working conditions, and general cleanliness.

The inspection of work areas, tools, and equipment will point up hazards that must be corrected. Some corrections will be made on the spot, and some will have to be worked out through job improvements. The inspections will show the need for and the continuation of a good safety program. For more information on shop equipment, refer to the *Aviation Maintenance Ratings Supervisor* manual.

SAFETY INSPECTIONS

About 98 percent of all accidents can be prevented. This means that accidents can be prevented by educating personnel to the hazards or by completely eliminating the hazards. It's with this idea in mind that you will make your inspections. During the inspection, look for hazardous conditions that can be eliminated and for hazardous conditions that can be corrected through training. The two percent classified as unpreventable are caused by natural elements, such as wind, lightning, flooding, etc., and some steps can be taken to lessen these hazards.

Safety inspections should be continuous. A habit should be developed for noting everything. Everytime you walk through the shop, line area, around aircraft, or any area where your responsibility extends, think safety. When a hazardous condition is found, correct it. To put it off until later is to gamble with the safety of your men and equipment. The hard rule is that in matters of safety, "corrective action is required NOW."

SAFETY EDUCATION

Safety education depends on obtaining and passing out safety-related information. Safety information is gained through inspections, experience from directives, and by performing an analysis of job requirements. An effective safety program creates interest as well as supplies information.

The following examples point up the different ways safety information may be disseminated.

1. POSTERS—The Navy provides safety posters that should be posted in appropriate places to emphasize the safety message.
2. PRINTED MATERIALS—This covers the required reading list of safety precautions pertaining to safety. Printed material also covers physically posting operating procedures on the equipment.
3. GROUP DISCUSSIONS—Group discussions are usually conducted when the information is applicable to all hands. Safety movies fall into this category.
4. INDIVIDUAL INSTRUCTION—Individual instruction is normally given when the problem involves individual work habits or a particular hazard is pointed out to an individual during the work process.

ENFORCEMENT

Enforcement as it applies to safety is defined as the *formulation of rules and regulations and a safety policy that will be followed by all hands.* Enforcement includes reprimanding violators of safety rules, frequent inspections to determine adherence to rules, and continuous follow-up procedures to determine WHY THERE ARE VIOLATORS. Supervisors must enforce safety rules without fear or favor. Safety consciousness and the will of the worker to aid in preventing accidents lies with the supervisors. Supervisors must not jeopardize cooperation in safety by inconsistency in enforcement.

PLANNING FOR ADVANCED BASE OR FORWARD AREA OPERATIONS

AME Chiefs must be able to prepare for advanced base or forward area operations without sacrificing the safety program. They must estimate aircraft spare parts and supplies, equipment, and manpower requirements for aviation structural repair. In determining requirements for forward or advance base operations, consider the following:

1. Safety
2. Mission
3. Environment
4. Operating Factors
5. The availability of existing facilities

A knowledge of the material and manpower requirements listed in the *Advanced Base Initial Outfitting Lists of Functional Components* will be very helpful. The functional component is one of more than 300 standardized units of the system that the Navy has developed to enable it to build and operate its advanced bases in the least possible time and with minimum expenditure of planning and logistic effort.

A functional component is a list of the requirements for the performance of a specific task at an advanced base. It is a carefully balanced combination of material, equipment, and/or personnel.

Each functional component is grouped according to its primary function into 1 of 11 major groups, including aviation. Each major group is identified by letter designation and title. The functional components contained in each are identified by a combination letter, number, and its title designation. The major group designation for aviation is "H."

"H" components are designed to provide maintenance, support, and operation of aircraft in an advanced area under combat conditions. "H" components may be combined with other functional components to form several types of air stations.

Complete information and data are given in the abridged and the detailed outfitting lists for functional components. It should be apparent to the AMEC that the advanced base requirements may not be exactly as they appear in the *Advanced Base Initial Outfitting Lists.* To use these lists as guides, it will be necessary, in most cases, to alter or tailor them to fit the individual needs of the unit about to deploy.

Other necessary repair parts, supplies, and equipment may be determined from the outfitting lists for the aircraft or other weapon systems to be supported.

It is quite likely that the AMEC will be required to advise the personnel office in making assignments of individuals to advance base or forward area operating units. It would seem logical that the number of AMEs assigned to deploy be in the same ratio as the percentage of supported aircraft scheduled to deploy. This may be true if the proposed flight hours per aircraft of the detachment exactly equalled the planned utilization of the remaining aircraft. There must also be no significant environmental problems to be overcome (i.e., excessive heat or excessive cold conditions, depending on the location of deployment). The list of personnel assigned to deploy should represent a cross section of the skill levels available unless special maintenance factors indicate otherwise. The selection of personnel should be made as objectively as possible so the deployed unit can function as safely and efficiently as possible.

SAFETY PRECAUTIONS FOR HAZARDOUS SUBSTANCES

Learning Objective: *Identify safety precautions for working with hazardous substances and equipment.*

There are many ways for a careless or inexperienced worker to hurt themselves or others on the job. This section discusses safety precautions in three hazardous work areas: liquid oxygen, gaseous oxygen, and high pressure air. Other specific safety precautions are discussed in OPNAVINST 5100.19 (series).

It has been said that every safety precaution has been originally written in blood. There is no room for complacency in the performance of AME tasks. Every job must be performed in a "heads-up" manner to ensure maximum safety awareness is maintained. Anything less can and will be disastrous.

LIQUID OXYGEN

Aviators breathing oxygen (ABO) comes in both gaseous (type 1) and liquid (type 11) states. Liquid oxygen (LOX) is converted to a gas before its delivered to the aircrew. LOX requires frequent monitoring to prevent contamination and to ensure safe use. A surveillance program is the primary method of ensuring that each operation in the LOX supply system is carried out in strict compliance with established procedures. Surveillance begins with procurement or generation of LOX and continues throughout storage, handling, transfer, and servicing of aircraft.

The best assurance of personnel safety lies in the safety education of the people themselves. The safety of personnel can be assured only when there is thorough understanding of potential hazards, the correct procedures and equipment are used, and the equipment is in good working condition. Knowledge of a job situation and appropriate safety equipment is vital to successful completion of a job. Follow established safety procedures in NAVAIR 06-30-501.

Description and Properties of Liquid Oxygen

Oxygen can exist as a solid or gas, depending upon the temperature and pressure under which it is stored. At atmospheric pressure, oxygen exists as a solid at temperatures below its melting point, – 361°F (–281°C). Solid oxygen turns into a liquid at its melting point and remains in this state until the temperature rises to its boiling point, –297°F (–183°C).

At this latter temperature, LOX vaporizes into the gaseous state. Gaseous oxygen will turn into liquid at atmospheric pressure by cooling to a temperature below –297°F. By increasing the pressure, gaseous oxygen can be liquified at higher temperatures, up to its critical temperature, – 182°F (–119°C). Oxygen will not condense to a liquid at temperatures above its critical temperature regardless of the pressure applied. The pressure required to liquify oxygen at its critical temperature is known as its critical pressure, 736.5 psig. The application of high pressure and ultra-low temperatures to convert gases to their liquid state is known as the science and technology of cryogenics. LOX is a cryogenic fluid.

Physical Properties of Liquid Oxygen

Gaseous oxygen is colorless odorless, tasteless, and about 1.1 times as heavy as air. LOX is an extremely cold, pale blue fluid that flows like water. One gallon of LOX weighs 9.519 pounds, which is 1.14 times heavier than the weight of 1 gallon of water. LOX is stored and handled at atmospheric pressure in well-insulated containers that maintain the liquid at its boiling point (–297°F). Therefore, LOX is boiling as it slowly turns into gaseous oxygen. As the expanding gas from the boiling liquid increases in amount, it builds up pressure within the container. Therefore, the expanding gas must be vented to the atmosphere. Confinement of liquid oxygen can be dangerous to personnel, causing severe injury and death.

This section contains procedures and requirements for the quality control of LOX that is stored, transferred, handled, and used for breathing purposes by aircrews. This section applies to AME supervisors who must ensure all safety procedures and equipment are used during LOX servicing and handling by qualified personnel.

Personnel

Personnel selected to perform operations in the LOX supply system should be trained and have a thorough knowledge of the characteristics of LOX, the significance of contamination, and the dangers involved. Only those personnel who demonstrate understanding of safety and who maintain reliable performance should be assigned the duties and responsibilities of handling LOX.

LOX Contamination

During the handling and transfer of LOX, environmental contaminants must be prevented from entering the system. LOX strongly attracts and absorbs atmospheric gases. Contaminants make the ABO unusable. Conscientious attention to correct procedures during handling and transfer operations will prevent contamination and ensure safety.

The aircraft LOX converter system should be sampled and tested for contamination as follows:

Test for odor as soon as possible after a report of in-flight odors by the pilot or aircrew. Any abnormal psychological or physiological effects to an aircrew during or after flight should be cause to suspect possible oxygen contamination. Possible oxygen contamination should also be considered in any aircraft mishap when the circumstances of the mishap are vague or unknown. A sample should be taken and sent to a test site for analysis with supporting details of the incident, including history of the supply source of LOX. Appropriate reports must be submitted in accordance with OPNAVINST 3750.6. An information copy should be provided to the Naval Air Engineering Center program manager.

Applicable squadrons selected by area commands must, during each calender month, take a LOX sample from at least one filled converter and residual LOX from one converter (taken from an aircraft after a flight mission), and forward both to a test site for contamination checks.

Aircraft oxygen and LOX systems, and LOX converters, must be purged in accordance with the applicable maintenance instructions manual (MIM) and/or NAVAIR 13-1-6.4, *Oxygen Equipment Manual.* Purging is done when the system or the converter is left open to the atmosphere, when empty, or whenever contamination is suspected.

GASEOUS OXYGEN

The supervision of aviators gaseous breathing oxygen requires the same surveillance as for LOX. Adequate and reliable supervisory control of aviators gaseous breathing oxygen demands that each operation in the gaseous breathing oxygen supply, and aircraft servicing system, be carried out in strict compliance with procedures established to assure safety of flight and mission completion.

This section establishes procedures and requirements for the quality control of gaseous oxygen that is stored, transferred, and used for breathing purposes by aircrews. This section is applicable to all personnel who are responsible for supervising or performing the operations associated with and servicing of the aircraft with aviators breathing oxygen.

Quality Control Requirements of Gaseous Oxygen

The procurement limits for purity and contamination, which include the absence of odor, of aviators gaseous breathing oxygen must meet the requirements of the current issue of MIL-O-27210.

The on-station monitoring of aviators gaseous breathing oxygen for contamination is performed by a sniff odor test.

WARNING

The odor test is very hazardous due to the high pressure in the cylinder. Do not place your face or nose directly into the venting gas stream and do not take deep breaths. Discontinue "sniffing" any gas at the first indication of irritation of the nasal passages or at any sign of physical discomfort. Some contaminants are extremely irritating, poisonous, or toxic, and can cause physical injury. The odor test can only be performed safely if the procedures are followed exactly.

NOTE

Persons temporarily unable to detect or classify odors because of head colds, hay fever, etc., must be excluded from the assignment of inspecting for the presence of odorous contaminants.

If an odor is detected, discontinue the inspection process. When detected, an attempt should be made to classify it, such as "acrid," "sweet, " "rotten egg," "glue like," etc., as this will help in the identification of the source of the contaminate.

Gaseous Oxygen Servicing Trailer

Gaseous oxygen servicing carts must be sampled and tested whenever contamination is suspected or after the completion of any maintenance action performed on the cart. An odor test must be conducted prior to servicing any aircraft system. This is accomplished by opening slightly the valve at the terminal end of the recharging hose and smelling the escaping gas in accordance with the procedures described in the A6-332AO-GYD-000. If an odor is present, the servicing cart will not be used to service the aircraft. Each cylinder must be inspected for the following:

- Proper painting and marking.
- Valves are tightly closed and not leaking.
- Safety caps and safety plugs are secure.
- Hydrostatic test date is current.
- All valves, manifold, servicing hose, and cylinders are clean and free of grease and oil. The presence of any grease or oil on the valves or cylinders must be reported to the maintenance officer for necessary action, and the servicing cart must be placed in a contaminated status.

HIGH-PRESSURE AIR

Using high-pressure compressed air safely requires knowledge and skills. Despite all the safety programs and posters regarding this shop hazard, reports of fatalities and serious injury from this cause continue to accumulate.

High-pressure compressed air is provided from one of three sources:

1. A portable high-pressure cylinder
2. A cascade-type servicing trailer equipped with several cylinders
3. Direct service from a portable high-pressure air compressor

Each of these sources is no less dangerous than the precautions already discussed for handling oxygen cylinders. Precautions apply generally as well for the handling and stowage of compressed air cylinders.

Do not fill any cylinder with a gas other than that gas for which the cylinder has been specifically designated. Explosive mixtures may be formed when cylinders containing residual combustible gases such as hydrogen, propane, or acetylene are charged with air or oxygen. The reverse of this procedure is equally hazardous.

Cylinders used for aviators' breathing oxygen, dry nitrogen, dry argon, dry helium, or dry air that are found to have open valves and/or a positive internal pressure of less than 25 psi (gauge) should be tagged "Dry Before Refilling."

When operating the compressed air servicing trailers, (gaseous oxygen or nitrogen) the following precautions should be observed:

1. Only qualified operators should operate the trailers while charging. Complete familiarity with the trailer is a basic prerequisite for safe operation.
2. The servicing hose end and installation connection fitting should be thoroughly inspected prior to servicing and any foreign matter removed.
3. Never charge an installation without the proper fusible safety plug and blowout disc in the trailer charging system.
4. Always know the pressure existing in the system to be filled and the pressure in all cylinders to be used in the cascading process before starting charging operations.
5. A malfunctioning pressure regulator should be disconnected from the line by closing its associated shut-off valve. The trailer can then be operated with the remaining pressure regulator.
6. The charging hose should never be stretched tightly to reach a connection. Position the trailer so that the servicing hose is not under tension while charging.
7. Always open all valves slowly. The dangers of rapid cascade charging must be avoided. Compressed air should never be blown towards anyone, used for cleaning of personal clothing, or as a means of cooling off a person.

SAFETY PRECAUTIONS FOR EJECTION SEATS AND EXPLOSIVE DEVICES

Learning Objective: *Identify the importance of the ejection seat check-out program.*

Ejection seats have several inherently dangerous features that are a definite hazard to uninformed and/or careless personnel. Consequently, whenever the aircraft is on the ground, all safety pins must be installed and not removed until the aircraft is ready for flight. Caution must be observed at all times during maintenance of and around the seats to avoid injury and equipment damage by explosive devices of the seat. Safety precautions and correct procedures cannot be overemphasized.

Keep all cartridges away from live circuits. Under no circumstances should any person reach within or enter an enclosure for the purpose of servicing or adjusting equipment without the immediate presence or assistance of another person capable of rendering aid.

When removing cartridges for inspections or for safety reasons, they must be marked for identification so they can be reinstalled in the same device from which they were removed. Under no circumstances should an unmarked or unidentified cartridge be installed in any cartridge-actuated device.

Cartridges should be handled as little as practicable to minimize risk of fire, explosion, and damage from accidental causes. All safety devices must be kept in good order and used only as designated.

Cartridges must be stored where they will not be exposed to direct rays of the sun, and they must be protected from extremely high temperatures. When in containers, they must be stored in a cool, dry place where they can be readily inspected.

The seat must always be disarmed before removal from the aircraft because firing of the seat may occur. While handling percussion-fired cartridges, you must exercise extreme caution not to drop cartridges because they can fire upon impact.

The following general precautions should always be kept in mind.

1. Ejection seats must be treated with the same respect as a loaded gun.
2. Always consider an ejection seat system as loaded and armed.
3. Before you enter a cockpit, know where the ejection seat safety pins are located, and make certain of their installation.
4. Only authorized personnel may work on, remove, or install ejection seats and components, and only in authorized areas.

EJECTION SEAT CHECK-OUTS

The modern, high-performance aircraft used by todays Navy place extreme demands on emergency escape systems. These systems contain highly explosive devices that are designed for one-time use only. Actuation of these devices could result in severe injury or death to personnel and damage to or destruction of aircraft. Therefore, due to the inherent dangers associated with ejection seats and canopy systems, a seat/canopy check-out procedure is required. The Egress/ Environmental Work Center (AME shop) is responsible for indoctrinating all personnel in the hazards and safety precautions associated with these systems. A thorough seat check-out will be given, by a qualified Aviation Structural Mechanic (Safety Equipmentman) (AME), to all newly assigned maintenance personnel prior to their performing any aircraft maintenance work on the aircraft, and every 6 months thereafter. In addition, any personnel removed from aircraft maintenance responsibilities for over 90 days must receive a seat check-out before performing any aircraft maintenance. The AME work center and the other maintenance work centers will maintain records of seat check-outs, including date given, date due, and the signature of the AME performing the check-out.

The seat check-out program will be established by a squadron MI. All personnel due seat check-out requalification will be listed in the monthly maintenance plan.

EJECTION SEAT CARTRIDGES AND CARTRIDGE-ACTUATED DEVICES (CAD)

The types of explosive devices incorporated in egress systems are varied. The AME working with these devices must know how they function, their characteristics, how to identify them, their service-life limitations, and all safety precautions.

The AME who understands the importance of all these factors and who correctly uses the maintenance manuals is better equipped to supervise and train others. The following manuals are required for the AME to meet the above requirements:

1. *Description, Preparation for use, and Handling Instructions, Aircrew Escape Propulsion System (AEPS) Devices,* NAVAIR 11-85-1
2. *General Use Cartridges and Cartridge Actuated Devices for Aircraft and Associated Equipment (CADS),* NAVAIR 11-100-1.1, NAVAIR 11-100-1.2, NAVAIR 11-100-1.3
3. Specific aircraft MIMs
4. OP 4, *Ammunition Afloat*
5. OP 5, *Ammunition and Explosives Ashore*

Service Life

The service life of a CAD is the specific period of time that it is allowed to be used. These periods of time are affected by various environmental conditions, which have resulted in the assignment of time limits or overage requirements. These limits are shelf life and installed life.

The establishment of service-life limits is based upon design verification tests, qualification tests, and surveillance evaluations. The established limits are approved by the Naval Air Systems Command. Therefore, the establishment of service-life time limits is not arbitrary and must be adhered to as specified.

Before deployment to areas that do not permit ready supply and servicing of cartridges or cartridge-actuated devices, an inspection must be made of all CAD service-life expiration dates. If, during this inspection, it is determined that a CAD will become overage during the period of the deployment, the CAD must be replaced prior to the deployment. Before installation of any CAD, the service life expiration date of the unit must be checked to ensure that the unit is not overage and will not become overage prior to the next periodic maintenance cycle of the aircraft.

During standard depot-level maintenance (SDLM), the expiration dates of all installed CADs must be checked. Those CADs assigned to organizational level for maintenance and have expiration dates prior to the next scheduled inspection after the aircraft is returned to its custodian must be replaced. CADs assigned to depot level for maintenance that have expiration dates falling prior to the next scheduled SDLM should also be replaced. The exception is systems replaced exclusively through the use of a field modification team. Adherence to these procedures will prevent loss of aircraft mission capability due to CAD service-life expiration.

Expiration Dates

To determine service-life expiration dates, both the shelf life and installed life must be computed. First, compute the shelf life of the CAD by using its lot number to determine the month and year of manufacture. Refer to table 1-1 to ensure correct interpretation of the lot number since there are currently two methods used to derive lot numbers. Obtain the established shelf life (number of months and years) for the individual CAD from the NAVAIR 11-100-1 series manual. Add this figure (shelf life) to the

Table 1-1.-Derivation of Lot Number

KEY	DEFINITION
a	Lot sequence number
b	Manufacturer's identification symbol
c	Month of production (two digit)
d	Year of production (two digit)
e	Month of production (single alpha) JAN - A MAY - E SEP - J FEB - B JUN - F OCT - K MAR - C JUL - G NOV - L APR - D AUG - H DEC - M
f	Interfix number
g	Lot suffix (alpha)

Example:
Lot Number, Method 1: 11 ABC 0578
Key: (a) (b) (c)(d)
(Note that (c) and (d) will be used to compute service life.)

Example:
*Lot Number, Method 2: XYE 78 E 001-011A
Key: (b) (d) (e) (f) (a)(g)
(Note that (d) and (e) will be used to compute service life.)
*Further details of explanation are available in MILSTD-1168A.

month and year of manufacture determined from the CAD lot number. The resulting sum (date) is the shelf-life expiration date of the CAD in question.

Example:

Lot number/date of manufacture	0579
+ Shelf-life in years	+ 6
Shelf-life expiration date	0585

Next, determine the installed-life expiration date of the CAD by referring to the NAVAIR 11-100-1 series manual. Obtain the installed-life figure (number of months or years), and add that figure to the date (month) the CADs hermetically sealed container was opened. The resulting sum (date) will be the installed-life expiration date for the CAD in question.

Example:

Date opened	0879
+ Installed life in months	+ 42
Installed-life expiration date	0283

Then, compare the two dates derived (shelf-life and installed-life). Whichever date occurs first is the CAD service-life expiration date.

Example:

Shelf-life	0585
Installed-life	0283
Service-life expiration date	0283

Since only the month and year are used in computing service-life dates, the date the hermetically sealed container is opened and the expiration date must be computed to the last day of the month involved. If the date the sealed container was opened is not available, the installed-life must be computed from the date of manufacture as determined from the lot number.

Marking Expiration Dates

Before installing a CAD in an aircraft system, both CAD service-life expiration dates (shelf-life and installed-life) should be computed. The time limit that is exceeded first will be the service-life expiration date of the CAD. The service-life expiration date must be entered in the aircraft logbook.

Use permanent ink for marking CADs with container opened dates and service-life expiration dates. Do not scribe, scratch, or eletroetch these dates, as damage will occur to the CAD's corrosion resistance surface. The marking pen, NSN 7520-00-043-3408, is available from GSA supply, and is recommended for this purpose.

When you install a CAD in an aircraft system, a log entry must be made on OPNAV Form 4790/26A, as directed by OPNAVINST 4790.2 (series). When a CAD's hermetically sealed container is opened, the container opened date and the service-life expiration date (month and year) must be marked with indelible ink on the container and on each CAD in the container.

Service-Life Extension

Contingency service-life extensions for the CADs listed in the NAVAIR 11-100-1 (series), not to exceed 30 days, may be granted by the commanding officer or his authorized representative. The extensions may be applied to a specific CAD on a one-time only basis when replacements are not available and failure to extend the service-life would disrupt flight operations. The contingency authority is granted on the condition that Naval Ordnance Station, Indian Head, Maryland; NAVAIRSYSCOM, Washington, D.C.; and SPCC, Mechanicsburg, Pennsylvania, be immediately notified by message or speed letter when such authority is exercised.

When the situation warrants, an additional service-life extension beyond the 30-day contingency extension may be requested by message from NAVORDSTA. All extensions beyond 30 days must be approved by the NAVORDSTA or NAVAIRSYSCOM. All approved additional service-life extensions will be transmitted by message to the activity making the request. When a service-life extension is granted, an entry must be made in the aircraft logbook. When an aircraft is transferred with a service-life extension in effect, the gaining activity must be notified, and no new contingency service-life extensions may be granted by the commanding officer of the gaining activity.

Service-life Change

The permanent service life of a CAD maybe changed only by a rapid action change (RAC), interim rapid action change (IRAC), or formal change to NAVAIR 11-100-1 (series) as directed by COMNAVAIRSYSCOM, Washington, D.C. If the change affects those items installed in an aircraft, the change will be recorded in the aircraft's logbook. A line will be drawn through the service-life expiration date shown and the new computed expiration date entered, citing the authority for the change; for example, message number, rapid action change number, or change number. Each new expiration date will supersede the previous date. The latest expiration date entered in the aircraft logbook will always be the final date the CAD may remain installed in the aircraft.

When a contingency service-life extension has been authorized for a specific CAD, the new computed service-life expiration date (month and year) will be added to the original aircraft logbook entry for that CAD. When an additional service-life extension has been granted for a specific CAD, the new service-life expiration date (month and year) will be added to the original aircraft logbook entry.

CAD Maintenance Policy

CAD maintenance policy prohibits unauthorized maintenance or adjustments to a CAD at any of the three levels of maintenance: organizational, intermediate, or depot. Authorized maintenance actions are limited to removal, inspection, and replacement, unless specifically detailed in the aircraft MIM or by a technical directive.

CADs and items of equipment in ejection systems are for one-time use only. They are never to be refurbished or used again after firing. This is equally true of functional equipment, rigid lines, plumbing lines, and hoses. Ejection seats and escape system components that have been used in an ejection or fired, regardless of apparent condition, are prohibited from reuse, and must be disposed of as directed by OPNAVINST 4790.2 (series), OPNAVINST 3750.6 (series), and the applicable CAD and rocket manual.

Because of the extreme stress and strain to the ejection seats and escape system components during ejection, they cannot be reused. This stress could reduce the structural or mechanical reliability of these items. In the case of an inadvertent firing of a cartridge or CAD, all contaminated ballistic lines and devices must be replaced because of the corrosive nature of the explosive.

The service-life of wire-braid, Teflon®-lined hoses installed in ballistic applications is the same as that of the aircraft in which it is installed, unless it is used. A hose is considered to be used if the device to which it is attached is fired, either intentionally or accidentally. If this occurs, the hose and related fittings must be replaced. Before you install a hose or fitting (line, elbow, T, etc.) make sure that it is not contaminated with hydraulic fluid, oil, or a similar type of contaminant. All hoses in the escape system must be inspected for accidental damage at every phased inspection, upon seat removal, after removal of any part of the escape system, and for disconnection of any hose.

When CADs are not installed in an aircraft, the inlet and outlet ports must be sealed with protective closures to prevent the entrance of moisture and foreign matter. For shipping purposes, the safety pins and protective closures provided with the replacement CAD must be returned with the replaced CAD to ensure it is in a safe condition during handling and storage. During ejection system maintenance actions, all disconnected CADs and associated ballistic lines must be protected with flexible plastic plugs that conform to MIL-C-5501/10A and flexible plastic caps that conform to MIL-C-5501/11. NAVAIR 11-100-1.1 provides information relating to these caps and plugs,

Cartridges are carefully designed and manufactured, but their performance in cartridge-actuated devices is dependable only when they have been properly handled and installed. Care must be observed to maintain the devices in perfect condition.

Since individual cartridges cannot be tested, the responsibility for proper functioning is in the hands of the supervisor and the personnel who maintain them. The quality and reliability of an ejection system are largely dependent on the supervisors and the mechanics who maintain the systems.

Supervisors take note. Nothing is foolproof because fools are so ingenious. Personal safety for those who work around ejection seats cannot be guaranteed. A high level of safety can be achieved if personnel have the proper attitude, understanding, training, and most importantly adequate supervision. Unless proper maintenance procedures are followed exactly, even the most routine ejection seat maintenance tasks can grow drastically out of proportion and bring about an accident or injury. Education of the workers involved is the best assurance for personnel safety. The workers should be made aware of potential hazards and the proper means of protecting themselves. Workers should be assigned tasks according to their capabilities.

Reporting

All malfunctions, discrepancies, and accidents involving CADs must be reported by message to the Naval Ordnance Station, Indian Head, Maryland, in accordance with OPNAVINST 4790.2 (series). If the suspected defect is with the CAD, the message must be addressed to NAVORDSTA for action. If the report describes an inadvertent actuation of an aircraft system resulting in the CAD functioning normally, the action copy of the report must be submitted to the cognizant field activity (CFA) for the aircraft with an information copy to NAVORDSTA, Indian Head, Maryland. Accidents and incidents involving CADs may require reporting in accordance with OPNAVINST 3750.6 in addition to the OPNAVINST 4790.2 (series). Submission of the reports required by the maintenance instruction does not satisfy the requirements of the safety instruction. If dual reporting is required, you should ensure the reports are adequately cross-referenced to satisfy the requirements of all commands involved.

All CADs suspected of being discrepant, malfunctioning, or involved in an accident or incident must be clearly identified and turned in to the station or ship's ordnance or weapons department. These CADs must be marked "hold for 30 days for engineering investigation (EI) pending disposition instructions." The report should contain the turn-in document number, and it should identify the activity holding the material. If CFA response is requested, NAVORDSTA will respond with complete disposition and shipping instructions.

INSTALLED EXPLOSIVE SAFETY DEVICES (OPNAV 4790/26A)

This form (fig. 1-1) is used in the logbook and the Aeronautical Equipment Service Record (AESR). This section of the logbook/AESR contains a record of all explosive safety devices (for example, initiators and canopy releases) installed in the aircraft/major assemblies. Explosive devices installed in major assemblies/ equipment (for example, ejection seats and in-flight refueling stores) must be recorded in the Installed Explosive Safety Devices page of the appropriate AESR. Explosive devices installed in personnel parachutes are recorded on the Parachute Configuration Inspection and History Record, and when installed in other safety and survival equipment, on the History Card - Aviation Crew System. All other explosive safety devices must be recorded on the Installed Explosive Safety Devices Form of the logbook/AESR. This form is not required when the recording of escape system explosive components in F-14A aircraft is done in accordance with NAVAIR 11-100-1.1 (NOTAL).

Certain equipment is transferred from one aircraft to another during SDLM and replaced during periods of scheduled maintenance. This emphasizes the need to carefully and periodically check this record regarding the status of the explosive devices currently installed in the aircraft/equipment. This record is maintained in a current status by all activities having custody of performing rework on the aircraft/equipment in which explosive safety devices are installed.

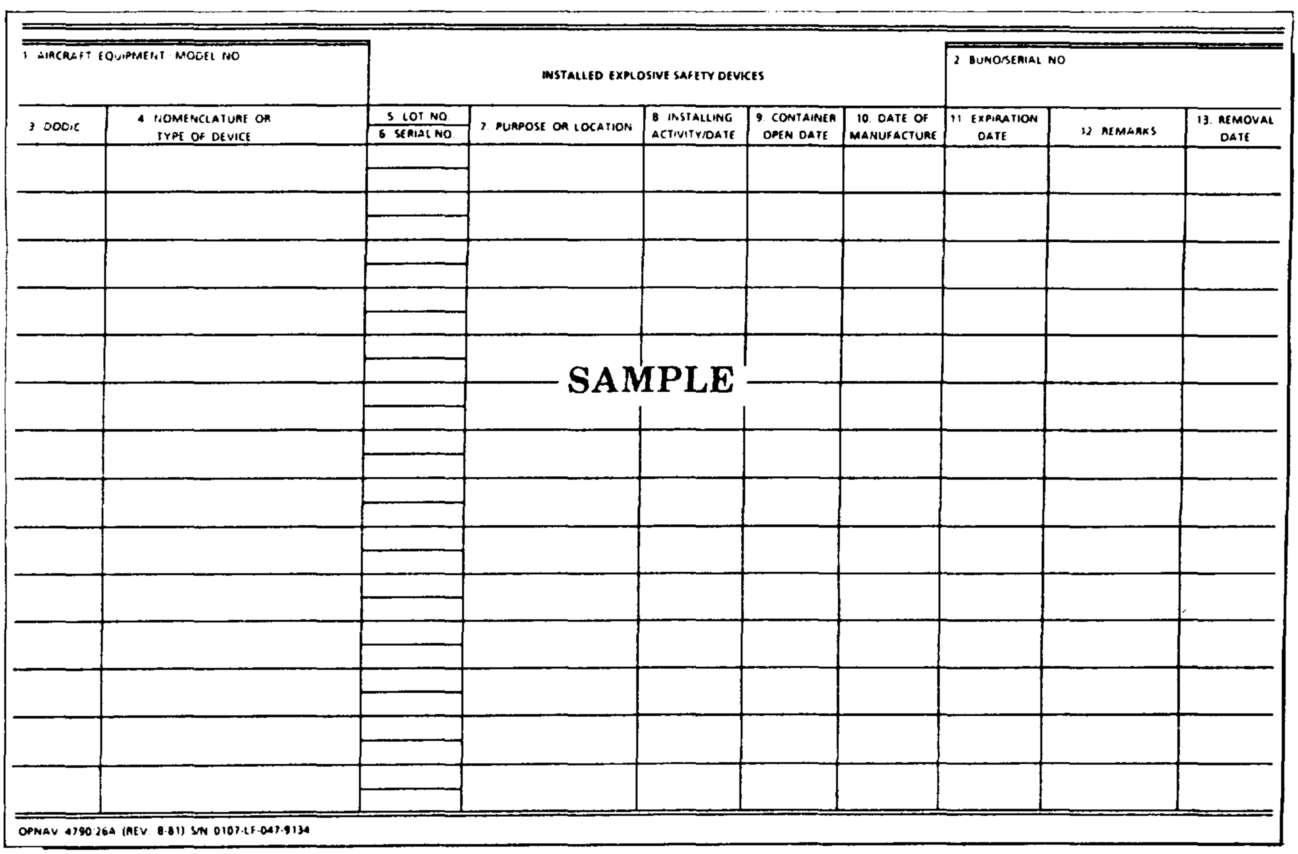
Documentation requirements is a must. A single line entry is required for each installed explosive safety device. All data columns must be complete.

The following information explains what to report in each block.

Block 1—Aircraft Equipment/Model No. Enter the aircraft or equipment T/M/S.

Block 2—BUNO/Serial No. Enter the aircraft BUNO or equipment serial number.

Block 3—DODIC. Enter the Department of Defense Identification Code (DODIC) or the



1 AIRCRAFT EQUIPMENT MODEL NO

INSTALLED EXPLOSIVE SAFETY DEVICES

2 BUNO/SERIAL NO

3 DODIC	4 NOMENCLATURE OR TYPE OF DEVICE	5 LOT NO 6 SERIAL NO	7 PURPOSE OR LOCATION	8 INSTALLING ACTIVITY/DATE	9 CONTAINER OPEN DATE	10 DATE OF MANUFACTURE	11 EXPIRATION DATE	12 REMARKS	13 REMOVAL DATE

SAMPLE

OPNAV 4790/26A (REV 8-81) S/N 0107-LF-047-9134

Figure 1-1.-Installed Explosive Safety Devices (OPNAV 4790/26A) (Logbook) (AESR).

Navy Ammunition Logistic Code listed in the Navy Ammunition Stock Microfiche, TWO10-AA-ORD-010/NA 11-1-116A (NOTAL). DODICs are also specified in the four technical manuals mentioned in the details for block 11.

Block 4—Nomenclature or Type of Device. Enter the name/type device.

Block 5—Lot No. Enter the lot number of the device.

Block 6—Serial No. Enter the serial number of the device. For devices not serialized, enter "NA."

Block 7—Purpose or Location. Enter the purpose or the location of the device.

Block 8—Installing Activity/Date. Enter the short title of the activity and the month and year that the device was installed; for example, VA34/JUL90.

Block 9—Container Open Date. Enter the month and year the container was opened; for example, JUL 90. When the container open date is not required for AEPS devices, "NA" will be entered.

Block 10—Date of Manufacture. Enter the date, month, and year of manufacture; for example, JUL 90. For CADS enter manufacture date, and for AEPS enter propellant manufacture date.

Block 11—Expiration Date. Enter the computed month and year; for example, JUL 90. Installed service-life expiration dates for explosive devices are computed from the date of manufacture, the date the hermetically sealed container is opened, and the date the device is installed. The method used in computing the expiration date of explosive devices and the number of months/years a specific device may remain in service is contained in NA 11-85-1-1.2(NOTAL), NA 11-100-1.1(NOTAL), NA 11-100-1.2(NOTAL), and NA 11-100-1.3(NOTAL). When installed explosive safety devices have extensions granted, the expiration date will be updated by drawing a line through the old expiration date and placing the new expiration date above it. The authority granting the extension, for example, message originator and date time group (DTG or IRAC number and manual), will be logged in the Remarks Column (block 12).

Block 12—Remarks. Make applicable remarks. This block is limited in size; use the Miscellaneous/History page if additional space is required.

Block 13—Removal Date. Enter the month and year the device was removed; for example, JUL 90.

POLICY FOR SAFETY PROGRAM

Learning Objective: *Recognize the importance of training personnel to fully comply with safety precautions and directives.*

While no attempt has been made in this training manual to cover all the areas of safety responsibility pertaining to the AME rating, enough has been presented to stress to the AME1 and AMEC the importance of safety. Senior AMEs must continually strive to improve the safety program.

The AME must interpret and apply safety directives and precautions established by the Department of the Navy, type commander, local command, and the precautions required for each job. Safety directives and precautions must be followed to the letter. This will save lives, prevent injuries, and prevent damage to equipment. Should an occasion arise in which doubt exists about the application of a particular directive or precaution, the measure to be taken is that which will achieve maximum safety. A shipboard operation requires more attention to safety than a shore-based operation. Although, in most instances, the hazards and the precautions are the same whether the work is done afloat or ashore.

CHAPTER 2

ELECTRICALLY OPERATED CANOPY SYSTEM

Chapter Objective: *Upon completion of this chapter, you will have a working knowledge of the electrically operated canopy system and its components to include normal and emergency operation procedures.*

As you know, the canopy system provides an access for the aviator to enter and exit the cockpit. It also provides protection from the elements. We will use the F/A-18C canopy system to discuss a typical electrically operated canopy system (fig. 2-1).

CANOPY SYSTEM

Learning Objective: *Recognize the components of the canopy system.*

Under normal conditions, the canopy is electrically operated and controlled by either the internal canopy control switch in the cockpit or the external canopy control switch, as shown in figures 2-2 and 2-3. A manual backup control mode operates the canopy when utility battery power is low, internal or external electrical power is not available, or the actuation control system has failed. The emergency canopy jettison system jettisons the canopy during emergencies and ejection.

SYSTEM COMPONENTS

You need to be familiar with the system components to enhance your understanding of the system's operation. Therefore, the following major components are described.

Canopy

The formed-stretched acrylic canopy is mounted in a metal frame. A canopy unlatch thruster and two rocket motors and related ballistic components are mounted on the canopy for emergency jettison. An index pin, a control cam, and three latches are mounted on each side of the canopy frame.

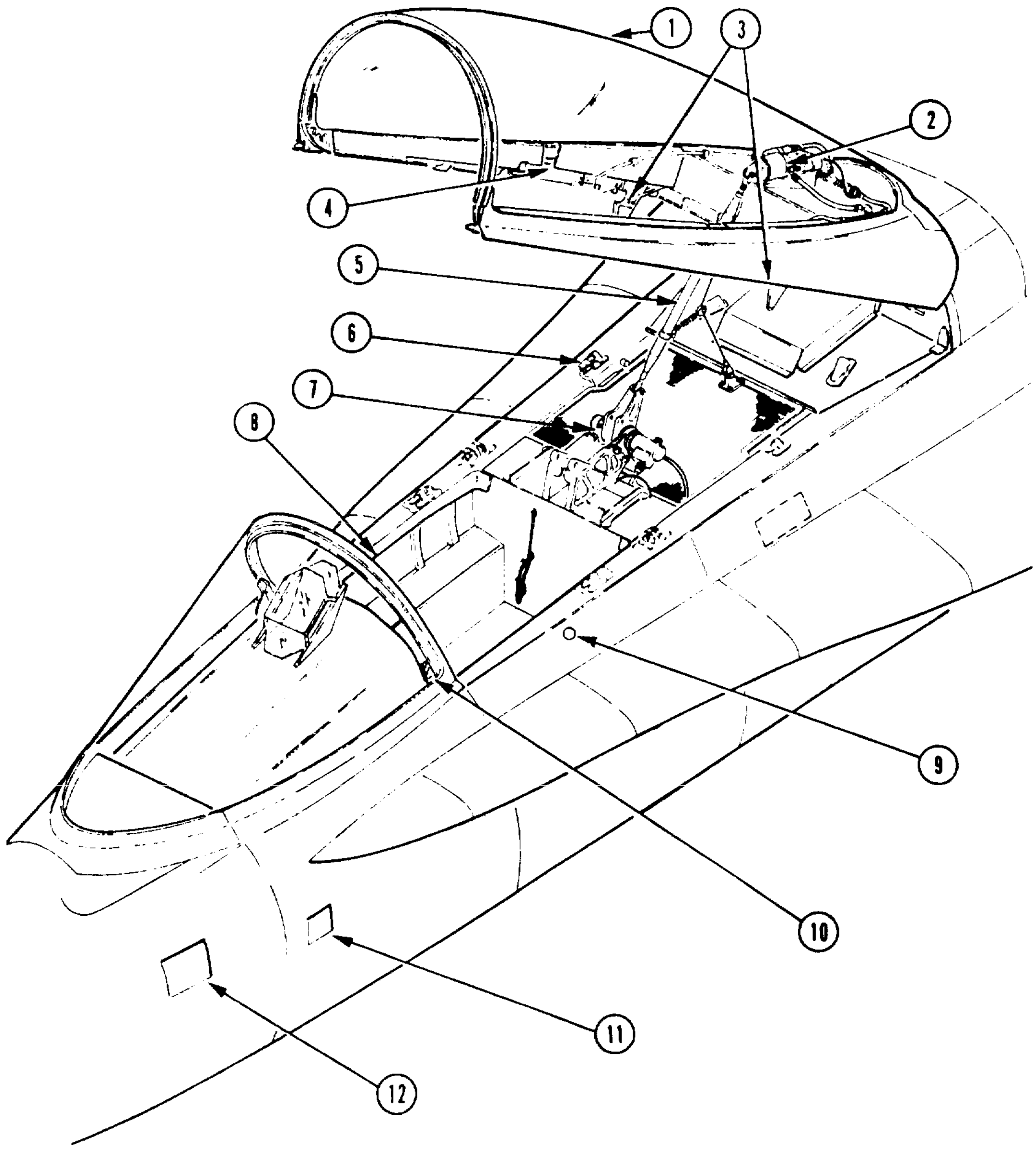
Canopy Pressure Seal

An inflatable canopy pressure seal is located around the canopy arch, along the side frames, and across the canopy deck. When the seal is inflated by the air-conditioning system, the canopy is sealed to the fuselage and windshield arch, allowing the cockpit to be pressurized. A noninflatable weather seal is located parallel to and outboard of the pressure seal. When the pressure seal is deflated, the weather seal prevents entry of water into the cockpit.

Canopy Actuator

The canopy actuator is located behind the aircraft ejection seat on the canopy deck and functions to open and close the canopy. A thermal protection device is provided in the actuator that will automatically interrupt power to the actuator when an overheat condition exists. It will automatically reset within 60 seconds after removal of the overheat condition.

The mechanical components of the canopy actuation system consist of the canopy actuator and the canopy actuation connecting link, which



1. Canopy
2. Canopy unlatch thruster
3. Canopy control cams
4. Canopy jettison rocket motor
5. Canopy actuation link
6. Canopy latch retainer
7. Canopy actuator
8. Internal canopy control switch
9. Canopy external manual jettison receptacle
10. Internal canopy jettison handle
11. External canopy control switch
12. External canopy jettison handle

Figure 2-1.—Electrically operated canopy.

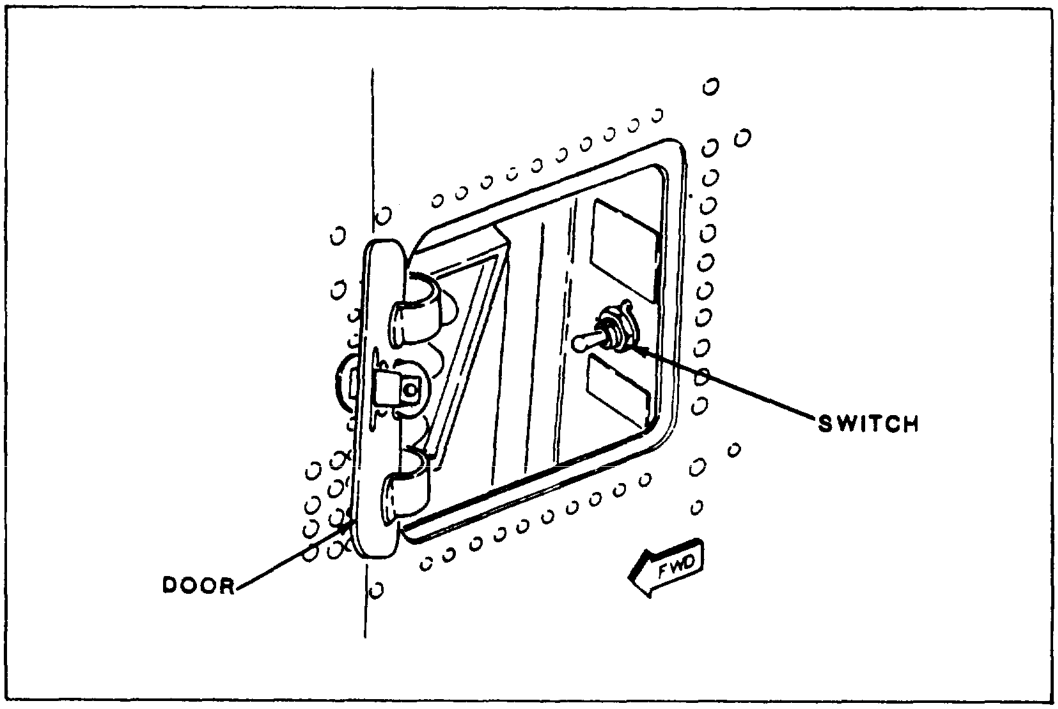


Figure 2-2.-External canopy control switch.

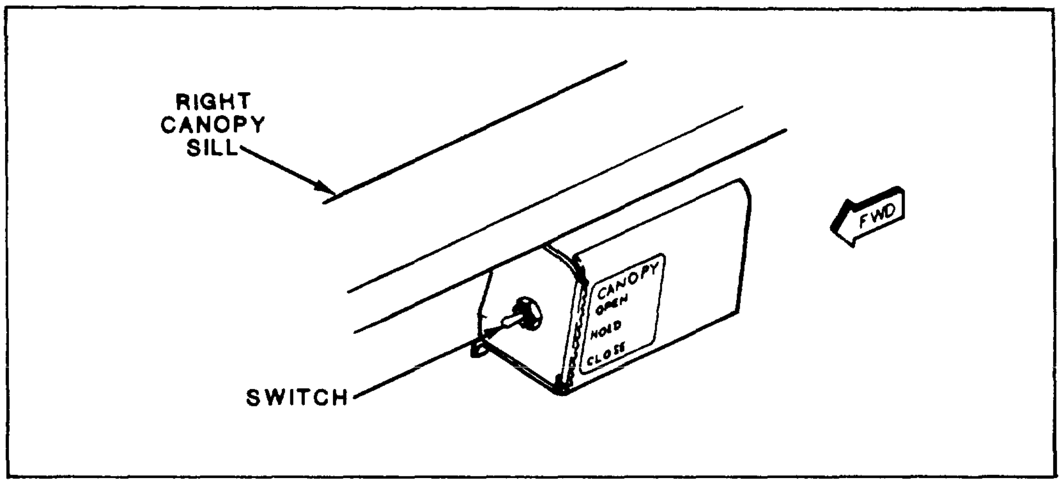


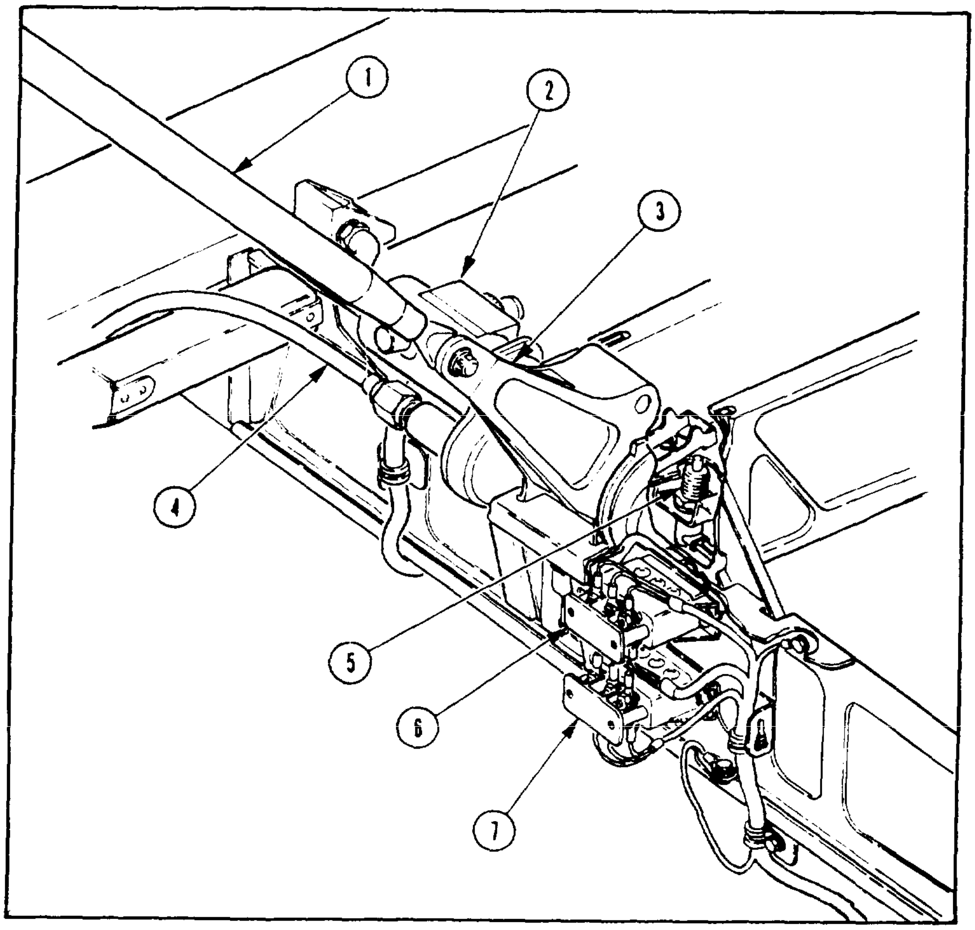
Figure 2-3.-Internal canopy control switch.

is attached to the canopy unlatch thruster, as shown in figures 2-4 and 2-5.

Canopy Actuator Manual Drive Unit

The canopy actuator manual drive unit is located in the cockpit under the left canopy sill. It is used to manually raise and lower the canopy.

The internal manual canopy opening handle is located on the canopy actuator manual drive unit. The handle is used to operate the drive unit from inside the cockpit. The opening handle shaft assembly is located between the canopy actuator manual drive unit and the canopy actuator. The



1. Connecting link
2. Actuator
3. Actuator arm
4. Manual opening shaft assembly
5. Canopy locked switch
6. Canopy down contactor
7. Canopy up contactor

Figure 24.-Canopy actuator.

shaft assembly provides a mechanical link between the drive unit and the canopy actuator. (See fig. 2-6.)

The canopy external manual drive receptacle is mounted flush with the fuselage skin below the left canopy sill. The drive receptacle is used to operate the drive unit from outside the cockpit with the aid of a 3/8-inch drive tool. (See fig. 2-7.)

Canopy Control Switches

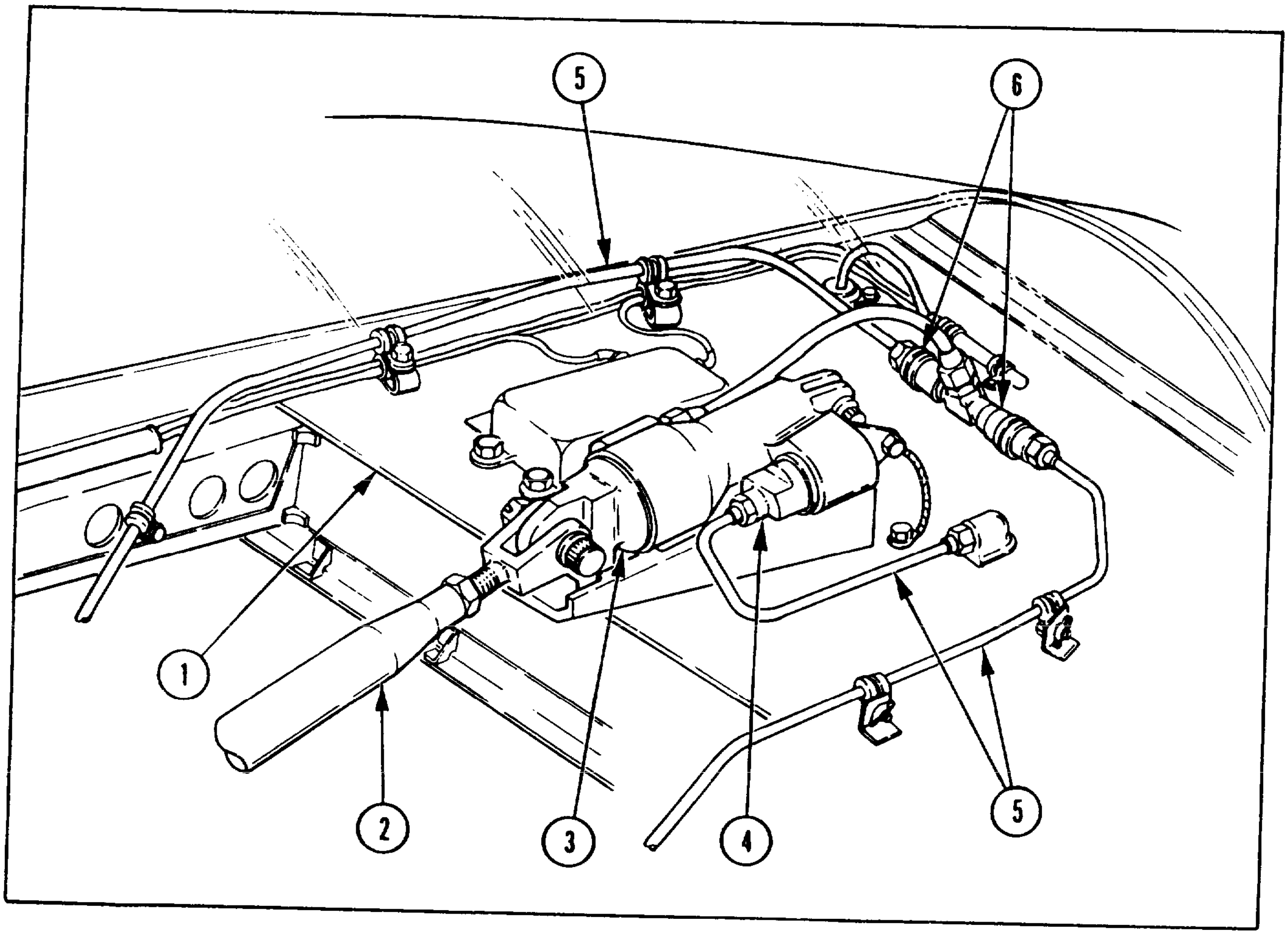
Two canopy control switches are provided for normal electrical operation of the canopy. The external canopy control switch is located inside the external electrical power receptacle door. (See fig. 2-2.) The internal canopy control switch is located in the cockpit under the right canopy sill. (See fig. 2-1.)

Canopy Contractors

The two contractors for canopy up and down are located on the forward bulkhead of the upper equipment bay. The down contactor supplies power to the close winding of the canopy actuator. The canopy up contactor supplies power to the open winding of the canopy actuator. (See fig. 2-4.)

Canopy Locked Switch

The canopy locked switch is located in the upper equipment bay under the canopy actuator. (See fig. 2-4.) When the switch plunger is depressed by the actuator arm, an electrical signal



1. Canopy deck
2. Actuation connecting link
3. Canopy unlatch thruster
4. Canopy unlatch thruster cartridge
5. SMDC
6. Canopy jettison rocket motor initiator

Figure 2-5.-Canopy unlatch thruster.

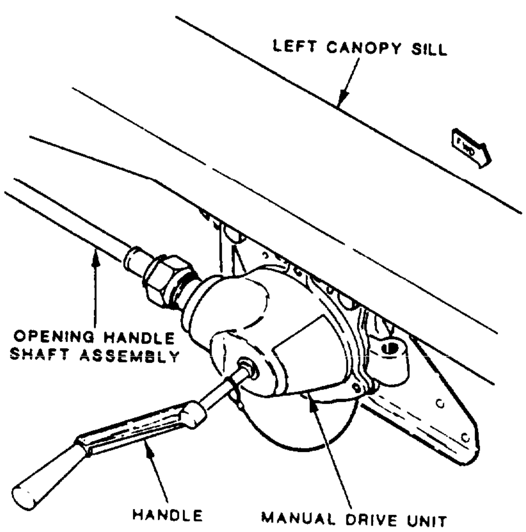


Figure 2-6.-Canopy actuator manual drive unit and handle.

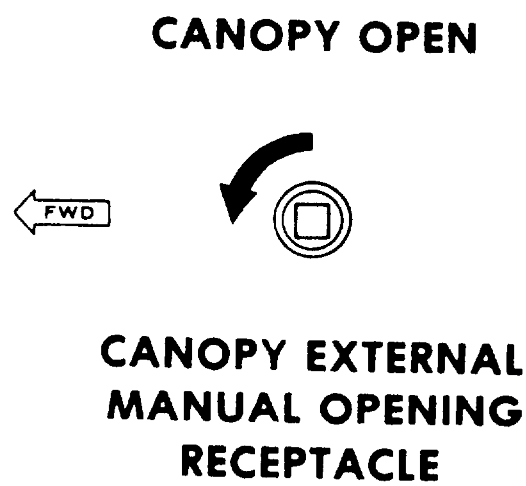


Figure 2-7.-Canopy external manual drive receptacle.

is supplied to extinguish the canopy warning light. The switch also interrupts power to the actuator.

Canopy Position Switch

The canopy position switch is mounted on the right canopy sill in the No. 4 canopy latch retainer. When the plunger switch is depressed by the No. 4 right canopy latch, an electrical signal is supplied to extinguish the canopy warning light. (See fig. 2-8.)

MISCELLANEOUS COMPONENTS

Other systems and components that are related to the canopy system are the canopy electrical system, air-cycle air-conditioning system, maintenance status display and recording system, mission computer system, and the multipurpose display group.

The F/A-18 aircraft electrical system supplies 28-volt dc power for canopy operation. Because the bus distribution system varies, depending upon the bureau number of the aircraft, refer to the maintenance instruction manuals to determine the applicable configuration. (See electrical system schematic shown in figure 2-9.)

The air-cycle air-conditioning system supplies partially cooled bleed air for the inflation of the canopy pressure seal to maintain cabin pressurization.

The maintenance status display and recording system, mission computer system, and multipurpose display group all receive inputs from the canopy system. Inputs are processed and supplied to the left digital display indicator and master caution light. The inputs are also processed, recorded, and displayed as maintenance codes on the nosewheel well digital display indicator. Canopy caution and warning indicators

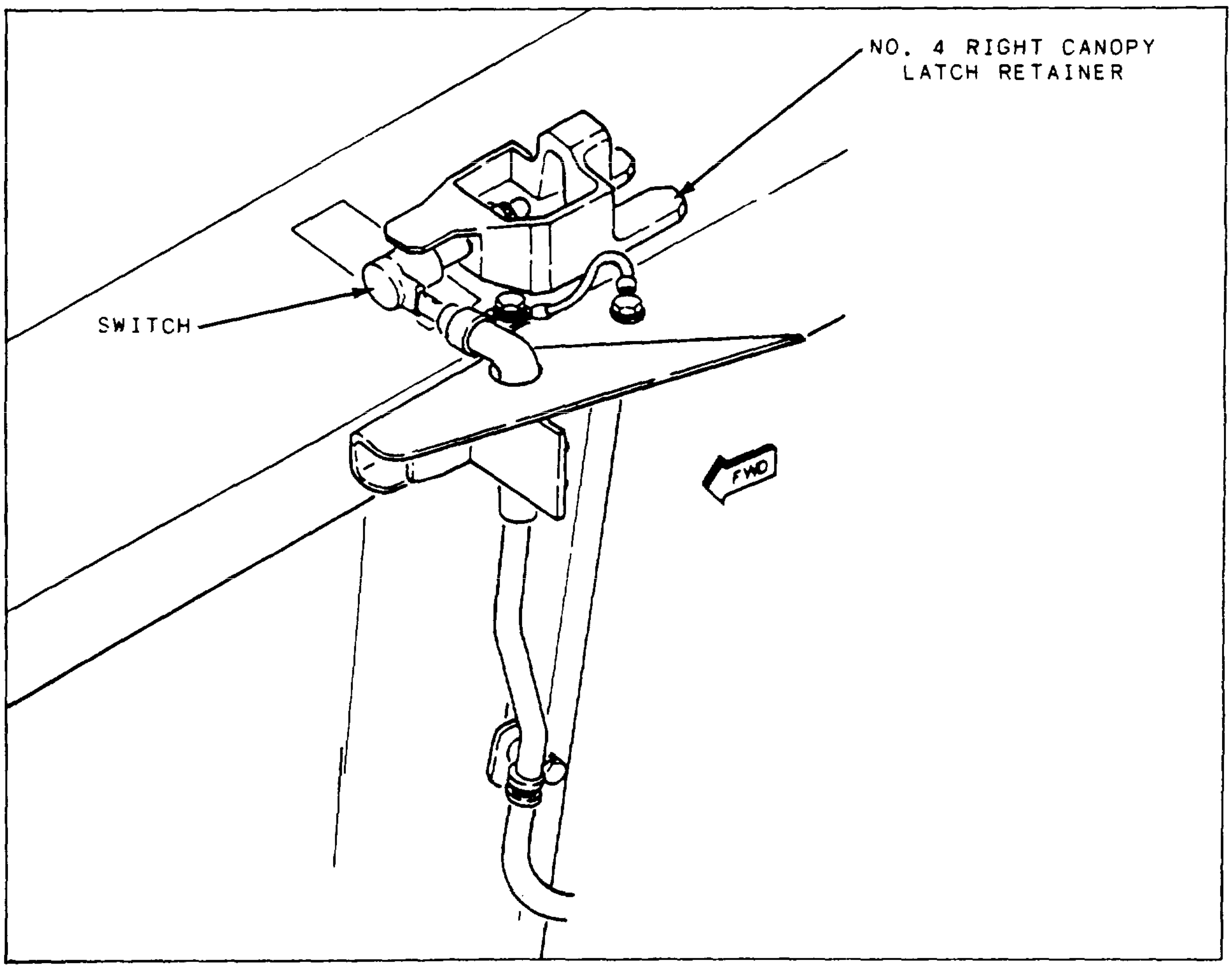


Figure 2-8.-Canopy position switch and latch retainer.

are made up of the following components: canopy caution light on the cockpit left digital display indicator, master caution light on the left-hand advisory and threat warning indicator panel, and the maintenance code display on the nosewheel well digital display indicator.

NORMAL OPERATION

Learning Objective: *Identify the canopy normal mode of operation to include the manual backup mode.*

The canopy is operated electrically by the external or internal canopy control switches in the normal control mode. The canopy can also be operated manually in the backup manual control mode if electrical power is not available.

NORMAL CONTROL MODE

The canopy may be operated with the external canopy control switch. To open the canopy, the switch is held in the OPEN position. The canopy stops automatically when the full open position is reached. To close the canopy, the switch is held in the CLOSE position until the canopy closes, moves full forward, and locks. The canopy stops automatically when the closed and locked position is reached. Motion may be stopped at any point during opening or closing by releasing the switch. The switch returns to the HOLD position when released.

To open the canopy internally with weight on the wheels, the internal canopy control switch is set to OPEN and released. The switch is magnetically held in the OPEN position until the canopy raises to full open and stops. The switch then returns to HOLD. Canopy motion may be stopped at any point during canopy opening by manually setting the switch to the HOLD position, which overrides the magnetic holding coil. The internal canopy control switch opening circuit is equipped with a weight-off-wheels relay that de-energizes the magnetic holding coil when the aircraft is in a weight-off-wheels condition. With the holding coil de-energized, the switch must be manually held to the OPEN position when opening the canopy.

When the canopy closes, moves full forward, and locks, the No. 4 right canopy latch depresses the canopy position switch plunger. Simultaneously, the canopy actuator arm rotates overcenter and depresses the canopy locked switch plunger. Depressing both switch plungers causes the master caution light and the canopy display on the left digital display indicator to extinguish, indicating the canopy is fully closed and locked. If both switches are not fully depressed or a failure occurs in either switch, the master caution and canopy caution indicators will remain illuminated. If both switch plungers are not depressed within 15 seconds, the canopy switches disagree and the maintenance code (889) will be displayed on the nosewheel well digital display indicator.

Electrical inputs supplied to the canopy actuator are transformed into mechanical motion used to raise and lower the canopy. The actuator is equipped with an up-travel-limit switch, which automatically interrupts power to the actuator when the full open position is reached. With no aircraft generator power or external power applied, a utility battery supplies power for at least five open and close cycles of the canopy. On some F/A-18 aircraft, a logic circuit in the battery and charger unit secures the canopy control power when the battery voltage drops below 19±1 volts.

Due to decreased battery capacity at low temperatures, canopy operation using battery power is not recommended when ambient temperature is below 0°F. Under these conditions, external electrical power should be used. When external power is not available, the canopy can be operated using the backup manual control mode.

To further understand how the opening and closing cycles function, refer to figure 2-9.

BACKUP MANUAL CONTROL MODE

The backup manual control mode is used to open and close the canopy when utility battery power is low, internal or external electrical power is not available, or a failure has occurred in the canopy actuation control system.

The canopy actuator manual drive unit is operated from inside the cockpit by using the internal manual canopy opening handle. The handle is removed from its stowage receptacle and clip, and then it is inserted into the crank socket. The handle is turned 70±1 turns clockwise to close the canopy or counterclockwise to open the canopy. The internal manual canopy opening handle shaft assembly mechanically links the drive unit to the canopy actuator. By operating the drive unit internally or externally, mechanical motion is transferred through the shaft assembly to the canopy actuator.

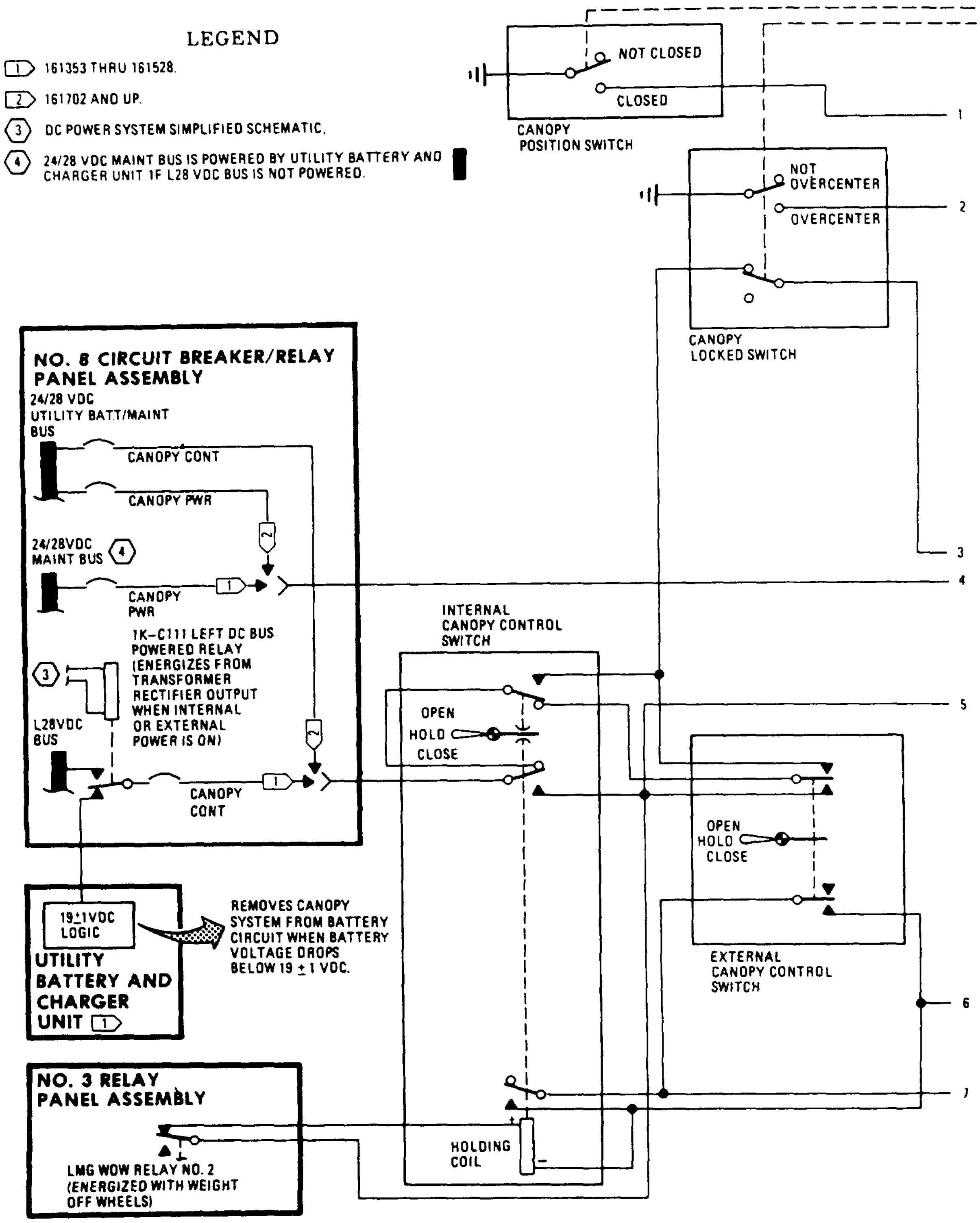


Figure 2-9.-Canopy electrical system schematic.

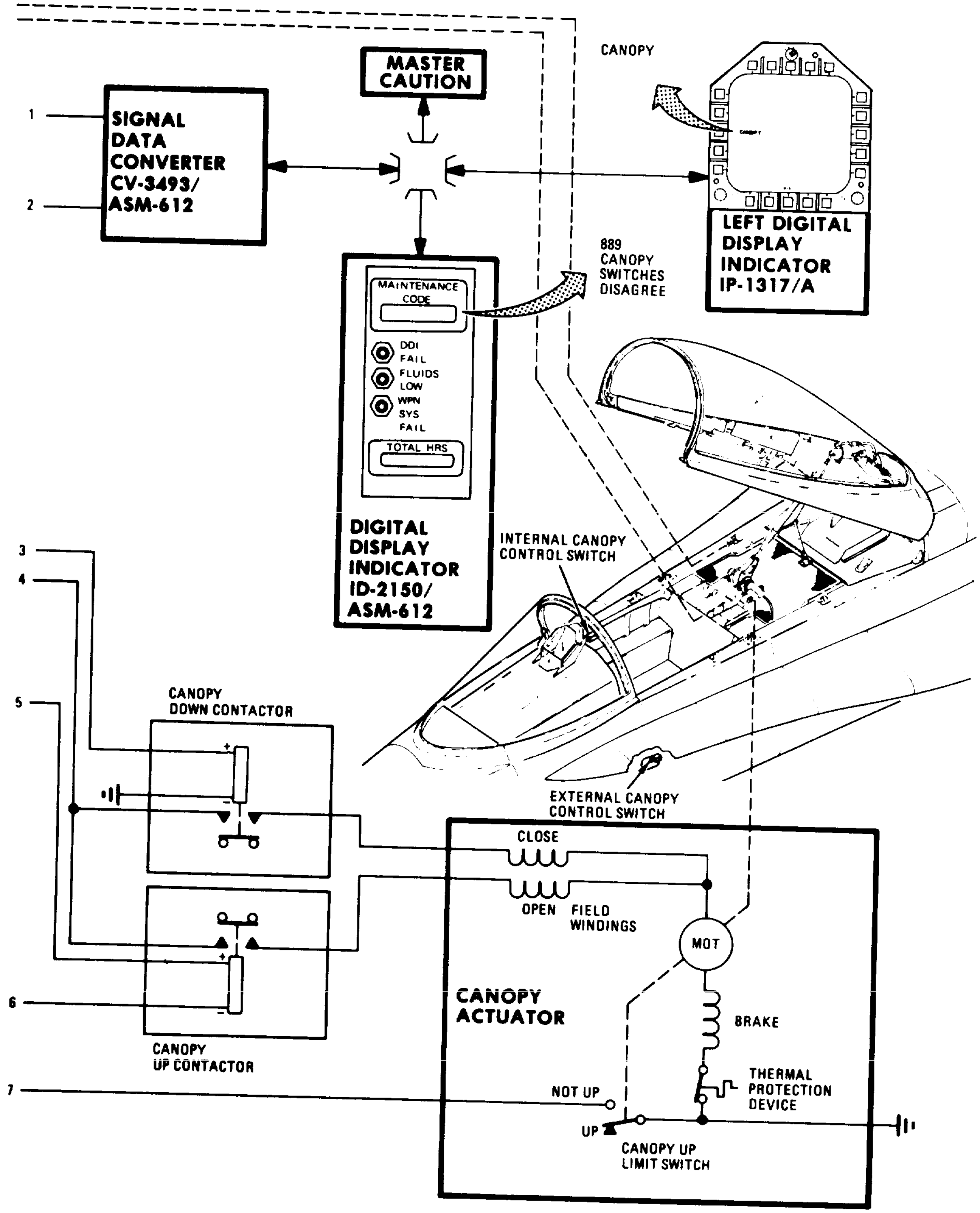


Figure 2-9.-Canopy electrical system schematic—Continued.

As previously stated, the canopy external manual drive receptacle is provided to operate the canopy actuator manual drive unit from outside the cockpit. A 3/8-inch drive tool is inserted into the drive receptacle and turned 35±1 turns counterclockwise to open the canopy or clockwise to close the canopy.

Manually operating the canopy overrides the mechanical brake in the canopy actuator. The brake engages to hold the canopy at any position when manual cranking is stopped. The actuator is equipped with a mechanical torque limiter that prevents damage to the actuator if excessive torque is applied to the manual backup control mode.

EMERGENCY CANOPY JETTISON SYSTEM

Learning Objective: *Recognize the system components and procedures for emergency canopy jettison.*

The emergency canopy jettison system provides the capability to ballistically jettison the canopy in case of an emergency. The canopy can be jettisoned internally or externally without initiating seat ejection. It can also be jettisoned by initiating ejection. This is accomplished by pulling the ejection control handle on the ejection seat.

COMPONENTS

Before discussing the internal and external methods of jettisoning the canopy, a description of the system's components is needed.

External Canopy Jettison Handles And Cables

The external canopy jettison handles and cables are stowed behind doors on each side of the aircraft near the radome. (See figs. 2-1 and 2-10.) Each handle is attached to approximately 8 feet of cable. The cables are routed through the gun bay and are joined to a common cable at the cockpit forward pressure bulkhead. This single, common cable runs through the bulkhead into the cockpit, where it connects to the internal canopy jettison lever linkage.

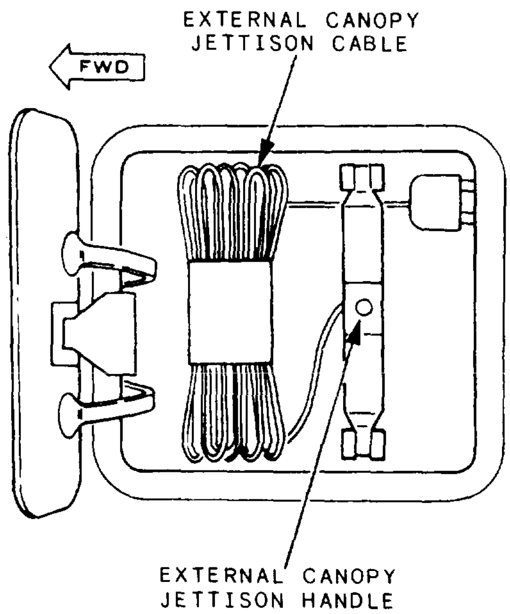


Figure 2-10.-External canopy jettison handle.

Internal Canopy Jettison Lever

The internal canopy jettison lever is located to the left of the main instrument panel. The lever is mounted on the canopy sill. (See fig. 2-11.) The lever gives the pilot the capability of starting the emergency canopy jettison sequence from inside the cockpit.

Canopy Jettison SMDC Initiator

The canopy jettison shielded mild detonating cord (SMDC) initiator is located below the canopy jettison lever. The initiator receives inputs from either the internal canopy jettison lever or external canopy jettison handles to initiate the jettison sequence.

One-way Transfer Valve

The one-way transfer valve is located on the ballistic panel in the upper equipment bay. The transfer valve acts as a check valve to prevent the backflow of SMDC detonation to the seat components.

Emergency Escape Disconnect

The emergency escape disconnect is located under the canopy deck. The disconnect provides a path for SMDC detonation to the canopy

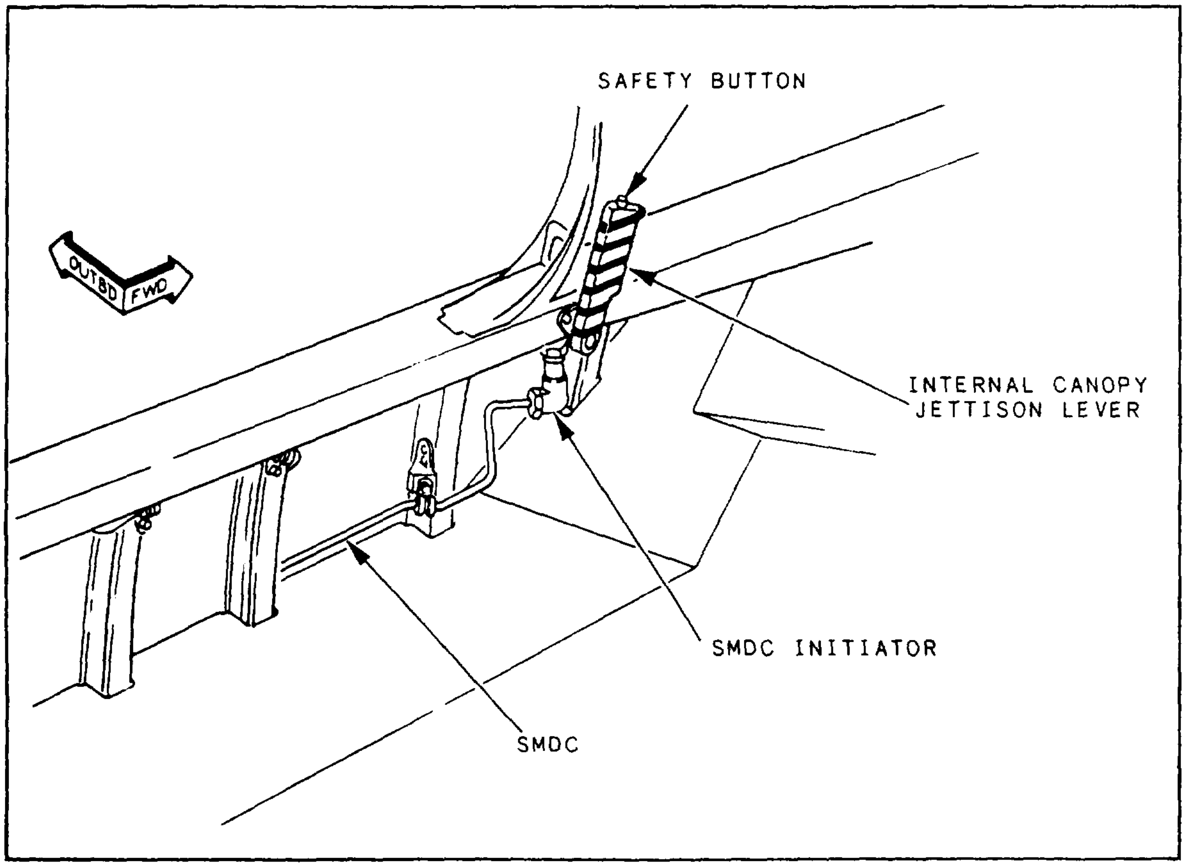


Figure 2-11.-Internal canopy jettison handle.

ballistic components and provides a disconnect point when the canopy is jettisoned or removed for maintenance.

Canopy Unlatch Thruster and Cartridge

The cartridge is mounted in the canopy unlatch thruster, as shown in figure 2-5. Pressure from the canopy jettison SMDC initiator fires the thruster mounted on the canopy deck. When fired, it moves the canopy aft to disengage the latches and separate the canopy from the actuation connecting link. Thruster ballistic gas is provided to the canopy jettison rocket motor initiators.

Canopy Jettison Rocket Motor Initiators

The rocket motor initiators are mounted on the canopy deck aft of the thruster as shown in figure 2-5. The initiators receive ballistic gas input from the thruster to produce SMDC detonation to fire the rocket motors.

Canopy Jettison Rocket Motor

The rocket motors are located on either side of the canopy frame. The rocket motors are fired by the rocket motor initiators and provide the vertical thrust required to separate the canopy from the aircraft.

SMDC/FCDC Initiators

The SMDC and flexible confined detonating cord (FCDC) are located between the various ballistic components. The SMDC and FCDC provide the energy transfer stimulus used in the emergency canopy jettison system. The SMDC is sealed in stainless steel tubing to protect the cord and to contain all gases produced by explosive detonation. The FCDC is sealed in a metallic sheath, which is protected by a braid over-wrap.

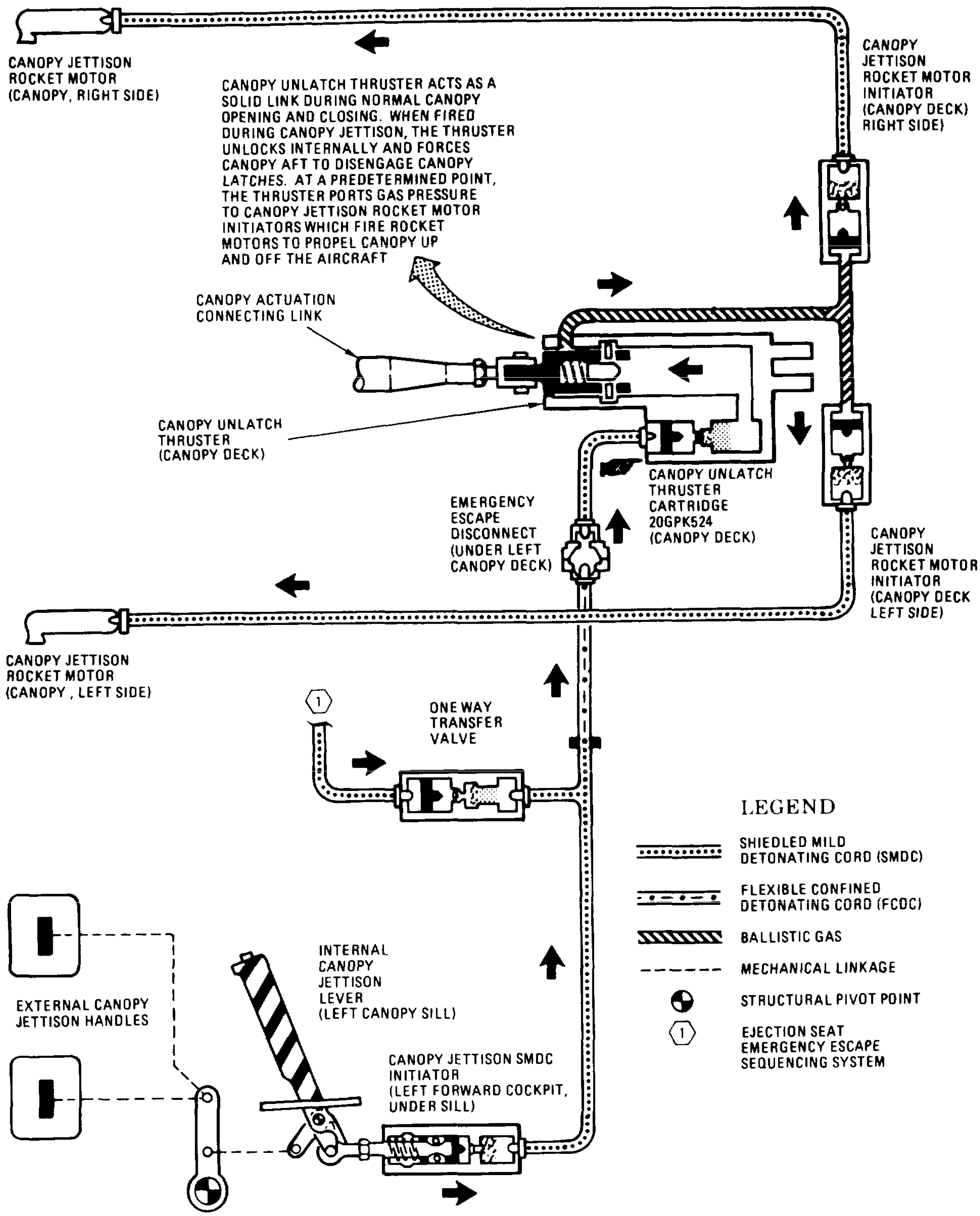


Figure 2-12.-Canopy jettison system schematic.

PROCEDURES

The canopy can be jettisoned by internal or external means. The following discussion summarizes both jettison procedures.

Internal Canopy Jettison

Internal canopy jettison is initiated by the internal canopy jettison lever. (See fig. 2-11.) By removing the canopy jettison safety pin and pressing down the safety button and pulling the lever aft, the canopy jettison SMDC initiator is fired. Explosive stimulus produced by the initiator is transferred through the SMDC to the emergency escape disconnect. The one-way transfer valve prevents the explosive stimulus from continuing toward the ejection seat components. The explosive stimulus continues through the emergency escape disconnect, via the FCDC, to the canopy unlatch thruster cartridge, which fires the canopy unlatch thruster. Firing the unlatch thruster pushes the canopy aft to disengage the canopy latches and separates the thruster from the connecting link. Ballistic gas produced by firing the thruster is transferred to the canopy jettison rocket motor initiators. The rocket motor initiators convert ballistic-gas pressure to explosive stimulus, which is transferred through SMDC to fire the canopy jettison rocket motors. The rocket motors produce the vertical thrust required to separate the canopy from the aircraft. (See fig. 2-12.)

External Canopy Jettison

Ground emergency external canopy jettison is started by opening the door on either the left or right side of the aircraft and removing the canopy jettison handle from its retaining clip. The handle is attached to approximately 8 feet of cable. When the cable is fully extended and pulled, the canopy jettison SMDC initiator is fired, which, in turn, initiates the emergency canopy jettison sequence. From this point on, the sequence is the same as internal canopy jettison. The cable action merely bypasses the internal canopy jettison lever. When the canopy is jettisoned, all canopy jettison ballistic devices are spent.

WARNING

Ensure that the proper canopy jettison safety pin is installed whenever the aircraft is not flying or during any maintenance task performed on the aircraft.

CHAPTER 3

UTILITY SYSTEMS

Chapter Objective: *Upon completion of this chapter, you will have a working knowledge of the operating principles and components of bleed-air utility systems.*

The utility systems of an aircraft provide an additional measure of flight safety, pilot comfort and convenience, and contribute to the overall mission capability of the aircraft.

BLEED-AIR UTILITY SYSTEMS

Learning Objective: *Recognize the operating principles and components for systems within the bleed-air utility system.*

Many aircraft have utility systems that rely on a bleed-air system to function. The P-3C deicing system and the A-6E rain removal system are examples of such systems and are discussed in this chapter. This material will increase your proficiency in troubleshooting and maintaining these and similar systems.

DEICE SYSTEMS

An anti-icing system is designed to prevent ice from forming on the aircraft. A deicing system is designed to remove ice after it has formed. An aircraft deice system removes ice from propellers and the leading edges of wings and stabilizers. These systems may use electrical heaters, hot air, or a combination of both to remove the ice formation. As an AME, you are primarily concerned with hot air as a method to remove the formation of ice on wings and stabilizers. The P-3C wing deice system is used as an example in this chapter to describe a hot-air system.

Description and Components

The P-3C wing deice system uses hot compressed bleed air from the engines. The air is ducted from the 14th stage of each engine compressor, as shown in figure 3-1. The bleed air is maintained at a fixed percentage of engine airflow for all altitudes and flight speeds.

The hot bleed air is directed and regulated to the leading edge ejector manifold through shutoff valves, modulating valves, thermostats, skin temperature sensors, and overheat warning sensors.

SHUTOFF VALVES.— The wing deice system contains several shutoff valves. The fuselage bleed-air shutoff valves, installed in the cross-ship manifold on the right and left wings, isolate the wings from the fuselage duct section. In addition, they maybe used to isolate one wing duct from the other wing duct. Each valve is individually controlled by a guarded toggle switch mounted on the bleed-air section of the ice control protection panel.

A bleed-air shutoff valve is also installed in each engine nacelle. These shutoff valves are physically identical. They are of the butterfly-type, and they are actuated by an electric motor.

An indicator, located on top of the valve housing, shows the position of the valve—open or closed. This indicator enables you to visually check the operation of the valve while it is still installed in the deice system.

MODULATING VALVES.— The P-3C deicing system has three modulating valves installed in each wing. These valves are thermostatically controlled and pneumatically operated. They maintain the constant engine compressor bleed-air temperature required for the wing leading edge. When deicing is not required, the valves operate as shutoff valves.

The modulating valves, shown in figure 3-2, have pilot solenoid valves that are electrically

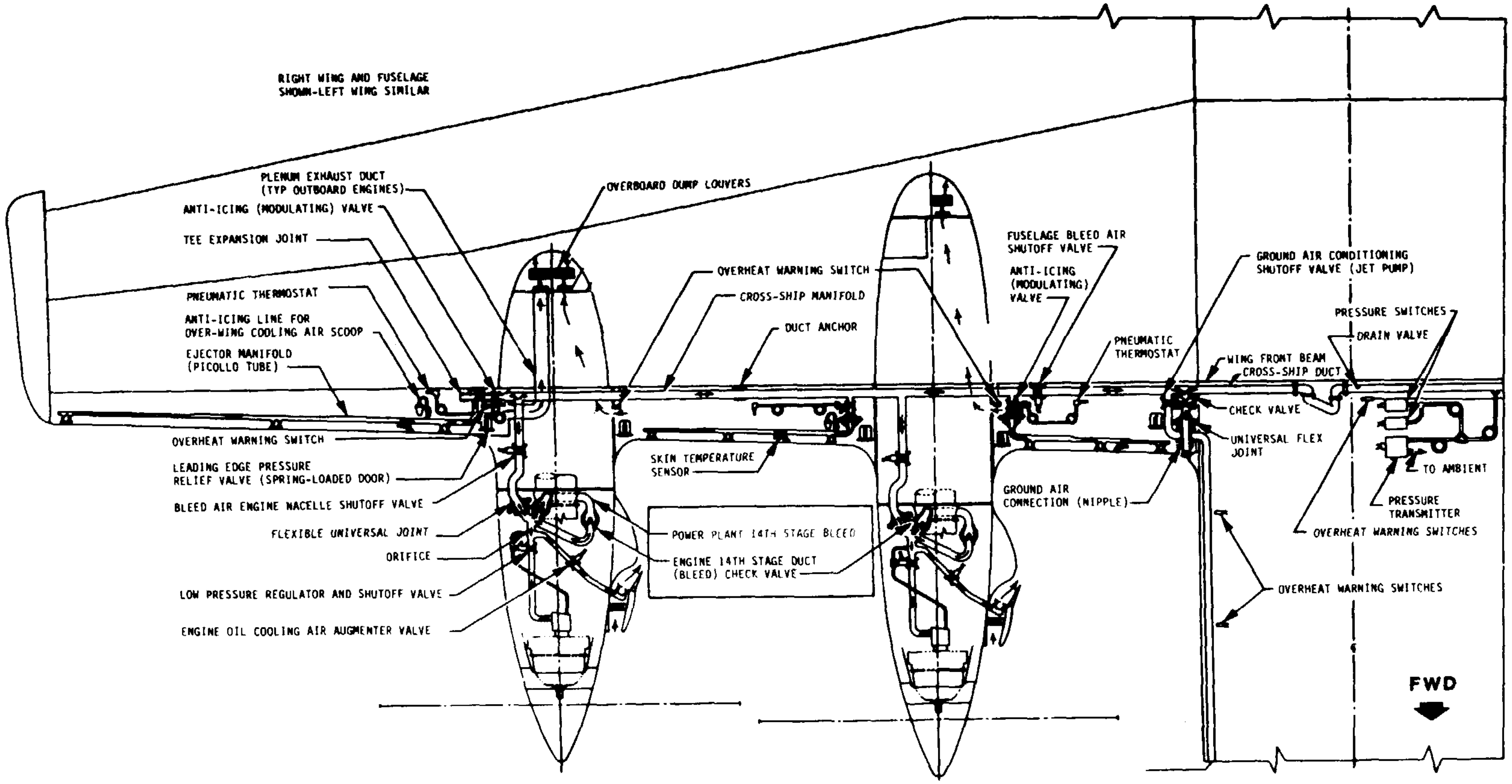


Figure 3-1.—P-3C wing deicing system schematic.

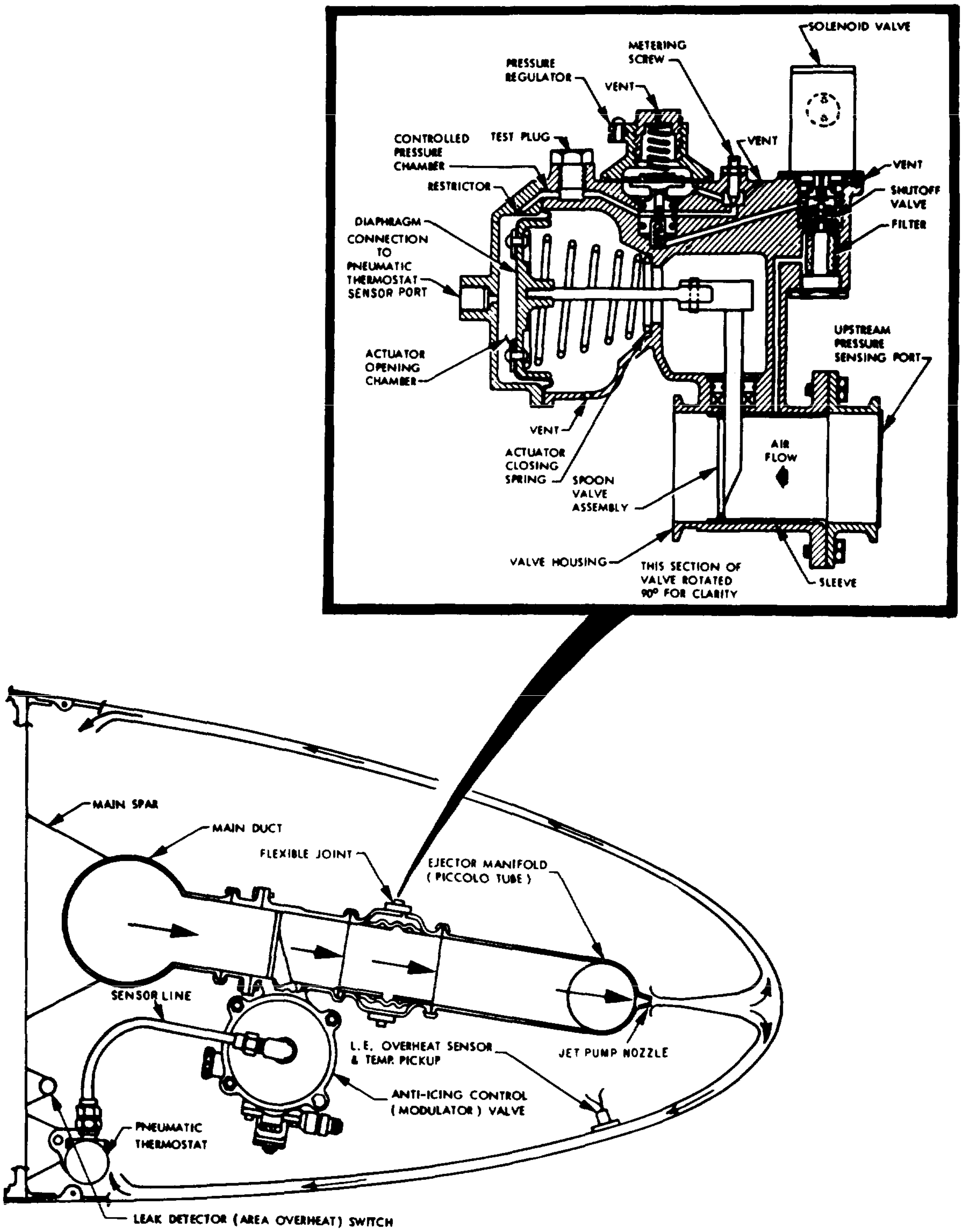


Figure 3-2.-Anti-icing modulating valve.

controlled by three switches on the bleed-air section of the ice protection panel. When the solenoid is energized, it admits filtered, regulated, bleed-air pressure to one side of a diaphragm chamber in the valve. The other side of the diaphragm chamber is spring-loaded to the closed position. Movement of the diaphragm operates a main line butterfly valve.

When the valve opens, hot air is admitted to the leading edge distribution system. The hot air goes through the modulator valve to the ejector manifold, out the jet nozzles, and into the wing leading edge plenum area. The bleed air is then directed across a pneumatic thermostat. Increased temperature across the thermostat actuates the sensor and opens a bleed passage from the diaphragm chamber. This reduces the pressure on the diaphragm and allows a spring to close the main valve.

THERMOSTATS.— The wing leading edge pneumatic thermostat is installed adjacent to each modulating valve. (See fig. 3-2.) The thermostat controls air pressure on the modulating valve diaphragm, and thereby controls the valve opening.

The unit is composed of a probe and a valve assembly. (See fig. 3-3.) The probe is a core made of layers of high- and low-expansion material that is locked to a sliding piston. In addition, the piston contains an override spring and ball-type metering valve.

Airflow from the leading edge flows over the core and causes the materials to expand or contract. As temperature rises, the core pulls the piston and metering ball from the seated position. This allows pressure from the modulating valve diaphragm to vent. Increasing temperature causes more air to be bled from the diaphragm chamber. Because of spring action, the modulating valve moves toward the closed position. This restricts flow through the modulator valve and drops the skin temperature.

LEADING EDGE TEMPERATURE AND OVERHEAT CIRCUIT.— To monitor the overheat warning system, six skin temperature sensors (one in the inboard section, one in the center section, and one in the outboard section of each wing) form a part of an amplifier circuit. When the wing leading edge skin temperature rises in excess of 230°F at any one or more sensors, the airfoil temperature control unit amplifier completes a caution light circuit, thus illuminating the leading edge caution hot light.

Also, there are three ducting overheat thermal switches installed in each wing and three installed in the fuselage adjacent to the bleed-air duct. These switches form a part of a loop that is connected to a signal light control assembly. When any one of the thermal leak detector switches closes, its respective caution light illuminates. Also, when the test switch is placed in the TEST position, both lights illuminate through their respective loop circuit.

The ducting overheat switches are single-pole, single-throw, explosiveproof, thermally actuated electrical switches with an integral temperature

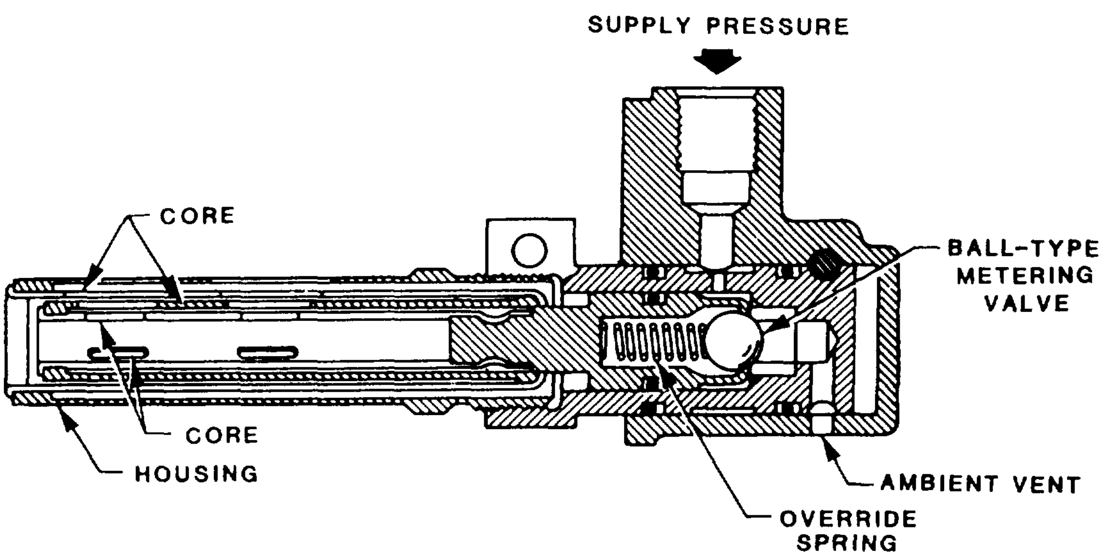


Figure 3-3.-Wing leading edge thermostat.

sensing element. The switches sense still air temperature. The outboard leading edge overheat warning switches open at approximately 205°F and close at approximately 220°F. The other wing and fuselage overheat warning switches open at approximately 175°F and close at approximately 190°F.

High temperature within the leading edge is generally caused by bleed-air leakage or malfunctioning modulator valves. You can detect the portion of the leading edge that has the overtemperature by placing the rotary selector switch, located on the ice control protection panel, to the different sensor positions: INBD, CTR, and OUTBD. (See fig. 3-4.) The temperature at the selected sensor is then read at the indicator adjacent to the rotary switch. An excessive temperature reading on the indicator denotes a malfunction within the area being tested.

Operation

Figure 3-4, the ice control protection panel, shows a basic diagram of the wing deice system. Each engine is labeled by an engine number. Directly below each engine block (in the diagram) is an OPEN light that illuminates when the bleed-air valve is open 2 degrees or more. The cross-ship manifold from the bleed-air valves goes to each modulating valve and the fuselage shutoff valves. The fuselage bleed-air shutoff valves are normally in the CLOSE position during normal deicing operation. The bleed-air pressure gauge reads cross-ship manifold pressure when one or both switches are opened.

A ground air-conditioning switch is located directly under the bleed-air manifold pressure gauge. Located above the switch is an annunciator light, which indicates VALVE OPEN when the ground air-conditioning valve is open. Either one or both fuselage bleed-air shutoff valves must be open to direct air to the ground air-conditioning unit.

A leak test switch is mounted on the upper right-hand side of the panel. This switch is used to determine if the leakage of the system is acceptable.

Three modulating valve control switches are located on the left side of the wing and empennage ice panel. The outboard switch controls the outboard modulating valve on the left and right wing, the center switch controls the two center modulating valves, and the inboard switch controls the two inboard modulating valves.

During normal operation of the deicing system, all four engine bleed-air valves are open to supply bleed air to the cross-ship manifold, and both fuselage bleed-air shutoff valves are closed.

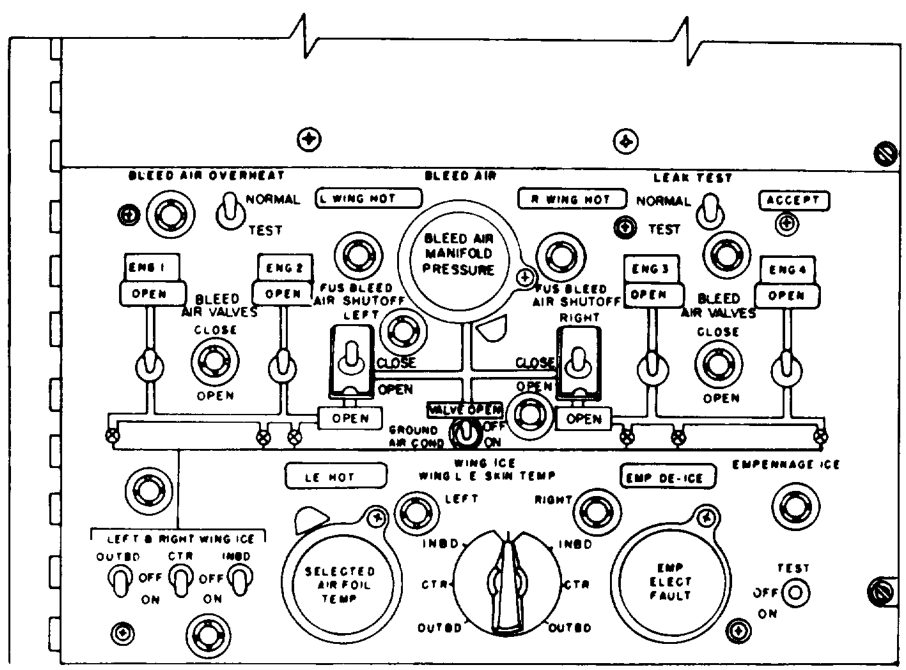


Figure 3-4.-Ice control protection panel.

The modulating valves maintain a controlled flow of bleed air to the leading edge distribution system, and they are controlled by pneumatic thermostats. The complete system is monitored for hot spots by heat-sensing switches.

Before flight, the deicing manifold system may be tested for leakage. This leak testis performed by pressurizing the system: OPEN the No. 4 engine bleed-air valve; the Nos. 1, 2, and 3 engine bleed-air valves remain CLOSED, and both fuselage shutoff valves are in the OPEN position. When the bleed-air pressure on the bleed-air manifold reads 70 psi, the No. 4 engine bleed-air valve is closed and the leak test switch is actuated. As the bleed-air pressure drops, the time-delay relay will illuminate the ACCEPT light after an 8-second delay if the system is tight. The light will go out when the test switch is released.

Maintenance

The involvement of the AME2 and AMEC in the maintenance of the deicing system normally consists of troubleshooting. To troubleshoot intelligently, you must be familiar with the system. In addition, you must know the function of each component in the system and have a mental picture of the location of each component in relation to other components in the system. This can be achieved by studying the schematic diagrams of the system.

As an aid, the aircraft manufacturer furnishes troubleshooting charts, which give recommended procedures to follow during troubleshooting. Figure 3-5 shows a deicing system overheat warning troubleshooting chart. This chart lists the most probable cause first and then branches to the next most probable cause. By following the recommended charts and procedures, you can save many valuable maintenance hours.

RAIN REMOVAL SYSTEM

The rain removal system shown in figure 3-6 controls windshield icing and removes rain by directing a flow of heated air over the windshield. This heated air serves two purposes. First, the air breaks the rain drops into small particles, which are then blown away. Secondly, the air heats the windshield to prevent the moisture from freezing

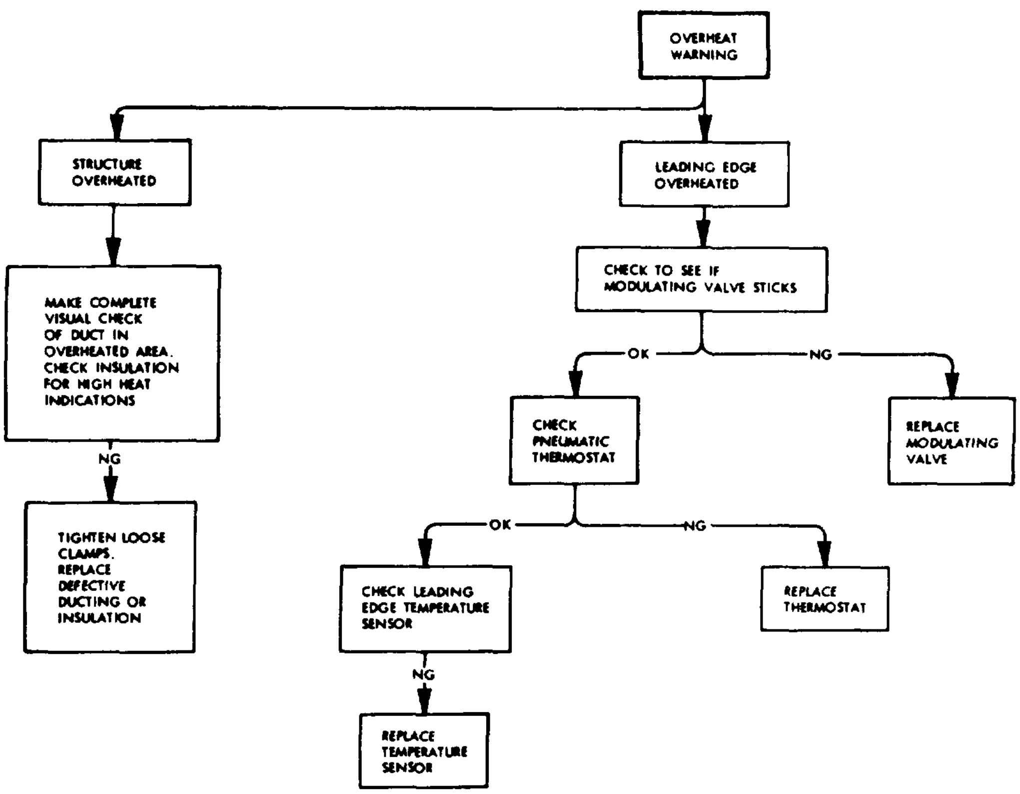


Figure 3-5.-Deicing troubleshooting chart.

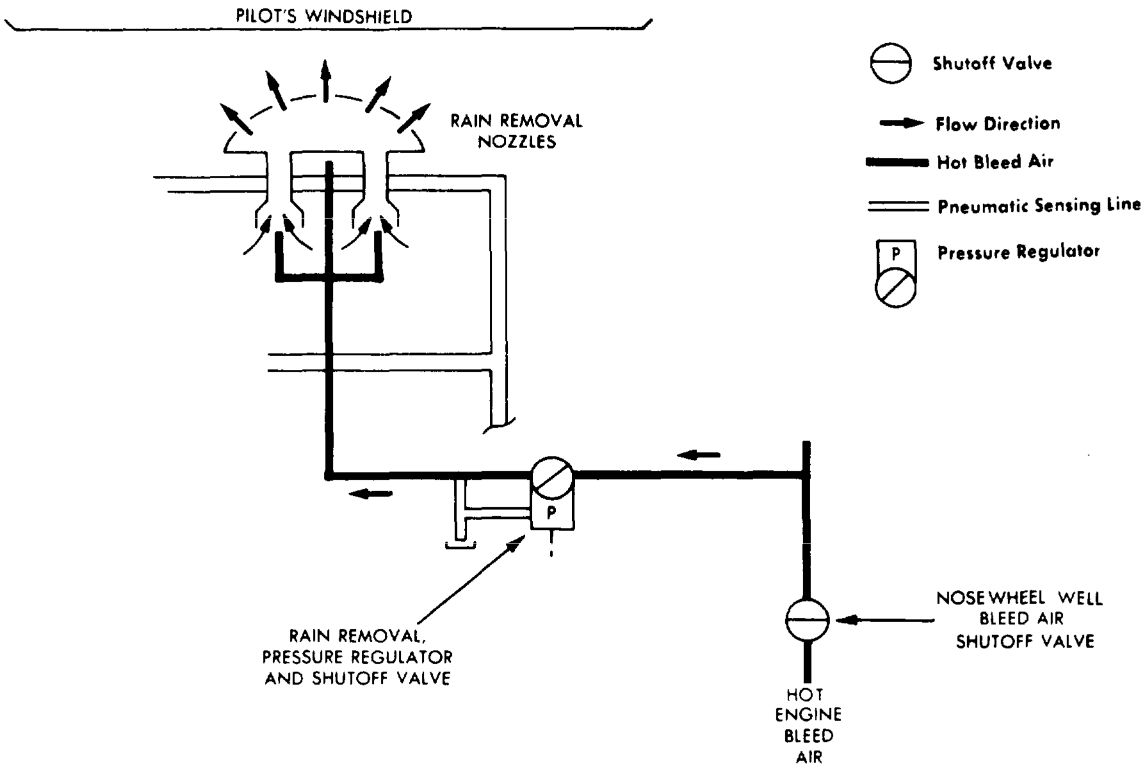


Figure 3-6.-Rain removal system.

on it. The A-6E rain removal system (for those aircraft with airframes change number 268 incorporated) is discussed in the following paragraphs.

Description and Components

The rain removal system is controlled by the windshield switch located on the air-conditioning control panel in the cockpit. (See fig. 3-7.) The system uses hot bleed air from the 12th stage compressor section of each engine. The nosewheel well bleed-air shutoff valve controls the flow of hot bleed air to the rain removal system.

Then the rain-removal, pressure-regulator shutoff valve controls the airflow from the rain-removal system to the windshield. When this valve is open, it allows hot bleed air to flow to the rain-removal nozzle assembly. The nozzle distributes the air through a series of diffuser outlets to form a wide stream of hot air over the windshield. The temperature of the air is lowered by a mixing ejector at the inlet of the rain-removal nozzle assembly. The ejector uses hot bleed air as its primary air, and it draws secondary air from the nose radome compartment to cool the rain-removal air.

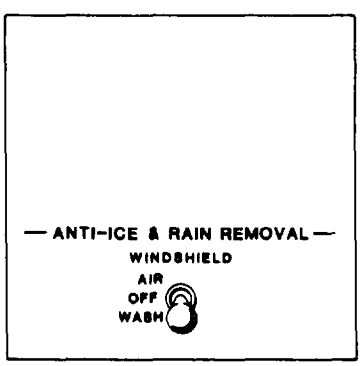


Figure 3-7.-Air-conditioning panel.

In the next several paragraphs, we will discuss the major components of the rain removal system. You should know the location and functions of these components to aid you in troubleshooting and maintaining the system.

NOSEWHEEL WELL BLEED-AIR SHUT-OFF VALVE.— The nosewheel well bleed-air shutoff valve is a butterfly-type that is electrically actuated and operated. The valve is installed in the hot bleed-air duct in the starboard engine compartment. The valve is controlled by the nosewheel well bleed-air switch on the fuel management panel. When the switch is set to the OFF position, the valve is closed by 115-volt ac power from the bleed-air circuit breaker. When the switch is set to the AUTO position, power is routed to the nosewheel well bleed-air relay. When the windshield switch on the air-conditioning panel is moved to the AIR position, or when left main landing gear weight-on-wheels switch is closed, the relay is activated and the valve opens. If electric power is lost, the valve will remain in the last selected position. The valve has a position indicator that can be viewed with the starboard engine-bay door open.

RAIN-REMOVAL PRESSURE-REGULATOR SHUTOFF VALVE.— The rain-removal pressure-regulator shutoff valve is a pneumatically operated, solenoid-controlled, 2-inch valve installed in the hot bleed-air duct to the rain-removal nozzle assembly. (See fig. 3-8.) Operation of the valve is controlled by the windshield switch on the air-conditioning control panel. Placing the switch to the AIR position energizes the solenoid of the valve. When the inlet pressure to the valve is between 15 and 50 psi, the valve is fully opened. When it is between 100 and 250 psi, the valve regulates the outlet pressure to the rain-removal nozzle at 75±3.5 psi. By placing the windshield switch to OFF, it de-energizes the solenoid. This causes the valve to close and shuts off the flow of bleed air to the rain-removal nozzle.

In the closed position, air from the upstream side of the valve passes through the control air passages to chamber A and leaks past the pilot valve stem to chamber B. With equal pressure on both sides of the large diaphragm, the pressure on the small diaphragm and the spring force on

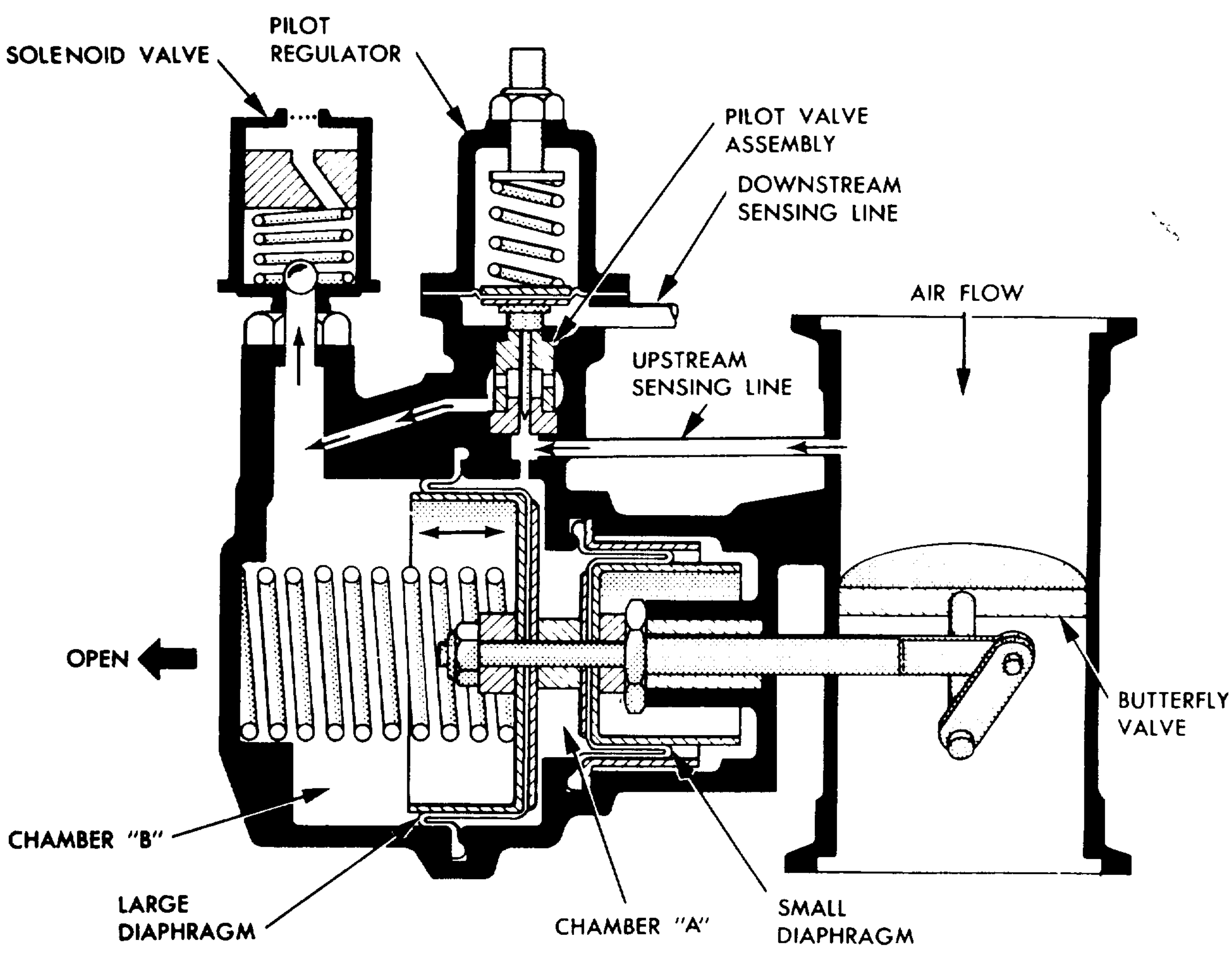


Figure 3-8.-Rain-removal Pressure-regulator shutoff valve.

top of the large diaphragm combine to hold the valve closed.

When the solenoid is energized, air supplied to chamber B bleeds off through the solenoid and the butterfly valve opens. As the butterfly valve opens, air pressure from the downstream side of the valve is applied to the bottom of the pilot regulator diaphragm. This unseats the regulator valve stem and permits upstream air to flow to chamber B. As the downstream pressure varies, a varying amount of air is metered by the pilot regulator valve to chamber B. The metering positions the diaphragm and the butterfly valve to maintain the proper downstream pressure. If the downstream pressure increases to a value in excess of the regulator setting, the pilot valve opens. When this occurs, the solenoid valve is not capable of bleeding off the increased airflow in chamber B. Therefore, chamber B pressure increases, and the butterfly valve moves toward the closed position until regulation pressure is reached.

RAIN-REMOVAL NOZZLE ASSEMBLY.— The rain-removal nozzle assembly consists of two ejectors, a plenum chamber, and 26 nozzles. The bleed-air duct has two nozzles aligned with and located beneath each ejector tube. The ejectors mix cool air from the nose radome compartment with the hot bleed air. The mixture is distributed by the plenum to the nozzles, which results in a wide stream of air across the windshield. The plenum chamber provides an approximately equal pressure at each nozzle. The rain-removal nozzle assembly is beneath the left windshield,

WINDSHIELD SWITCH.— The windshield switch is a single-pole, three-position switch mounted on the air-conditioning control panel in the cockpit. The three positions are OFF, AIR, and WASH. This switch controls the operation of the windshield-washing shutoff valve and rain-removal pressure-regulator shutoff valve. The switch is spring-loaded to the OFF position. The AIR and WASH positions are momentary contacts. If the switch is placed in the WASH position, it directs streams of washing fluid against the base of the windshield. If it is placed to the AIR position, it directs a wide stream of hot air across the glass.

NOSEWHEEL WELL BLEED-AIR SWITCH.— The nosewheel well bleed-air switch is a single-pole, two-position switch mounted on the fuel management panel in the cockpit. The two positions are OFF and AUTO. This switch controls the operation of the nosewheel well bleed-air shutoff valve. Placing the switch in the OFF position closes the nosewheel well bleed-air shutoff valve. When the switch is set to AUTO position, the nosewheel well bleed-air shutoff valve will open when the rain-removal system is energized or when the left main landing gear weight-on-wheels switch is actuated.

NOSEWHEEL WELL BLEED-AIR RELAY.— The nosewheel well bleed-air relay is a double-pole, double-throw, relay mounted in aft bay relay box No. 3. Its operation is controlled by the windshield switch on the air-conditioning panel or by the left main landing gear weight-on-wheels switch. When energized, the relay completes a 115-volt ac circuit to open the nosewheel well bleed-air shutoff valve. When de-energized, the relay completes a 115-volt ac circuit to close the nosewheel well bleed-air shutoff valve.

LEFT MAIN LANDING GEAR WEIGHT-ON-WHEELS SWITCH.— The left main landing gear weight-on-wheels switch is a double-pole, double-throw switch mounted on the lower torque arm of the left gear shock strut. The switch is closed when the shock strut piston is extended. When the shock strut piston is compressed, the plunger of the switch is fully extended. When the switch plunger is extended, a 28-volt dc circuit is completed to energize the nosewheel well bleed-air relay.

WINDSHIELD RAIN-REMOVAL WARNING RELAY.— The windshield rain-removal warning" relay is a double-pole, double-throw, sealed relay mounted in the cockpit center console below the wing fold panel. Its operation is controlled by the windshield switch on the air-conditioning panel. When the windshield switch is in the AIR position, 28 volts of dc power is directed from the air-conditioning circuit breaker to energize the relay and illuminate the windshield air caution light. The relay is de-energized when the windshield switch is set to OFF. At this time, the windshield air caution light will go out.

WINDSHIELD AIR CAUTION LIGHT.— The windshield air caution light is located on the caution light panel in the cockpit. It illuminates to indicate that the windshield switch is in the AIR position. The operation of the light is controlled by the windshield rain-removal warning relay.

System Operation

The rain-removal system is activated by placing the windshield switch in the AIR position. With the switch in the AIR position, a 28-volt dc circuit is completed from the air-conditioning circuit breaker, through the windshield switch, to the solenoid of the rain-removal pressure-regulator shutoff valve, to the nosewheel well bleed-air relay, and to the windshield rain-removal warning relay. When the nosewheel well bleed-air relay is energized, the 115-volt ac circuit from the bleed-air circuit breaker, through the AUTO position of the nosewheel well bleed-air switch, is completed to the open windings of the nosewheel well bleed-air shutoff valve. With the circuit completed, the windshield air caution light will illuminate. When you move the windshield switch to the OFF position, the windshield air caution light will go out. The nosewheel well bleed-air shutoff valve directs the 115-volt ac power to the close windings of the motor. The weight-on-wheels switch will energize the nosewheel well bleed-air relay.

When the rain-removal pressure-regulator shutoff valve solenoid is energized, the valve opens and allows pressure-regulated (75±3.5 psi) hot bleed air to flow to the ejectors of the rain-removal nozzles. To lower the temperature of the hot bleed air, the ejectors draw cool air from the nose radome compartment. The cool air and hot bleed air mix in the plenum of the nozzle assembly. The air passes through the plenum to 26 nozzles, which direct the hot air in a wide stream across the windshield.

CHAPTER 4

AIR-CONDITIONING SYSTEMS

Chapter Objective: *Upon completion of this chapter, you will have a working knowledge of the operating principles and components of air-conditioning.*

AMEs maintain the air-conditioning and pressurization systems of naval aircraft. These systems provide heating and cooling of the cabin and, at altitude, the pressurization required for breathing. As an AME, you will be assisting aircrews and troubleshooting discrepancies. A good knowledge of the systems is necessary to perform effectively. This chapter uses the S-3 environmental control system as the basis for discussion. To simplify matters, we have divided the system into two subsystems: bleed air and air-conditioning.

BLEED-AIR SYSTEM

Learning Objective: *Identify the operating principles and components of a bleed-air system.*

The bleed-air system is the air source for the environmental control system (ECS) and for deicing functions. There are three sources of bleed air available. The primary source is the compressor sections of the two aircraft engines. Secondary sources are from the auxiliary power unit (APU) and from an external air supply such as support equipment (SE).

SYSTEM OPERATION

As previously stated, the source of air for the bleed-air system may be from the aircraft engines, the APU, or SE. Operation of the system using each of these sources is presented in the following paragraphs. Frequent referral to the bleed-air system schematic (fig. 4-1) will aid you in understanding the material.

Engine Bleed Air

The engine bleed air is extracted from the 10th- and 14th-compression stages of each engine. The low-stage bleed-air check valve supplies the 10th-stage air, which is the primary source for operation of the ECS. When 10th-stage air is insufficient to meet ECS demands, 14th-stage air is supplied through the high-stage, bleed-air regulator valve.

One bleed-air shutoff valve is installed in each engine pylon downstream of the 10th- and 14th-stage engine-compressor bleed ports. The bleed-air shutoff valves are controlled by switches on the eyebrow panel in the flight station. Lights on the instrument panel indicate the position of the bleed-air shutoff valves. The lights illuminate when the valves are closed regardless of the position of the switches. When open, the bleed-air shutoff valves allow engine compressor bleed air to flow into the bleed-air manifolds.

The bleed-air manifold distributes bleed air from both engines into the air-conditioning and pressurization systems. Two crossover duct isolation check valves prevent the possibility of an overbleed of both engines should a rupture occur in the left or right bleed-air manifold.

The check valves, located in the left and right manifolds, allow bleed air to flow in one direction

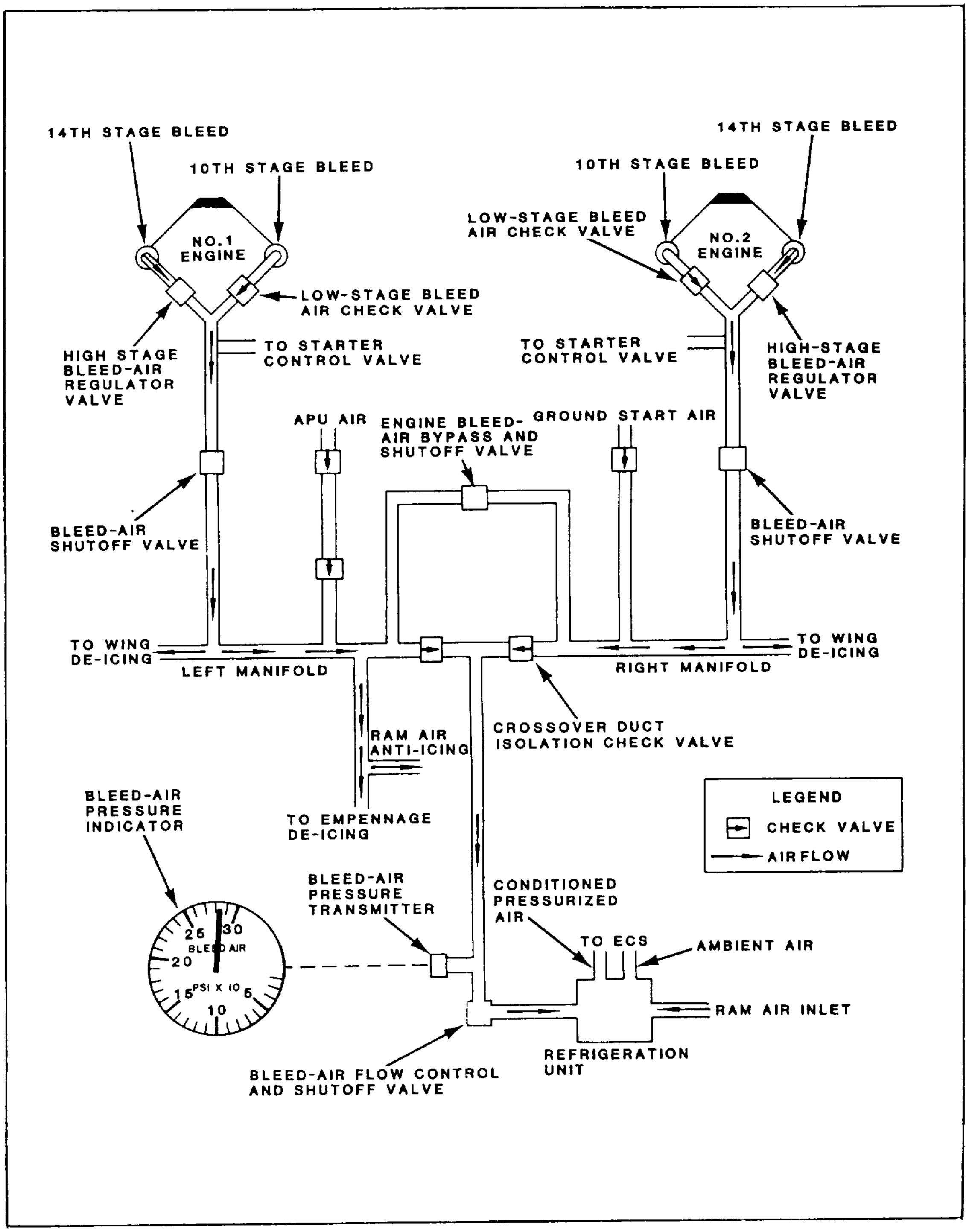


Figure 4-1.-Bleed-air system schematic.

only. If the left or right engine bleed air is secured, or if a rupture occurs in the left or right bleed-air manifold, the appropriate check valve closes. This allows the air-conditioning and pressurization subsystems to operate from the opposite bleed-air source. An open engine bleed-air bypass and shutoff valve allows bleed air to bypass the check valves and flow from the left-to-right or right-to-left manifolds. The engine bleed-air bypass and shutoff valve is open during engine starting. It is also open when operating the deicing system with one engine secured.

Bleed-air pressure is sensed by the bleed-air pressure transmitter located in the bleed-air supply duct downstream of the crossover duct isolation check valves. The pressure is displayed on the bleed-air pressure indicator on the environmental panel.

Bleed air from the left and right manifolds flows through the crossover duct isolation check valves to the bleed-air flow control and shutoff valve. The bleed-air flow control and shutoff valve is electrically controlled and pneumatically actuated to modulate the bleed-air flow to the air-conditioning and pressurization systems in response to predetermined flow schedules.

Two alternate air supply sources, APU air and ground start air, connect to the left and right bleed-air manifold. The APU air duct supplies bleed air through two check valves to the left manifold. The ground start duct supplies high-pressure air through a check valve to the right manifold. These alternate air supply sources are used primarily for starting engines and for ground operation of the air-conditioning system.

APU Bleed Air

Bleed air flows from the APU compressor through two one-way check valves in the APU duct to the left one-way check valve in the cross-breed manifold. Bleed air is also supplied to the bleed-air shutoff valve, the left side of the engine bleed-air bypass and shutoff valve, empennage deice valve, the left wing deice valve, and the ram air anti-icing valve. With the bleed-air switch in the ON position, the left bleed-air shutoff valve is opened. In the open position, bleed air is supplied to the left engine starter control valve.

To provide bleed air to the right side of the cross-breed manifold, the engine bleed-air bypass and shutoff valve is opened to allow bleed air to the right bleed-air shutoff valve and to the right wing deice valve. With the bleed-air engine No. 2 switch set to ON, the right bleed-air shutoff valve is opened. In the open position, bleed air is supplied to the right engine starter-control valve.

SE Ground Start Air

When support equipment is the source of air, the ground air start hose is connected to the ground start connection nipple located in the right wheel well. External high-pressure air flows through the engine starting duct check valve into the right cross-bleed manifold. Normal flow is through the right one-way check valve in the cross-breed manifold to the bleed-air flow control and shutoff valve. High-pressure air is available to the right bleed-air shutoff valve and the right wing deice valve. Opening the right bleed-air shutoff valve provides air to the right engine starter-control valve.

To provide SE air to the left cross-bleed manifold, the engine bleed-air bypass and shutoff valve is opened. When the valve is open, air flows around the cross-bleed check valves to the left bleed-air shutoff valve, the left wing deice valve, the ram air anti-icing valve, and the empennage deicing valve. To provide air to the left engine starter-control valve, open the left bleed-air shutoff valve.

SYSTEM COMPONENTS

Now that you are familiar with the operation of the system as a whole, let's look at its components and their operation. Knowledge of the individual components makes troubleshooting easier and faster. To aid you in locating parts of the components, numbers within parenthesis ( ) are included that correlate to the numbers on the illustrations.

High-stage Bleed-Air Regulator Valve

The high-stage, bleed-air regulator valve is a normally closed, differential-pressure regulator.

(See figure 4-2.) Air from the inlet (13) passes through the filter (14), and then through the reverse-flow check valve (15). The air then enters the reference regulator (16), where it is pressure regulated (as a function of altitude) by an evacuated bellows (1). The air is then passed through a control orifice (6), a shuttle valve (8), and to the actuator section (10) of the high-stage, bleed-air regulator valve to open the butterfly (12). The pressure of the air entering the regulator sensing line (11) with the spring pressure of the actuator section of the valve modulates the valve toward the closed position, as regulated by pressure from the shuttle valve. As aircraft altitude increases, the evacuated bellows expand and cause the reference regulator to close. The ambient vent (5) decreases the pressure to the open side of the actuator section, and thereby allows the spring to close the actuator section. This action also closes the butterfly.

When the cross-bleed start solenoid (3) is energized, the reference regulator larger diaphragm (2) is vented to ambient (4). Spring pressure on the reference regulator larger

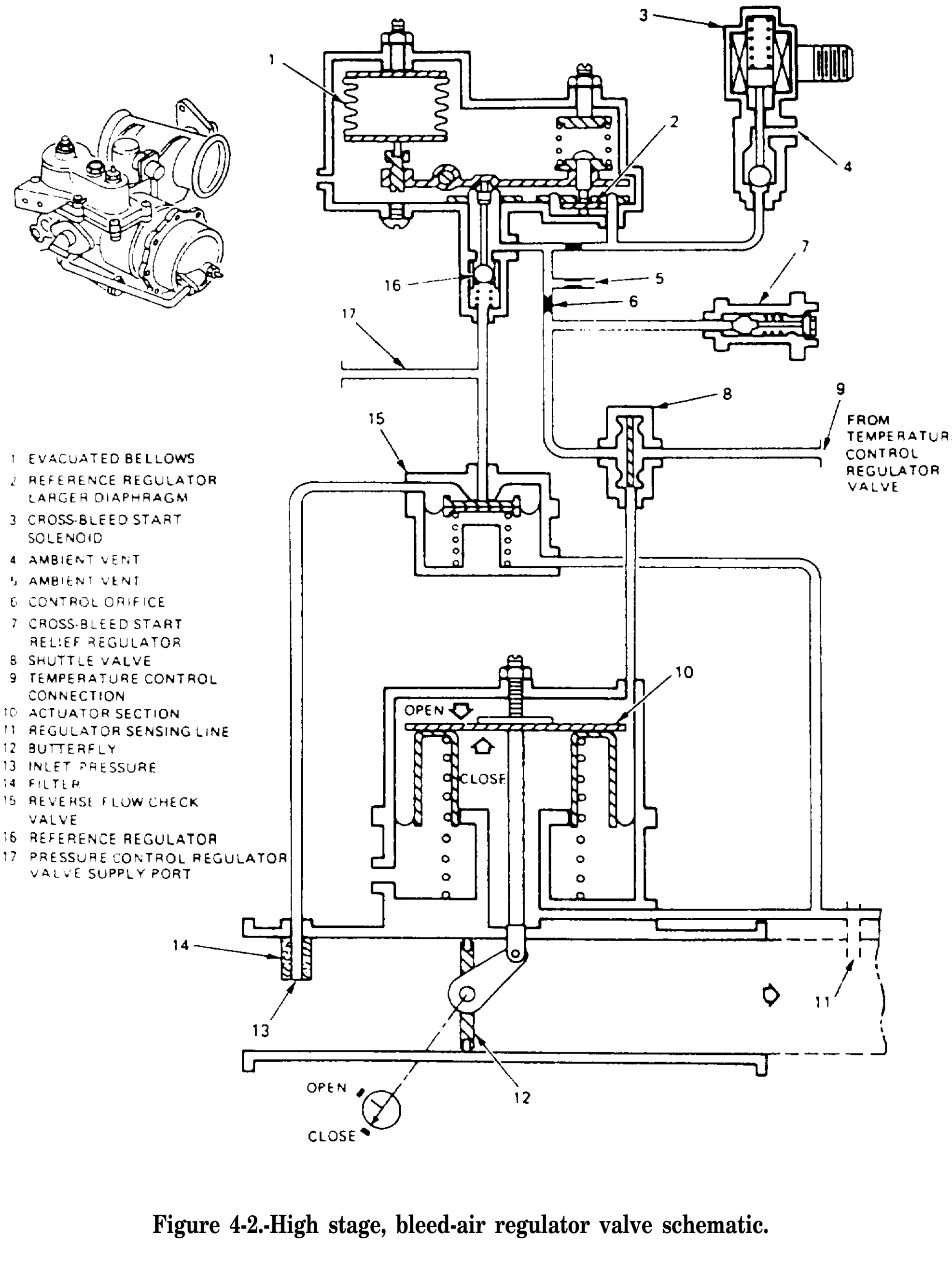


Figure 4-2.-High stage, bleed-air regulator valve schematic.

diaphragm causes the reference regulator to open. This results in pressure being passed through the control orifice, which is regulated by the cross-bleed start relief regulator (7). The pressure commands the actuator section to open with a corresponding opening of the butterfly.

During deicing operations, control pressure from the temperature control regulator valve is applied to the temperature control connection (9). This changes the shuttle valve position to allow the temperature control regulator valve pressure to open the actuator section and the butterfly. During deicing operations, pressure from the temperature control regulator valve overrides all other inputs to the shuttle valve.

Bleed-Air Shutoff Valve

The bleed-air shutoff valve is a normally closed, pneumatically operated, electrically controlled shutoff valve with provisions for automatic closure in the event of overtemperature, overpressure, or loss of electrical power (fig. 4-3.)

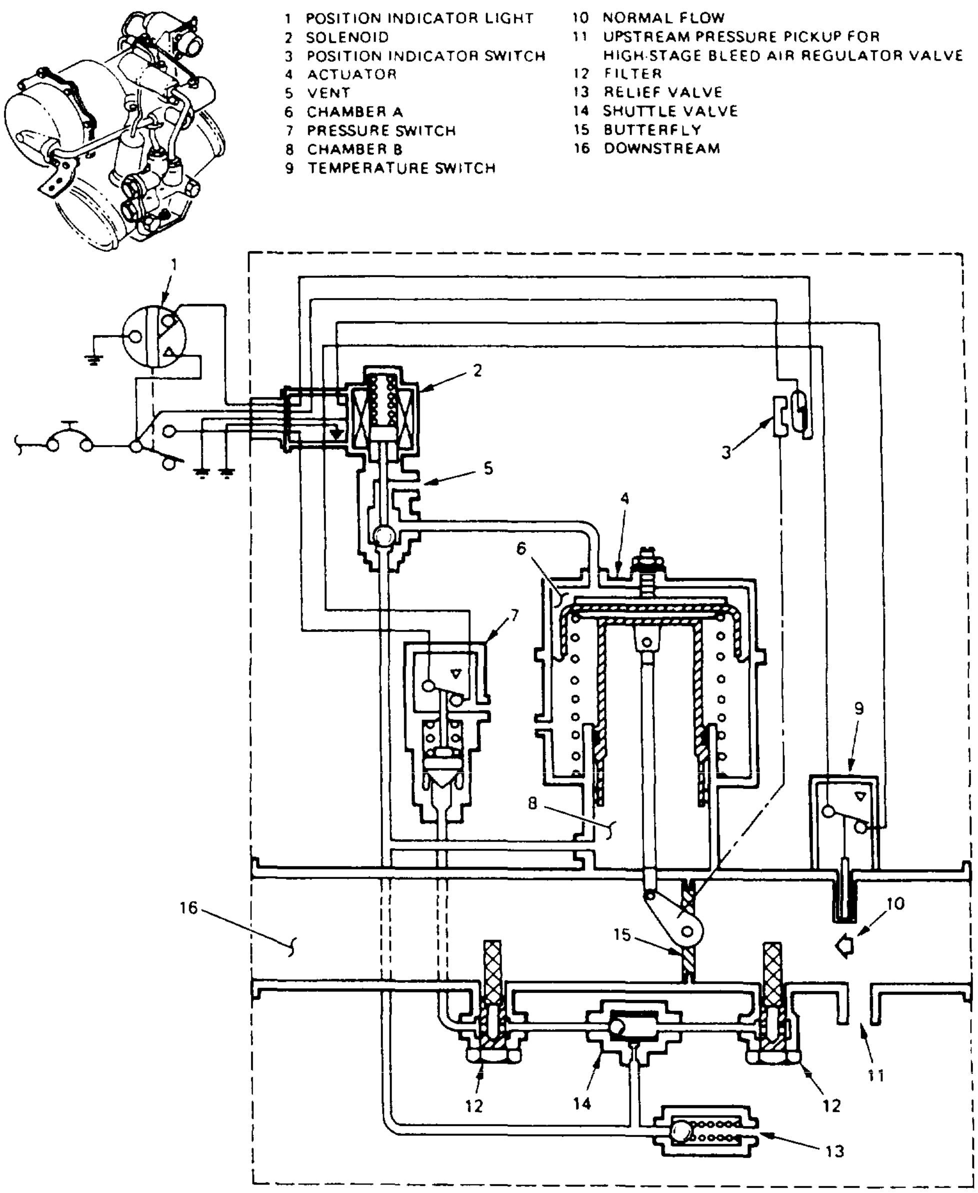


Figure 4-3.-Bleed-air shutoff valve schematic.

Inlet air pressure flows through the filters. to the shuttle valve (14), which selects the higher air pressure on each side of the butterfly (15) and routes the selected pressure to the solenoid (2) and chamber B (8). With the solenoid de-energized (as shown in figure 4-3), the opening side of the actuator (4), or chamber A (6), is vented (5) to ambient pressure through the solenoid. The resulting pressure differential between chambers A and B produces a force to keep the butterfly closed. A butterfly position indicator switch (3) controls a light (1) that indicates the butterfly is in a closed position. With the solenoid energized (opposite to the position shown in figure 4-3), air pressure is ported to chamber A, which opens the butterfly and keeps it open.

In the event of an overpressure that causes the inlet pressure downstream (16) of the butterfly to attain the preset value of the pressure switch (7), the switch actuates and de-energizes the solenoid electrical circuit to close the valve. When the inlet pressure returns to the switch reset value, the electrical circuit closes to re-establish solenoid control.

In the event of an overtemperature that causes the inlet temperature to attain the preset value of the temperature switch (9), the switch de-energizes the solenoid and closes the valve. When the temperature returns to the switch reset value, the solenoid re-establishes control.

Check Valves

Five check valves are used in the bleed-air system: two in the cross-bleed duct, two in the auxiliary power unit (APU) bleed-air duct, and one in the ground starting duct. These are 3-inch diameter, insert-type, spring-loaded closed split-flapper valves, which are designed to be inserted into, and contained by, the aircraft duct.

Low-Stage Bleed-Air Check Valve

The low-stage bleed-air check valve is installed in the engine pylon bleed-air duct on the right side of the engine. The low-stage bleed-air check valve allows bleed air from the 10th-stage engine compressor to enter the bleed-air subsystem to protect the engine when high-stage bleed air is scheduled.

The low-stage bleed-air check valve consists of a main housing and two semicircular flappers hinged on a post positioned radially through the center of the housing. The low-stage bleed-air check valve permits flow in the direction indicated by the arrow, and restricts flow in the opposite direction. The flappers are spring-loaded in the closed position.

Engine Bleed-Air Bypass and Shutoff Valve

The engine bleed-air bypass and shutoff valve, located in the cross-bleed manifold, is normally closed. It is open for engine starting and during single-engine, wing-deicing operations. (See figure 4-4.) When the solenoid (1) is energized, the shuttle valve (7) senses the higher pressure air from the right and left pressure inlets (3 and 5) and directs it through the solenoid to chamber A (6) to open the butterfly (4). When the solenoid is de-energized, air bypasses the solenoid and enters chamber B (2) to assist the spring in closing the engine bleed-air bypass and shutoff valve.

Bleed-Air Flow Control and Shutoff Valve

The bleed-air flow control and shutoff valve is a normally closed valve with two flow schedules: fixed and inlet pressure regulated. (See figure 4-5.) The valve is electropneumatically controlled and pneumatically actuated.

The venturi inlet (17) and throat pressure (18) are routed to the delta-P servo diaphragm (22). As the inlet pressure to the bleed-air flow control and shutoff valve is increased, regulated pressure routed to the actuator diaphragm (13) causes the butterfly (15) to open. When the resultant venturi delta-P reaches the predetermined value, as set by the calibration spring (12), the delta-P servo diaphragm moves. This causes the flexure beam (11) to lift off the servo valve and seat (20). This decreases pressure downstream of the control orifice (3), which closes the butterfly to a position that maintains the desired venturi delta-P. This delta-P corresponds to the desired high-flow setting when solenoid A (26) is de-energized.

When solenoid A is energized, regulated pressure acting on the high-flow low-flow reset diaphragm (7) moves the reset lever to the low-flow stop (10) and reduces the calibration spring load on the delta-P servo diaphragm. This causes the delta-P servo diaphragm to regulate the airflow at low condition. Solenoid A is operated electrically by an altitude switch (25). As the venturi inlet pressure increases, the inlet pressure compensating piston (5) moves against the reset lever (9) and modulates the air flow to a low value. The inlet pressure compensating spring preload and rate are selected to provide a prescribed schedule. When solenoid B (27) is energized, actuator pressure is vented to ambient, and the butterfly valve closes.

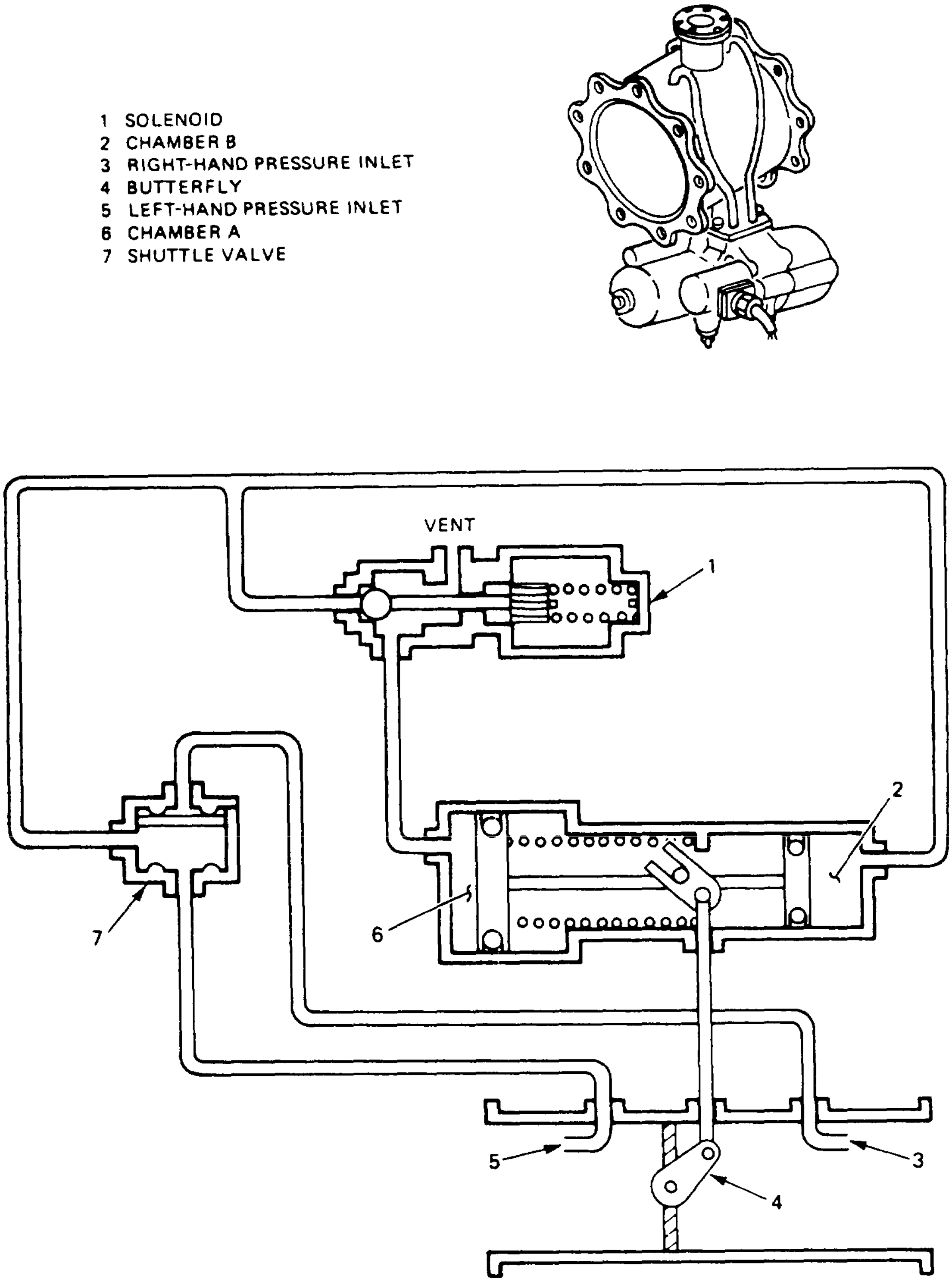


Figure 4-4.-Engine bleed-air bypass and shutoff valve.

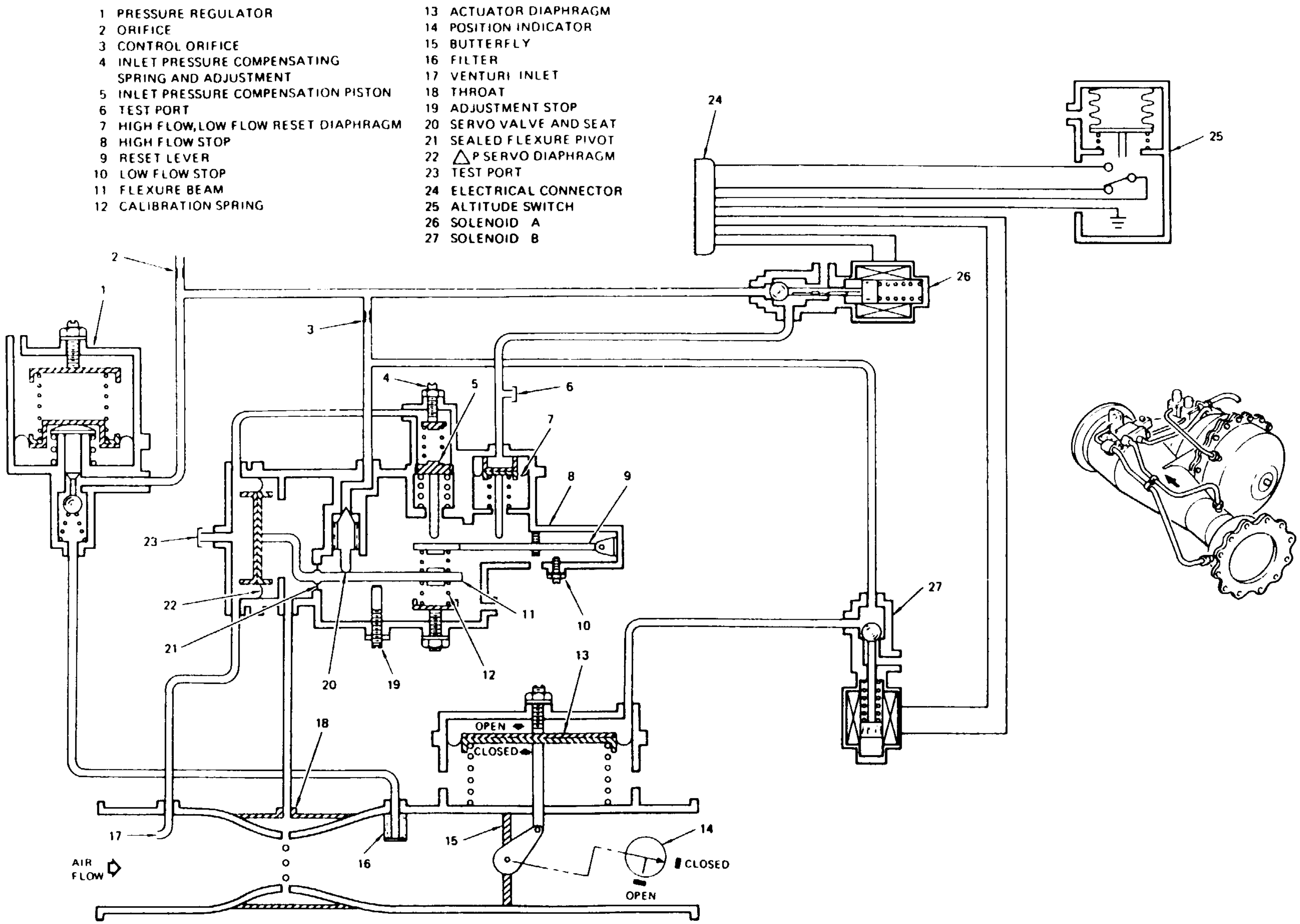


Figure 4-5.—Bleed-air flow control and shutoff valve schematic.

Bleed-Air Transmitter

The pressure transmitter senses the bleed-air pressure in the duct upstream from the bleed-air flow control and shutoff valve. The pressure transmitter transmits the pressure indication to the bleed-air pressure indicator on the environmental panel.

AIR-CONDITIONING SYSTEM

Learning Objective: *Identify the operating principles and components of an air-conditioning system.*

The air-conditioning system consists of two subsystems: refrigeration and cabin temperature control. These subsystems and their components are discussed in the following paragraphs.

REFRIGERATION SUBSYSTEM

The refrigeration subsystem, shown in figure 4-6, consists of two physically separated packages: refrigeration and cabin air/water separator. The refrigeration subsystem operates on bleed air, which is temperature and pressure regulated. Passage through the ram air-cooled heat exchanger reduces the bleed-air temperature to

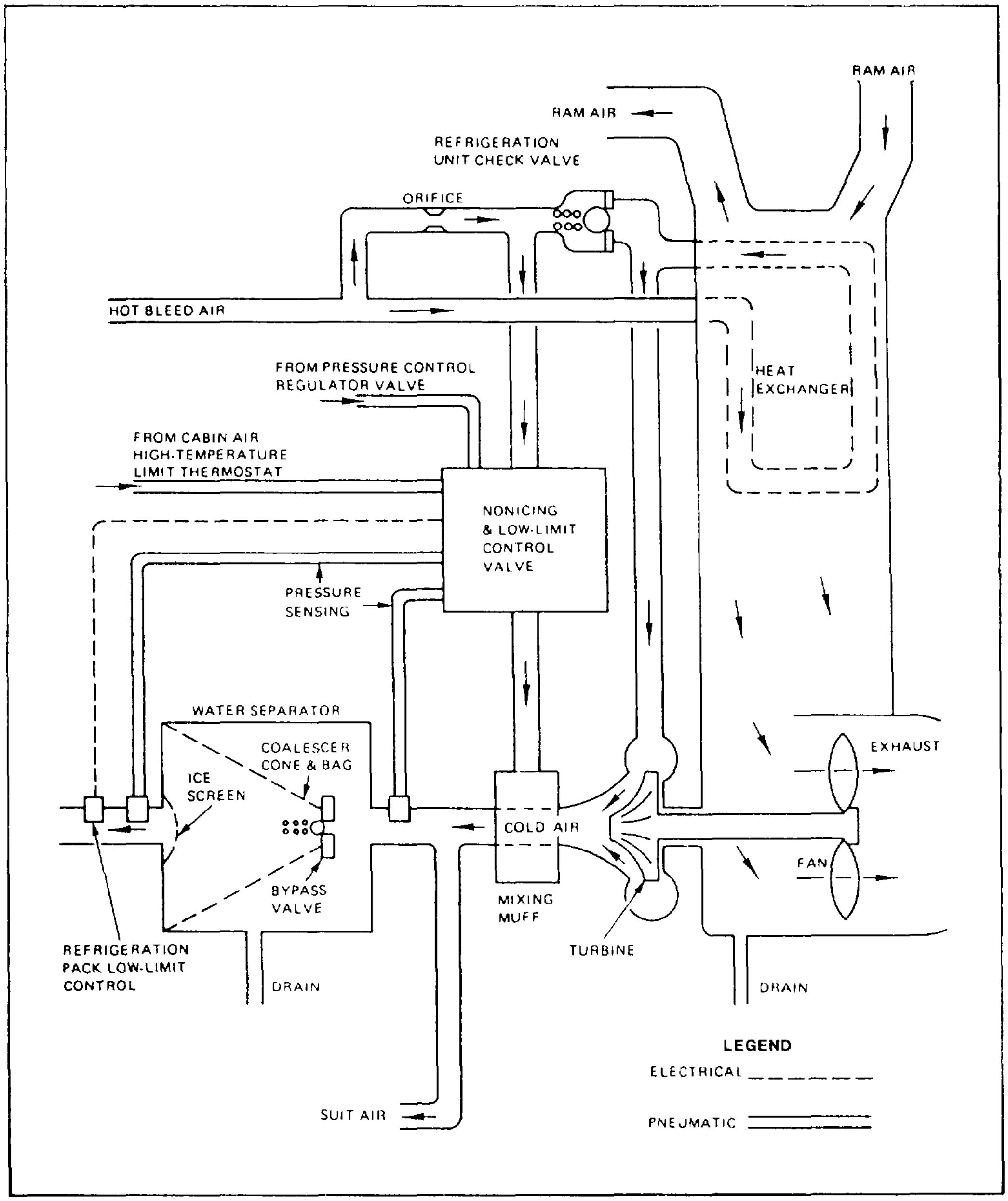


Figure 4-6.-Refrigeration subsystem schematic.

within a few degrees of ambient air temperature. Further temperature reduction results from expansion at the turbine. Condensation is removed in the water separator.

System Operation

Regulated hot bleed air from the bleed-air supply subsystem enters the refrigeration unit heat exchanger, where it is cooled to within a few degrees of ram-air temperature. The cooled high-pressure bleed air enters a radial flow turbine, where it expands to approximately cabin pressure. The power output of the expansion turbine drives an axial-flow cooling air fan. A substantial temperature drop occurs in the expansion of high-pressure air to cabin pressure (165 psi bleed-air to 15 psi cabin air), which results in air temperatures well below ram-air temperature.

Depending upon the cool air temperature and dew point, a portion of the water vapor in the air condences as small droplets. A water separator is installed downstream from the turbine discharge to remove between 50 and 70 percent of the moisture in the cooled air. If the turbine discharge air is also below 32°F, the water vapor condenses as ice crystals. Potential icing and blockage are eliminated by the nonice and low-limit control valve, the ice screen, and the mixing muff. The nonice and low-limit control valve senses any pressure drop through the ice screen. If ice accumulates, the nonice and low-limit control valve admits turbine bypass air into the mixing muff to increase air temperature above icing conditions.

Ram cooling air for the heat exchanger flows through the heat exchanger core. The turbine shaft drives the fan, which pulls the ram air through the heat exchanger and discharges it overboard through the heat exchanger exhaust duct.

Components

There are nine basic components in the refrigeration subsystem. Each of these components is discussed in the following paragraphs. The relationship of the items is shown in figure 4-6.

TURBINE AND FAN ASSEMBLY.— The turbine and fan assembly (fig. 4-7), which is mounted in the heat exchanger upper plenum (7), is a removable component of the refrigeration package. High-pressure, partially cooled bleed air drives the turbine, which is mechanically coupled to an axial flow fan. The fan is used to impel ram air through the heat exchanger and an overboard exhaust duct. Pressure reduction and final heat loss occur as a result of energy loss and expansion of bleed air as it passes through the turbine.

Wool wicks, with one end submerged in MIL-L-23699 oil, transmit lubricant to the bearings supporting the common shaft of the turbine and fan assembly. A sight gauge on the turbine housing is used to check the oil level.

Two overtemperature indicators are installed on the turbine. Each sensor probe head holds down a spring-loaded pop-up stem with an eutectic solder alloy. If the air in the passage reaches the melting point for the solder alloy, the indicator head pops up and stays exposed to alert maintenance personnel that the cooling turbine has been exposed to an excessive temperature level and needs to be replaced. The probe in the turbine inlet is set to trip at 217°±10°F, and the probe in the fan inlet will trip at 450°±10°F. Obstructions or collapse of the ram air inlet duct is the most likely cause of actuating this indicator.

HEAT EXCHANGER CORE, UPPER AND LOWER PLENUMS.— The heat exchanger lower plenum (2) contains the ducting for the ram air inlet and outlet. Cooling ram air (4) flows into the lower plenum and through the heat exchanger core (3) and out through the overboard exhaust duct (6) to the upper plenum, or to the ram air augmentation subsystem (5).

The heat exchanger upper plenum, which supports the turbine and fan assembly (1), is mounted on the opposite side of the heater core. Ram air drawn through the heater core for cooling purposes is diverted to the heat exchanger exhaust duct through the heat exchanger upper plenum. The heat exchanger core is the air-to-air heat sink, and it uses ram air to cool the bleed-air supply.

NONICING AND LOW-LIMIT CONTROL MODULATING VALVE.— The nonice and low-limit control valve maintains conditioned airflow through the water separator by adding bleed air at the mixing muff to prevent water separator

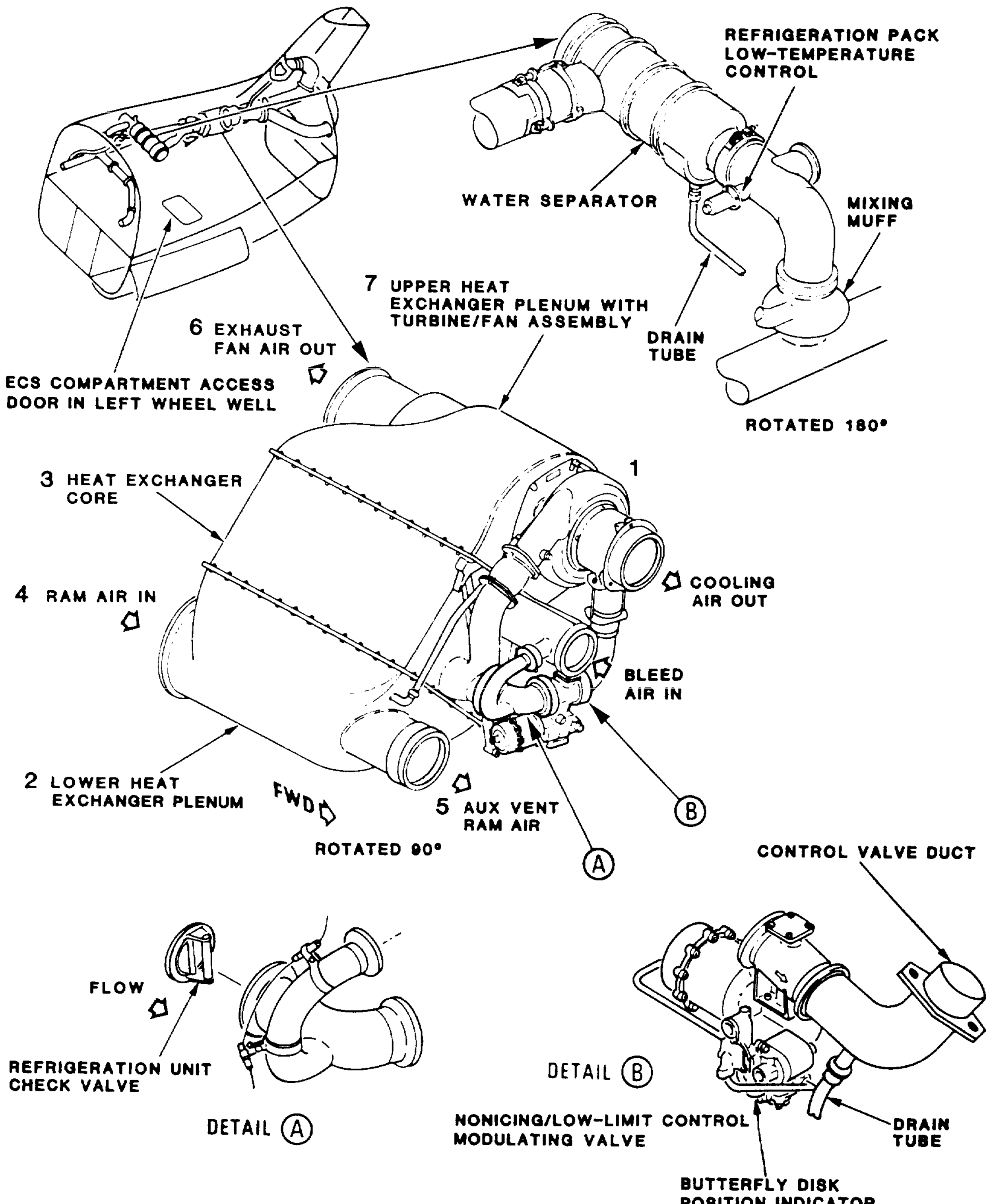


Figure 4-7.-Refrigeration package and water separator.

icing. (See figure 4-8.) Ice forming on the wire screen at the water separator discharge duct is detected by two pneumatic pickups located just before and after the water separator. These pickups sense a differential pressure across the water separator. If differential pressure is sensed across the water separator, the nonice and low-limit control valve will remain open until the temperature of the inlet air to the water separator is high enough to melt collected ice. When the ice is melted, the pressure differential returns to normal. In addition, the refrigeration pack low-limit control electrically signals the nonice and low-limit control valve when separator outflow drops to 0°F.

REFRIGERATION PACK LOW-LIMIT CONTROL.— The refrigeration pack low-limit control (fig. 4-6) is located in the ECS compartment. It is mounted downstream from the water separator in a 6-inch duct of cooled discharged bleed air.

The refrigeration pack low-limit control uses 28-volt dc power to energize its circuitry. A thermistor senses duct air temperature and compares it with an internally generated reference. The difference is amplified to modulate a torque motor in the nonice and low-limit control valve. (See figure 4-8.) The torque valve controls the regulated air supply (3) with a flapper valve (1), which controls the diaphragm pressure in a butterfly actuating linkage (12). The nonice and low-limit control valve can be returned to the differential pressure control mode by opening the cabin temperature high-limit thermostat (4). This causes the upper chamber (6) of the switcher valve (7) to be vented (17) and returned to its primary position. A check valve (5) is provided to prevent extraneous signals from affecting the nonice and low-limit control valve.

REFRIGERATION UNIT CHECK VALVE.— The refrigeration unit check valve (fig. 4-7, detail A) is an insert-type check valve with a split flapper spring-loaded in the closed position. The valve, which is installed in the refrigeration unit to prevent hot bleed air from entering directly into the turbine, is located in a tee arrangement in the system just downstream of an orifice.

Icing of the water separator will occur only at low altitudes where mass airflow and temperature are relatively high. Only a small amount of high-temperature air is required through the orifice to melt such a deposit. However, at high altitude where the mass flow and bleed-air temperatures are low, the refrigeration pack low-limit control operates to open the nonice and low-limit control valve. When the nonice and low-limit control valve is open, high differential pressure across the bleed-air orifice permits the refrigeration unit check valve to open. This allows intermediate-temperature air to bypass the turbine, and thereby maintain water separator temperature above 0°F. (See figure 4-6.)

CABIN AIR/WATER SEPARATOR, COALESCER CONE, AND COALESCER BAG.— The water separator is a welded cylindrical aluminum container installed downstream from the turbine and fan assembly. Its purpose is to remove a portion of the moisture condensed during the air-expansion process within the expansion turbine. (See figure 4-6.) The water separator container holds a coalescer bag, which collects the finely dispersed fog-like moisture discharged from the turbine. The wet air flows through the coalescer cone and through louvered swirl vanes to cause the heavier water particles to be deposited by centrifugal force against the outer surface of the collector section. Accumulated water is drained through the sump in the bottom of the collector section. The partially dried air then leaves the water separator by way of the air outlet duct. The coalescer bag may be removed for cleaning through an access cover secured with a quick-disconnect band coupling to the water separator shell.

WATER SEPARATOR ICE SCREEN.— An ice screen is located in the discharge end of the water separator to collect ice when moisturized airflow temperature is below the dew point temperature, or below 32°F. The condensed ice crystals gathered across the ice screen cause a pressure differential, which is sensed by the nonice and low-limit control valve. The nonice and low-limit control valve then increases the warm air supply through the mixing muff, the coalescer bag, and to the ice screen to melt collected ice.

WATER SEPARATOR BYPASS VALVE.— The bypass valve is a spring-loaded valve mounted in the water separator container. A failure of the nonice and low-limit control valve could cause ice particles to build up in the water separator coalescer bag. This ice would block the cabin air system. To ensure that air is supplied to the cabin, the water separator bypass valve allows turbine air to bypass the coalescer bag.

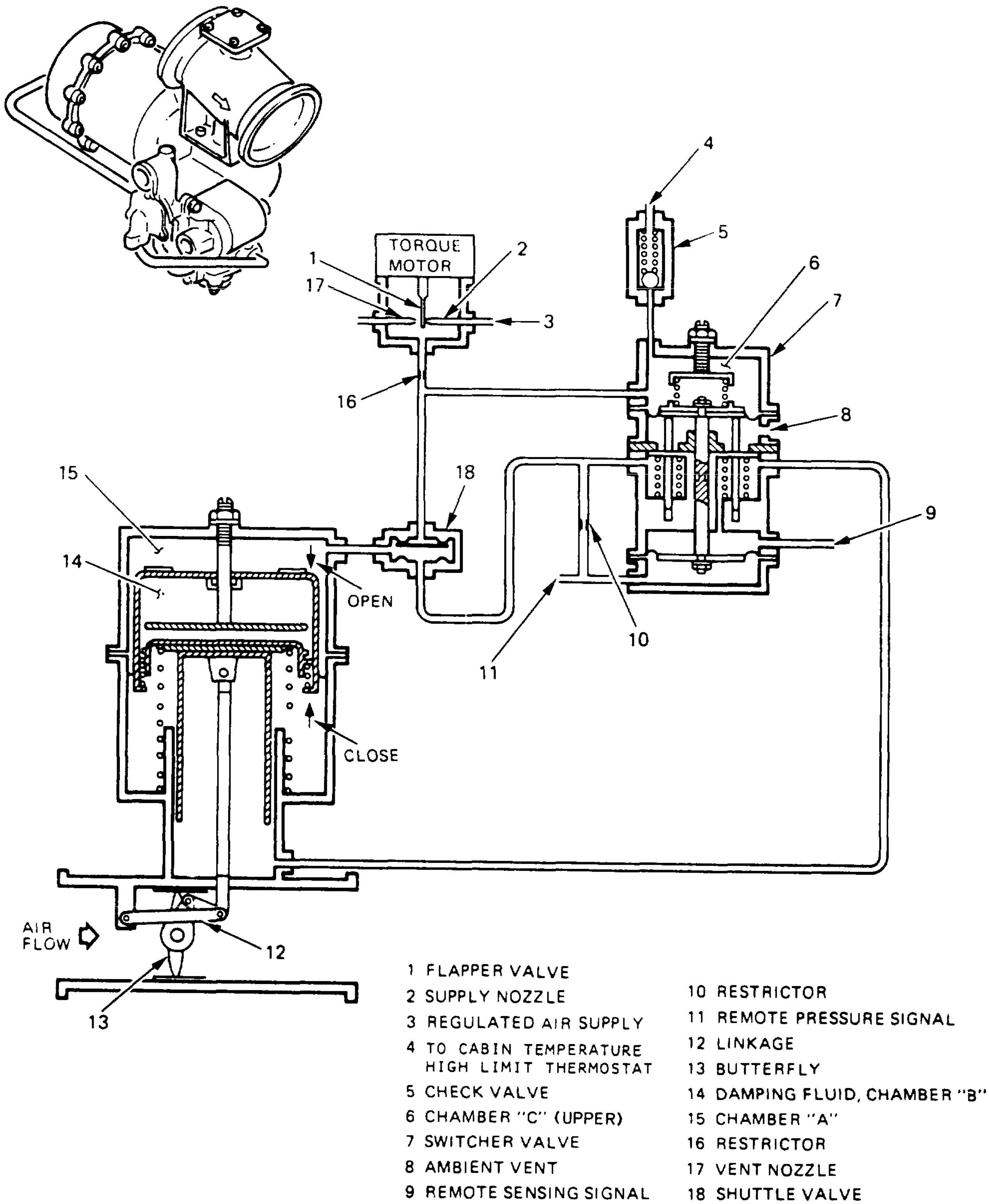


Figure 4-8.-Nonicing and low-limit control modulating valve schematic.

CABIN TEMPERATURE CONTROL SUBSYSTEM

A cabin air temperature control sensor is located mid cabin adjacent to the TACCO cooling air inlet. Its purpose is to ensure adequate airflow over the sensor, which measures cabin temperature and sends a signal, along with a signal from the cabin air temperature selector, to the cabin air temperature control. The cabin air temperature control then directs the cabin temperature control modulating valve to maintain a selected temperature in the cabin. During normal cruise, cabin air temperature is controlled by mixing water separator cold air with hot bleed air. The control also acts as an anticipator to stabilize response from the supply duct sensor to the cabin temperature demand.

System Operation

The cabin temperature control subsystem cools the bleed-air supply by air-cycle refrigeration and ram air mixing to provide a cabin temperature within the range of 60° to 80°F during steady and mild transient conditions. The cabin temperature is maintained within ±3°F of the selected value and a temperature differential of 10°F between the floor level and the head level. Humidity control ranges from a relative humidity of 5 to 70 percent. The cabin exhaust air, after passing through the internal avionics and the sonobuoy and weapons bays, is exhausted overboard.

Cabin air temperature is monitored by a sensor mounted on the aisle next to the cooling air inlet at the TACCO side console. The sensor measures the flight station air temperature and generates a signal that is transmitted to the cabin air temperature control. Additionally, a signal from the temperature select switch is sent to the control. The cabin air temperature control senses the inlet duct temperature and compares the signals to modulate the cabin temperature control valve. Based on this comparison, it allows the proper amount of hot bleed air to enter the mixing muff at the conditioned air outlet. The cabin air temperature control acts as an anticipator to stabilize the response of the supply duct air temperature to cabin temperature demands. It also minimizes cabin air supply duct temperature changes because of bleed- or ram-air temperature change. (See figure 4-9.)

In the manual mode, the automatic controls are overridden to provide manual control of the cabin temperature control valve. Since the cabin air temperature control is bypassed, the 160°±5°F limit on the cabin air temperature control is raised to 185°±15°F, as sensed by the cabin air high-temperature limit thermostat. If the pilot has selected the temperature select switch position for which this 185°±15°F is exceeded, the cabin temperature control subsystem will cycle open and closed until manual control is repositioned or conditions change to reduce maximum supply temperature.

The augmented air system provides ram air, as required, to supplement the conditioned bleed air and to provide auxiliary ventilation. This ram air is drawn from the ram-air scoop located in the base of the vertical stabilizer. The ram air is injected into the cabin air distribution ducting downstream from the mixing muff at the junction between the water separator discharge air and the cabin temperature control valve.

During unpressurized flight up to 3,500 feet (+1000 or –500 feet) with a ram air temperature between 20°±6°F and 72°±6°F, ram air supplements the conditioned bleed-air flow to the cabin. When operating in the automatic mode, the ram-air shutoff valve controls the duct-to-cabin pressure differential to 7.5 ± 2 inches of water to prevent flooding the cabin with ram air when the aircraft is flying at high speeds.

The ram-air shutoff valve is also used to provide auxiliary ventilation by securing the refrigeration package and relying on the pilot-operated auxiliary vent switch to adjust the ram-air shutoff valve. (See figure 4-10.) With the air-conditioning switch set to OFF, setting the auxiliary vent switch to ON closes the cabin recirculating air temperature control valve and opens the cabin pressure regulator valve. If the setting of the ram-air shutoff valve is such that ram pressure fails to satisfy cabin exhaust fan requirements, the negative pressure relief valve opens. This draws additional ambient air from the environmental control system compartment to compensate for any airflow deficiencies.

In the event of an automatic shutdown of the air-conditioning or pressurization system during single-engine waveoff, the cabin air supply temperature may change because the ram-air shutoff valve opens. Operation is restored by setting the air-conditioning switch to OFF/RESET and then back to ON, or by setting the auxiliary vent switch to modulate the ram airflow.

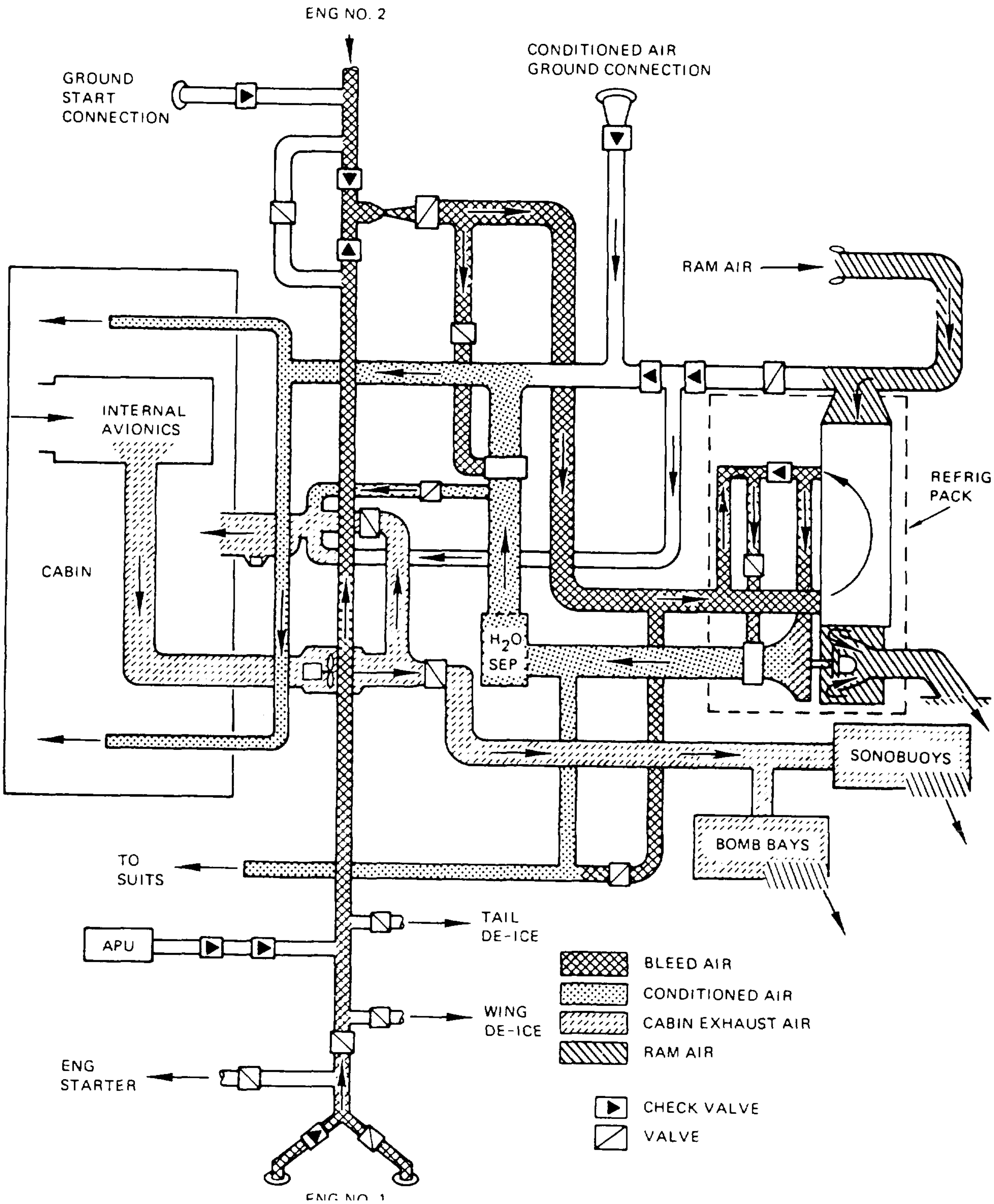


Figure 4-9.-Environmental control system operation during pressurized flight.

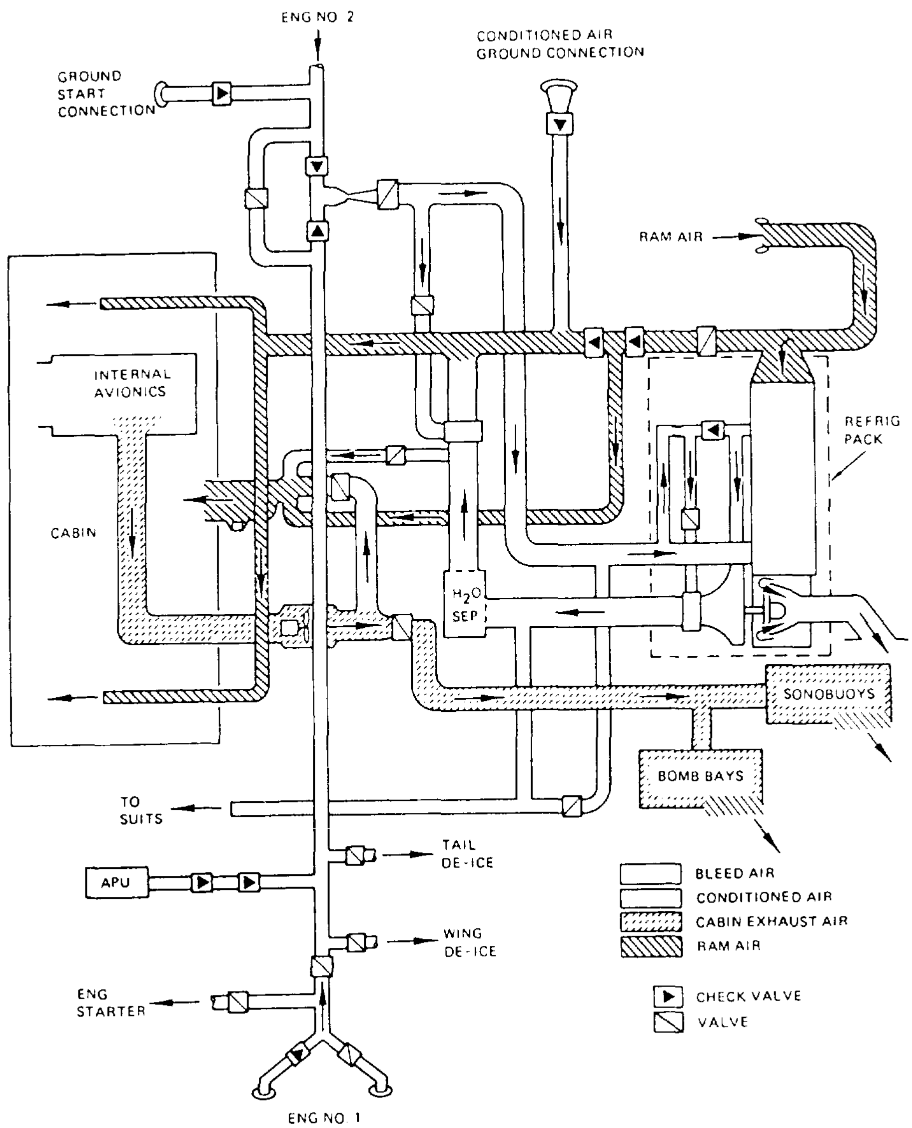


Figure 4-10.-ECS operation in aux vent mode.

System Components

Seven components are used to control cabin temperature. These components are discussed in the following paragraphs.

CABIN TEMPERATURE CONTROL MODULATING VALVE.— The cabin temperature control modulating valve has a visual position indicator and is spring-loaded to the closed position. It is located between the hot bleed-air duct going to the refrigeration unit and the cooled air duct coming from the refrigeration unit. The cabin air temperature control provides electrical power to a torque motor in the valve, which converts electrical signals into pneumatic signals that modulate the butterfly to a specific opening.

CABIN AIR TEMPERATURE CONTROL.– The cabin air temperature control, which is located in the cabin inlet duct, senses duct temperature with two thermistors and a control circuit for signal comparison. The cabin air temperature control output signal is in proportion to the sensed temperature differential between the inlet duct temperature and an input from the cabin air temperature sensor. The output of the cabin air temperature control, which goes through the cabin air temperature selector, provides a controlling signal for the cabin temperature control valve.

CABIN AIR HIGH-TEMPERATURE LIMIT THERMOSTAT.— The cabin air high-temperature limit thermostat is a pneumatic control valve that actuates as a function of cabin inlet air temperature sensed at the cabin air inlet duct. The thermostat's internal valve opens between 182° and 200°F and dumps regulated air pressure from the cabin temperature control valve and the nonice and low-limit control valve. This induces both valves to close.

The thermostat uses a temperature-sensing liquid contained in a sealed-wall probe. Vapor forms above the liquid, varies in pressure with surrounding temperature, and actuates a disc spring that dumps the air pressure supply.

CABIN AIR TEMPERATURE CONTROL SENSOR.— The cabin air temperature sensor, located mid cabin, consists of two thermistor probes in parallel that have a nominal 4,000-ohm resistance at 77°F. The sensor, which operates over a temperature range of 55° to 85°F, is connected to the cabin air temperature control, and it is designed to control cabin temperature to within ±3°F of the selected temperature.

RAM-AIR SHUTOFF VALVE.— The ram-air shutoff valve (fig. 4-11) consists of a butterfly valve (9) and linkage. It is opened by a spring and closed by an air-pressure actuated diaphragm (11). The diaphragm is activated by a regulated air

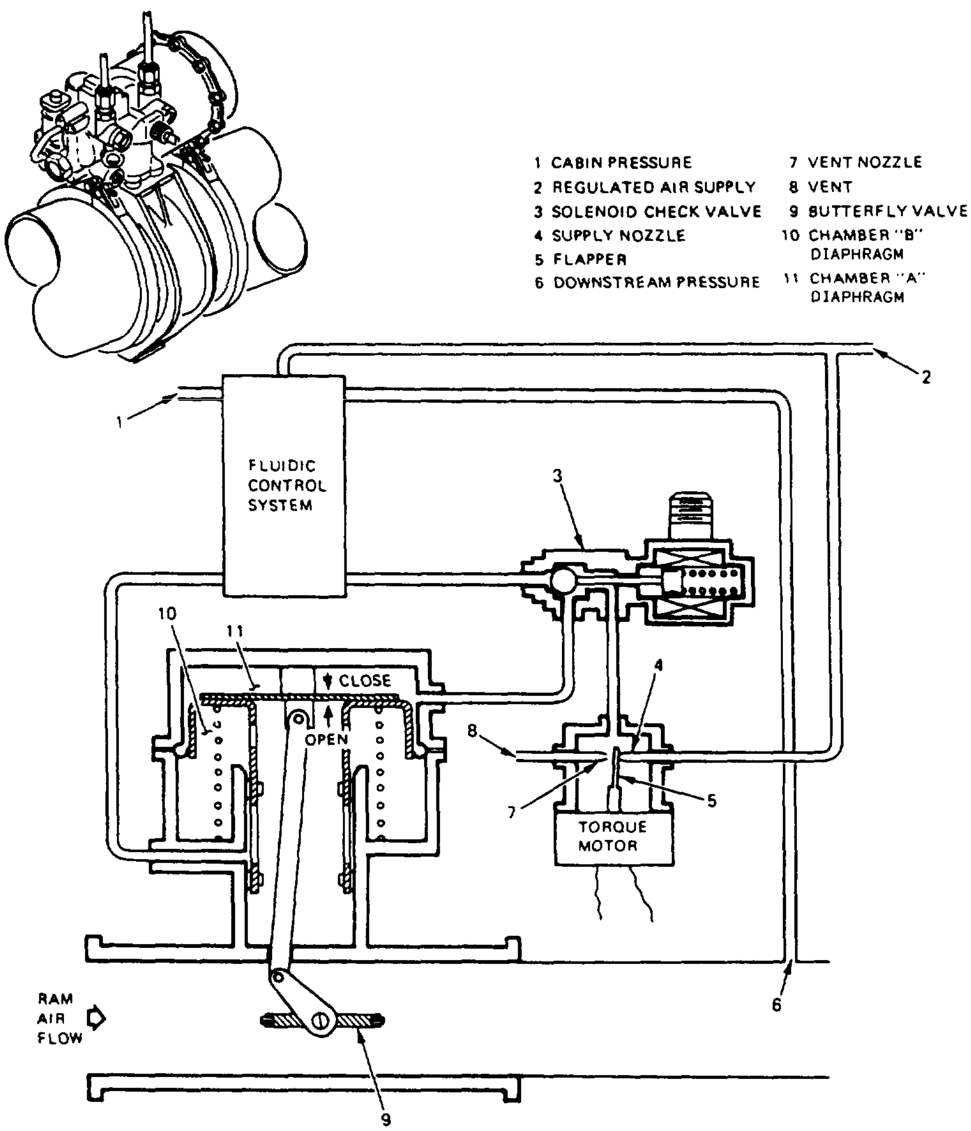


Figure 4-11.-Ram-air shutoff valve schematic.

supply that is controlled by a fluidic control system or a torque motor and flapper (5), depending upon whether the solenoid is energized or de-energized.

During the ram-air augmentation mode (automatic mode), the ram-air shutoff valve regulates downstream pressure to a fixed differential of 7.5 ± 2 inches of water above cabin pressure. The automatic mode is selected by energizing the solenoid. This allows the fluidic control to establish the differential across the valve actuator as determined by valve downstream pressure (6) and cabin pressure (1).

During manual operation (override mode), the auxiliary vent switch on the environmental panel is used to place the ram-air shutoff valve in any position from fully closed to fully open by varying electrical power to the valve torque motor. In the override mode, selected by de-energizing the solenoid, power is applied to the torque motor to close the pneumatic supply pressure nozzle and to open the vent nozzle, thereby lessening the ram-air shutoff valve actuator closing pressure. This permits the actuator spring to move the butterfly toward an open position.

RAM-AIR HIGH-AND LOW-TEMPERATURE LIMIT SWITCH.— The ram-air high- and low-temperature limit switch senses air temperature at the ram-air inlet duct. There are two circuits in the ram-air high- and low-temperature limit switch that are normally closed. One circuit opens with decreasing ram-air temperature, and the other opens with increasing ram-air temperature. The ram-air high- and low-temperature limit switch circuitry is interconnected with the bleed-air flow control valve, the ram-air shutoff valve, and the auxiliary vent switch. The ram-air high- and low-temperature limit switch operation controls the ram-air shutoff valve position when the ram-air shutoff valve is operating in the automatic mode.

GROUND AIR SUPPLY CHECK VALVE AND GROUND COOLING AIR CONNECTOR.— Support equipment provides low-pressure conditioned air when it is attached to the ground cooling air connector. The connector is located on the right side of the aircraft in the right wheel well at fuselage station (FS) 465. It is accessible through a hinged door on the underside of the sonobuoy deck. The connector consists of a silicone-impregnated nylon hose and a clamp supporting the air check valve.

The ground air check valve is a 4-inch diameter, split-flapper valve spring-loaded to the closed position. Ground cooling air opens the check valve and closes the ram and recirculated air check valves. The ground source low-pressure air bypasses the refrigeration unit and enters the cabin area because the air-conditioning system is not used when low-pressure ground air is connected. Therefore, the bleed-air flow control valve will be closed.

ENVIRONMENTAL CONTROL PANEL

The environmental control panel (fig. 4-12) is located on the center console and is used by the flight crew to control temperature, pressurization, and anti-icing functions. The discussion of this panel is limited to the ram-air valve position selector, air-conditioning switch, and the cabin air temperature selector.

Ram-Air Valve Position Selector

When the ram-air valve position selector (AUX VENT switch) is placed in the OFF position, the automatic mode is established by way of the fluidic control system. Clockwise rotation towards the ON position overrides logic controls of the air-conditioning system. Control of the ram-air shutoff valve is determined by the

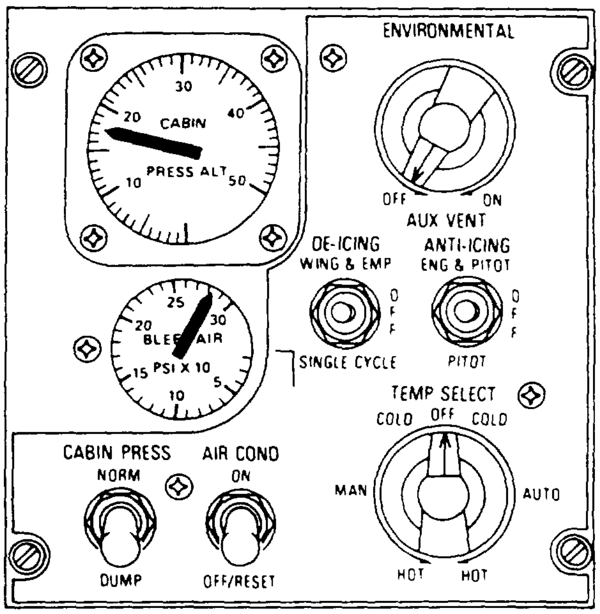


Figure 4-12.-Environmental control panel.

magnitude of the current, which is proportional to the setting of the auxiliary vent switch.

Air-Conditioning Switch

The air-conditioning switch (AIR COND switch) is used to activate the air-conditioning system. When air conditioning is automatically shutdown and the ram-air shutoff valve has fully opened, the air-conditioning switch must be set to OFF/RESET, and then back to ON to restore normal operation.

Cabin Air Temperature Selector

The cabin air temperature selector (TEM SELECT switch) has a manual and an automatic mode of operation. The temperature select switch operates manually in the same manner as the auxiliary vent switch. In the automatic mode, cabin temperature is selectable from 60° to 80°F.

CHAPTER 5

NAVY AIRCREW COMMON EJECTION SEAT (NACES)

Chapter Objective: *Upon completion of this chapter, you will have a working knowledge of the Navy Aircrew Common Ejection Seat (NACES), including functional description, physical description, component identification, and maintenance concepts.*

The incorporation of the Navy Aircrew Common Ejection Seat (NACES) in Navy aircraft represents a significant improvement in ejection-seat design that takes advantage of the latest escape system technology. The NACES system gives the aircrew improved chances for escape in all ejection situations, reduced potential for injury, extended preventive maintenance intervals, and a significant reduction in life-cycle costs. This Martin-Baker ejection seat will be fitted to the new Grumman F-14D *Tomcat*, the McDonnel Douglas/British Aerospace T-45A *Goshawk* two-seat trainer, and the McDonnel Douglas F/A-18C and D aircraft.

The purpose of the common ejection seat is to ease the logistics and maintenance problems on the Navy's inventory of aircraft. The new seat will increase the standardization and reliability of aircraft emergency escape and aircrew and ground crew training. The electronically controlled NACES represents the state-of-the-art in escape system technology, and it has been selected as the future standard of the U.S. Navy. The NACES series was engineered from the outset for future growth potential. The ejection seat is designed for simple reprogramming or modification to ensure that it maintains current technology.

As a senior AME, you already have the prerequisite knowledge and experience to understand ejection seat theory. New ideas have been incorporated into the NACES. Now all that is required is your willingness to learn these new ideas so that NACES characteristics become as familiar as previous Martin-Baker ejection seats.

SYSTEM DESCRIPTION AND COMPONENTS

Learning Objective: *Recognize the functional and physical description of the NACES and the components within the system.*

The NACES system uses a flexible configuration to meet the exact requirements of the crew station designer. Although this is a common ejection seat, the designator number for the seat versus aircraft types are different, as shown below.

SEAT	TYPE AIRCRAFT-LOCATION
1. SJU-17(V)1/A	F/A-18C, F/A-18D, rear cockpit
2. SJU-17(V)2/A	F/A-18D, front cockpit
3. SJU-17(V)3/A	F-14D, rear cockpit
4. SJU-17(V)4/A	F-14D, front cockpit
5. SJU-17(V)5/A	T-45, rear cockpit
6. SJU-17(V)6/A	T-45, front cockpit

Although the physical description may differ between the seats used in the F-14D as compared to the F/A-18 and T-45 (fig. 5-1), the functions of all the seats are the same. In this chapter we will use the F/A-18 ejection seat to discuss system description, operation, function, and component identification.

FUNCTIONAL DESCRIPTION

WARNING

The emergency escape system incorporates several explosive cartridges and rockets containing propellant charges. Inadvertent firing of any of these may result in serious or fatal injury to personnel on, or in the vicinity of, the aircraft.

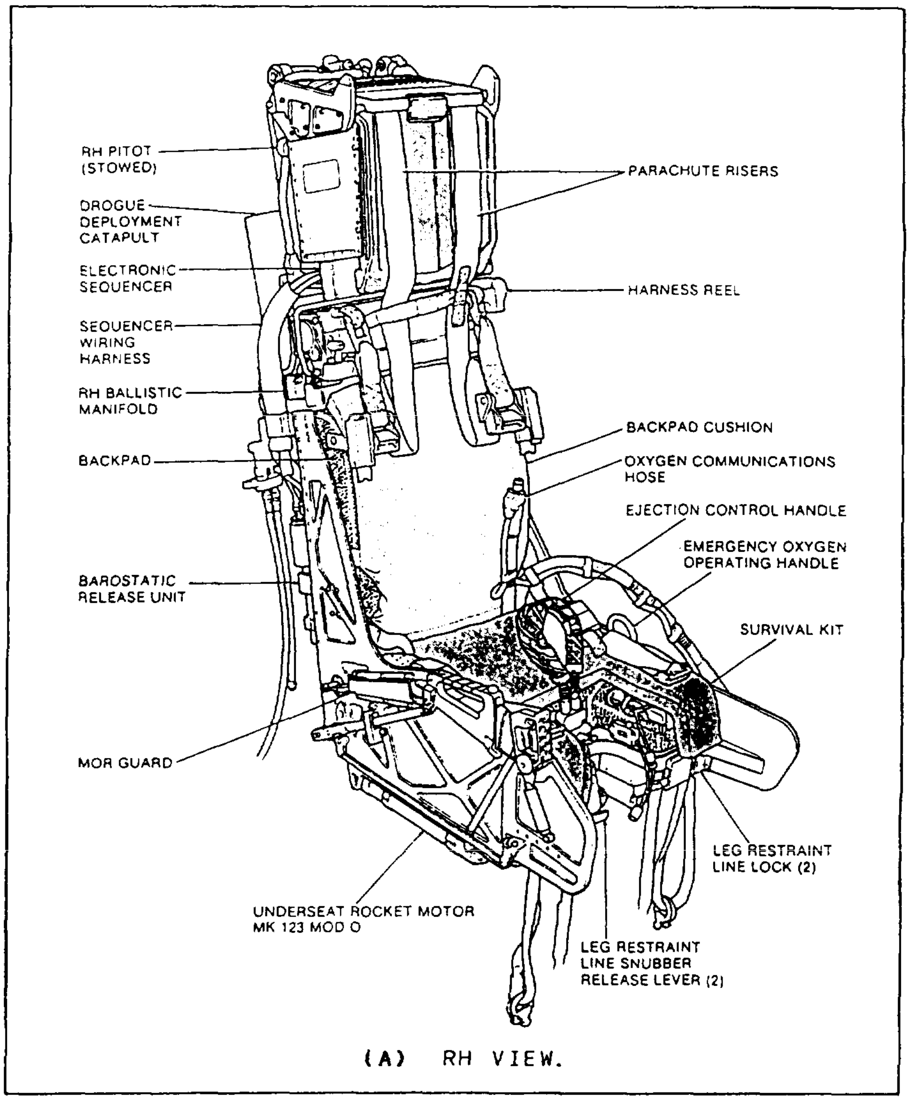


Figure 5-1.-Forward ejection seat; (A) right-hand view, (B) left-hand view.

Ejection control handle safety pins and safe/armed handles are provided to render the ejection seats safe when the aircraft is parked between flights and at all other times on the ground. The ejection control handle safety pins are removed by the aircrew before flight and installed by the plane captain after flight. Movement of the safe/armed handle is the responsibility of the aircrew.

Before entering the cockpit, personnel should ensure that the correct safety precautions have been applied.

The F/A-18 aircraft is equipped with a type SJU-17(V)1/A ejection seat. The F/A-18D aircraft is equipped with a type SJU-17(V)2/A and a type SJU-17(V)1 /A ejection seat installed in the forward and aft cockpits, respectively. The seats are interconnected by a command sequencing system. The two types of seat are essentially the same, but with differences to suit the two cockpit installations. For convenience, the description that follows applies equally to both ejection seats, except where noted. Where reference is made to the aft seat configuration on the F/A-18D, the description applies equally to the single seat (F/A-18C) installation.

All NACES seats incorporate fully automatic electronic sequencing and are cartridge operated and rocket assisted. Safe escape is provided for most combinations of aircraft altitude, speed, attitude, and flight path within the envelope of

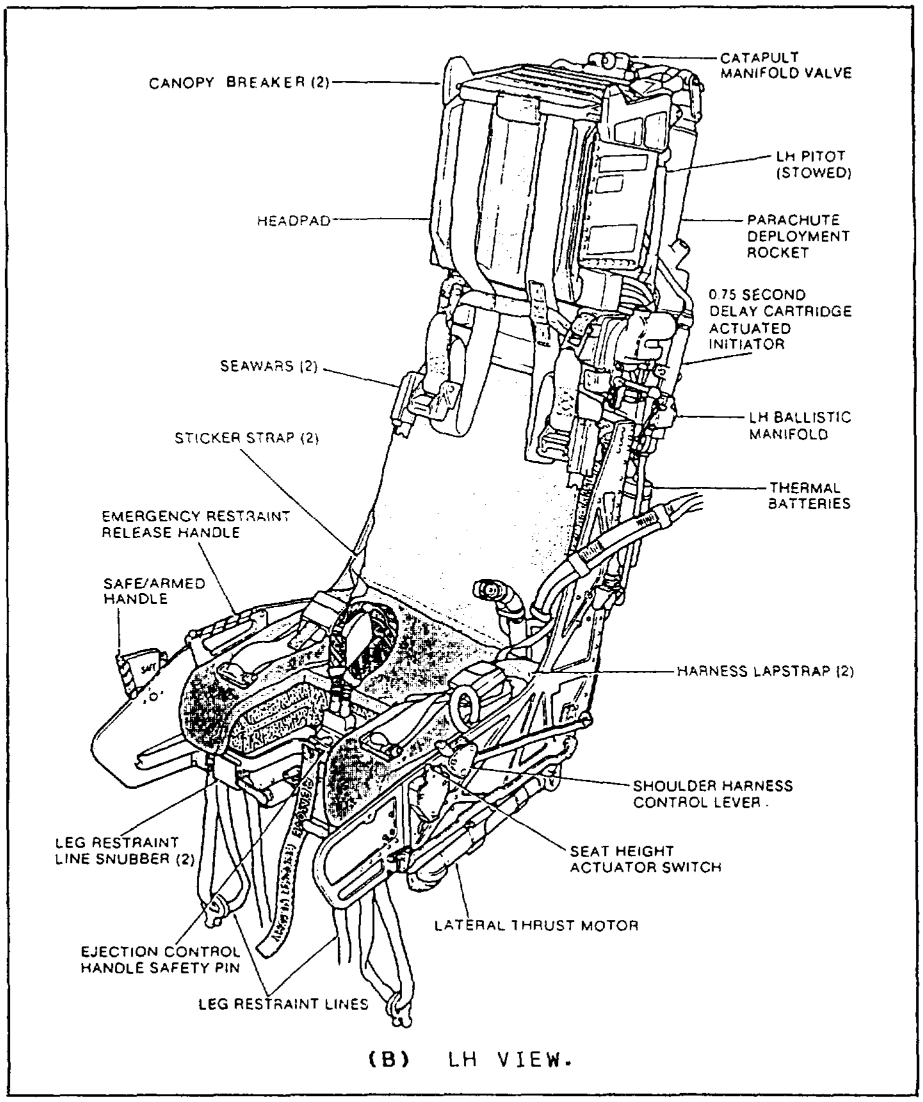


Figure 5-1.-Forward ejection seat; (A) right-hand view, (B) left-hand view—Continued.

zero speed, zero altitude in a substantially level attitude to a maximum speed of 600 knots estimated air speed (KEAS) between zero altitude and 50,000 feet.

Ejection is initiated by pulling a seat firing handle situated on the front of the seat bucket between the occupant's thighs. The parachute container is fitted with canopy breakers to enable the seat to eject through the canopy should the jettison system fail. After ejection, drogue deployment, man/seat separation, and parachute deployment are automatically controlled by an onboard multimode electronic sequencer. A barostatic harness release unit caters for partial or total failure of the electronic sequencer, and an emergency restraint release (manual override) system provides a further backup in the event of failure of the barostatic release.

The seat is ejected by action of the gas pressure developed within a telescopic catapult when the cartridges are ignited. An underseat rocket motor situated under the seat bucket is fired as the catapult reaches the end of its stroke, and sustains the thrust of the catapult to carry the seat to a height sufficient to enable the parachute to deploy even though ejection is initiated at zero speed, zero altitude in a substantially level attitude. The seat is stabilized and the forward speed retarded by a drogue and bridle system, followed by automatic deployment of the personnel parachute and separation of the occupant from the seat. Timing of all events after rocket motor initiation is controlled by the electronic sequencer, which uses altitude and airspeed information to select the correct mode of operation.

PHYSICAL DESCRIPTION

Each ejection seat, as installed in the aircraft, consists of five main assemblies. Each assembly is briefly described in the following paragraphs: (See figure 5-2.)

1. The catapult assembly is the means by which the ejection seat is secured to the aircraft structure during normal flight, and provides the initial force necessary to eject the seat from the aircraft during emergency conditions. The catapult assembly includes the barrel, ballistic latches, the piston, and the catapult manifold valve.

2. The main beams assembly includes the top and bottom crossbeams, top latch assembly, shoulder harness control handle, parachute deployment rocket motor, electronic sequencer, barostatic release unit, drogue deployment catapult, two multipurpose initiators, time-delay mechanism, two pitot assemblies, two ballistic manifolds, and two thermal batteries.

3. The seat bucket assembly includes the underseat rocket motor, lateral thrust motor, ejection control handle, safe/armed handle, leg restraint snubbers, emergency restraint release handle, shoulder harness control lever, seat height actuator switch, pin puller, and lower harness release mechanism.

4. The parachute assembly includes the parachute container and parachute canopy and drogue.

5. The seat survival kit assembly includes the lid assembly, emergency oxygen system, radio locator beacon, and rucksack assembly.

Catapult Assembly

The catapult assembly (figs. 5-3 and 5-4) secures the ejection seat to the aircraft structure

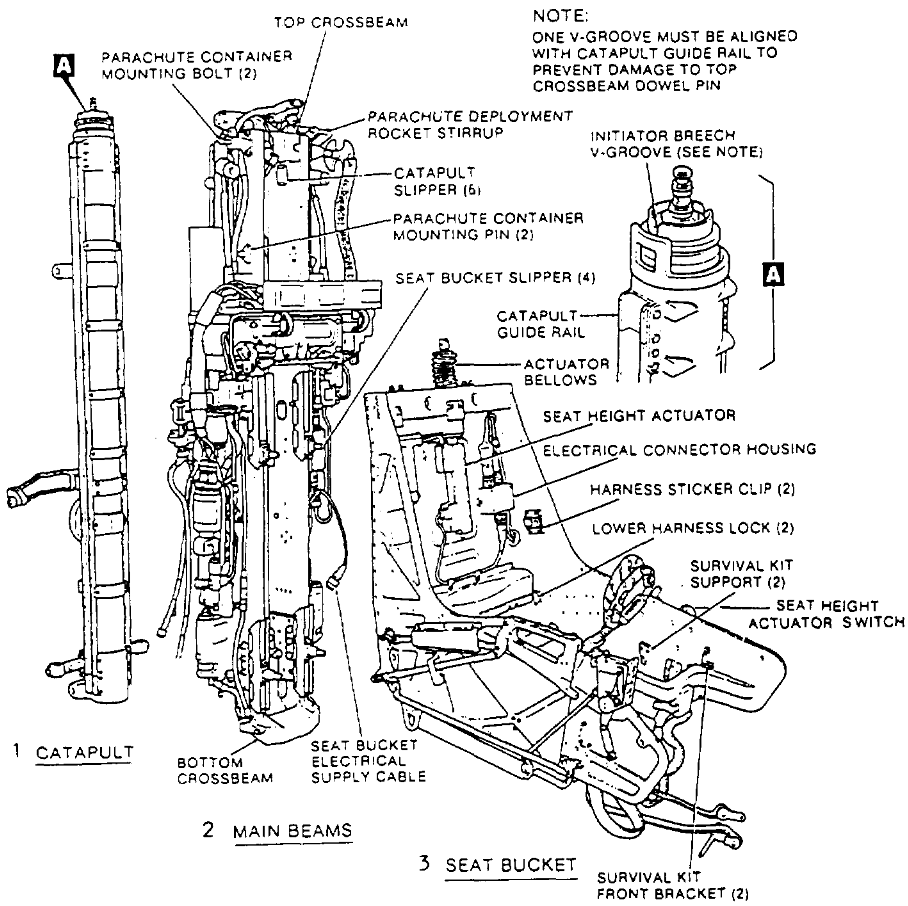


Figure 5-2.-Forward ejection seat main assemblies.

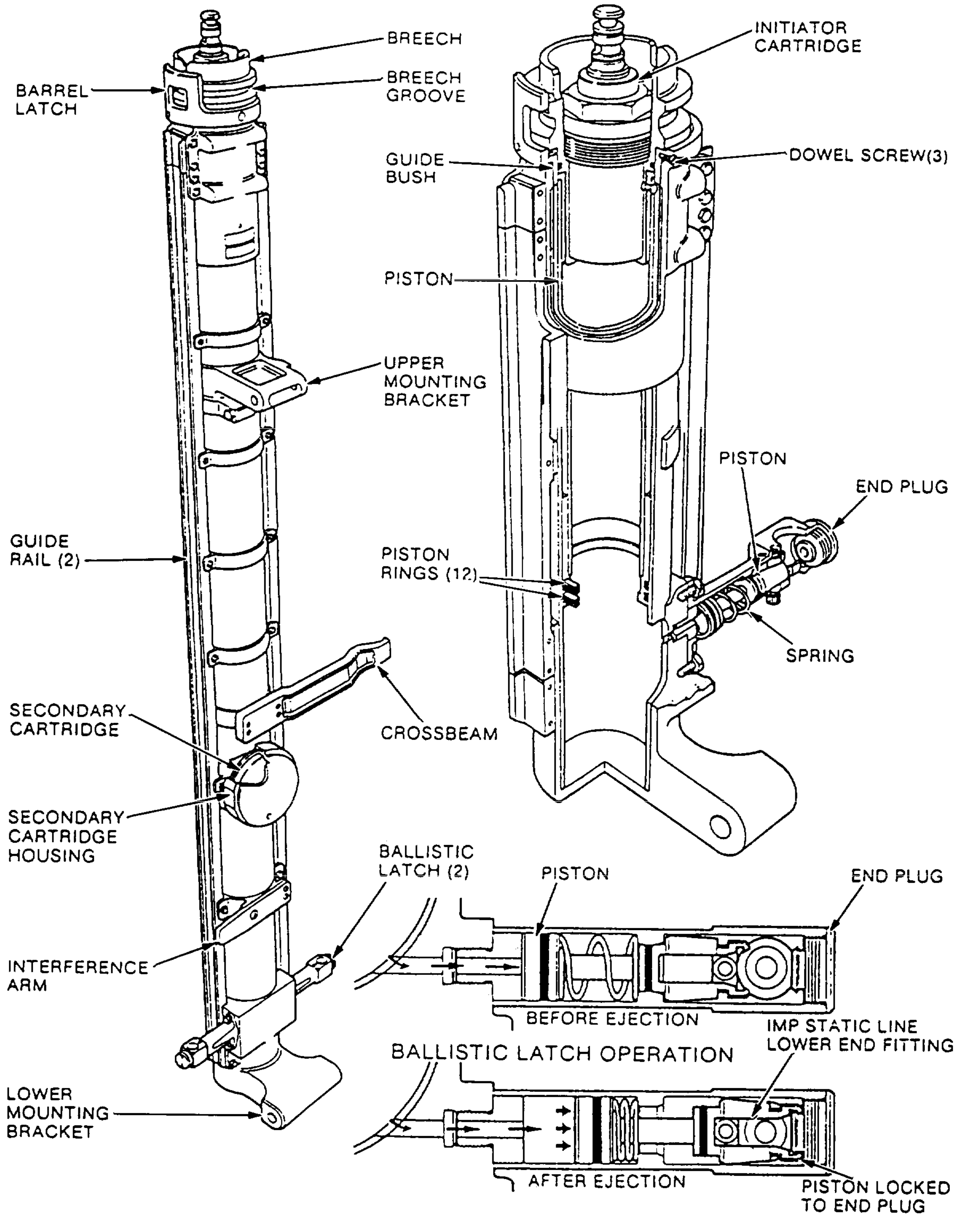


Figure 5-3.-Catapult assembly, forward seat.

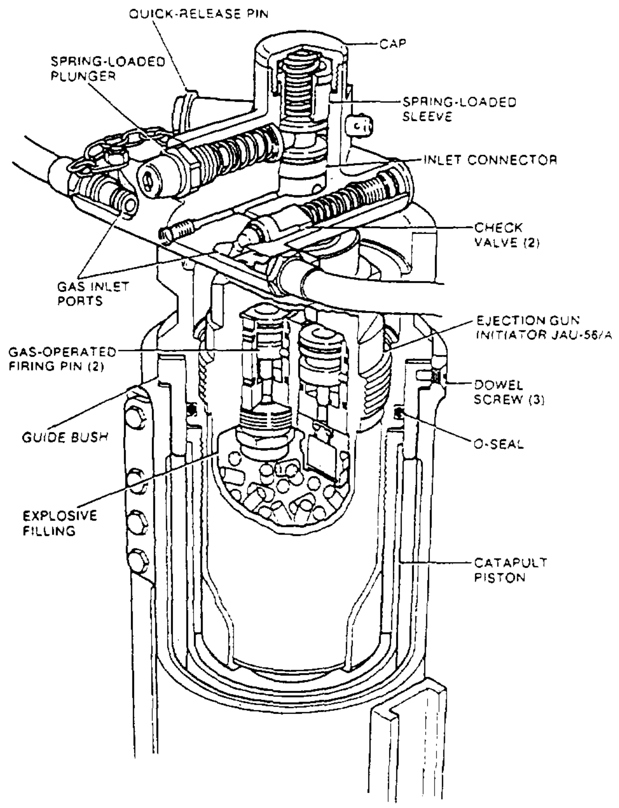


Figure 5-4.-Ejection gun initiator (JAU-56/A) and catapult manifold valve.

and provides the initial power for the ejection of the seat. The catapult consists of an outer barrel and an inner telescopic piston. The barrel is attached to the aircraft structure, and the piston and barrel are engaged at the top end by the top latch plunger installed in the main beams assembly.

The catapult assembly is operated by explosive charges. Assembly operation is discussed later in this chapter.

BARREL.— The barrel is a built-up structure consisting of a light alloy tube to which are permanently attached top and bottom end fittings. A housing situated towards the bottom end contains the secondary cartridge. Five brackets support two guide rails bolted on the outboard sides of the tube. The bottom end fitting incorporates the lower mounting bracket for attaching the catapult to the aircraft and studs for attachment of the ballistic latches.

The upper mounting consists of a bracket clamped on the barrel towards the upper end. It incorporates an interference shoulder on one side to ensure location of the catapult in the correct cockpit (fig. 5-5). An interference arm mounted on one of the guide rail brackets ensures that the correct main beams assembly is installed. A crossbeam secured to the barrel provides an anchorage point for the RH ballistic manifold quick-disconnect lanyard. The top end fitting of the barrel has a square aperture, the barrel latch, through which the plunger of the top latch mechanism fitted on the seat main beam protrudes when the seat is installed on the catapult. A guide bushing, fitted in the internal diameter of the top end fitting, is secured by three dowel screws; at the end of the catapult stroke, the dowel screws are sheared by the head of the piston striking the guide bushing. The piston then separates from the barrel, and the guide bushing remains on the piston (fig. 5-3).

BALLISTIC LATCHES.— Two ballistic latches are attached to the bottom end fitting by studs and nuts. Each latch comprises a body, which is internally drilled to form a cylinder and contains a spring-loaded piston. When operated during the ejection sequence, gas pressure from within the catapult acts on the latch pistons,

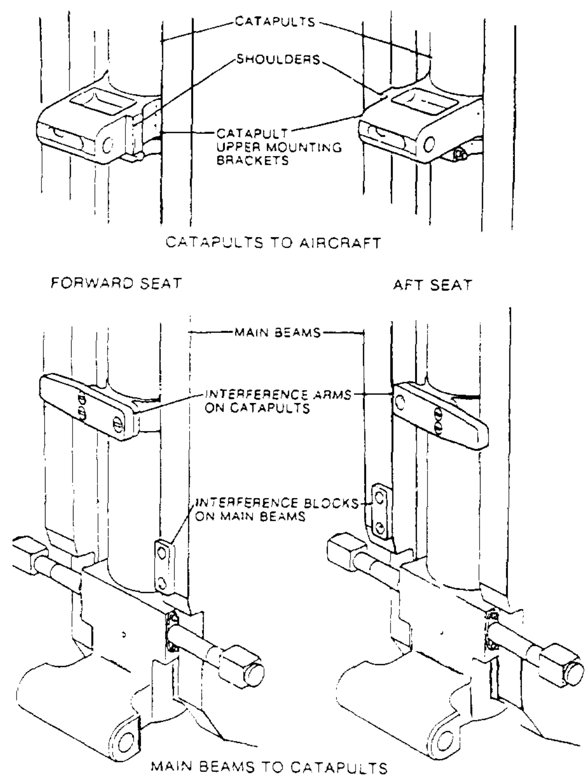


Figure 5-5.-Interference devices, forward and aft seats.

overcoming the springs and retaining the multipurpose initiator lanyard spigots (fig. 5-3).

PISTON.— The piston consists of a light alloy tube, attached to the lower end of which is a necked end fitted with piston rings to provide a gas seal between the piston and the barrel. At the upper end of the piston is a breech, into which the cartridge-activated initiator is inserted. The breech has a groove machined around its outer diameter, into which the plunger of the top latch mechanism on the seat main beams engages when the seat is installed on the catapult. A V-groove in the top of the breech engages a dowel on the seat top crossbeam when the seat is installed in the aircraft (fig. 5-3).

CATAPULT MANIFOLD VALVE.— The catapult manifold valve provides an interface between the ejection seat and the catapult. The catapult manifold valve is mounted on the top of the catapult. The valve is locked onto the cartridge-activated initiator by a spring-loaded plunger and a retaining pin. The valve contains two inlet ports that connect the hoses from the time delays.

Main Beams Assembly

The main beams assembly is manufactured almost entirely from light alloy and comprises two parallel main beams bridged by top and bottom crossbeams. Bolted to the inside face of each main beam are three slippers, which engage in the guide rails on the catapult. Two-seat bucket runner guides are attached to the front face of each main beam and accommodate the top and bottom seat bucket slippers. The slippers provide smooth movement of the seat bucket and incorporate threaded studs for attachment of the seat bucket to the main beams. Friction pads are incorporated in the studs to damp out lateral movement of the seat bucket. Drogue bridle retaining channels are secured to the rear of both main beams. Locating pins for the parachute container hooked brackets are bolted to the upper outside face of each main beam. Interference blocks on the right-hand (RH) beam (forward seat) or left-hand (LH) beam (aft seat) correspond with interference devices on the catapult and the seat bucket to ensure that only the correct assemblies are installed in forward and aft cockpits.

TOP CROSSBEAM.— The top crossbeam accepts and locates the top of the catapult, and takes the full thrust of the catapult during ejection. Incorporated into the crossbeam is the upper drogue bridle release unit. A dowel in the top crossbeam locates in one of the catapult breech V-grooves when the seat is installed in the aircraft.

BOTTOM CROSSBEAM.— The bottom crossbeam retains and separates the main beams at the bottom end. Incorporated into the crossbeam is a gas passage that forms part of the drogue bridle release system.

TOP LATCH ASSEMBLY.— The seat structure is secured to the catapult by the top latch assembly (fig. 5-6) fitted to the LH main beam. The assembly consists of a housing that contains a spring-loaded latch plunger, one end of which is shaped to engage the catapult piston. The plunger may be withdrawn by using the top latch withdrawal tool (handwheel). Passing through the center of the latch plunger is a spring-loaded indicator plunger. When the ejection seat is fitted

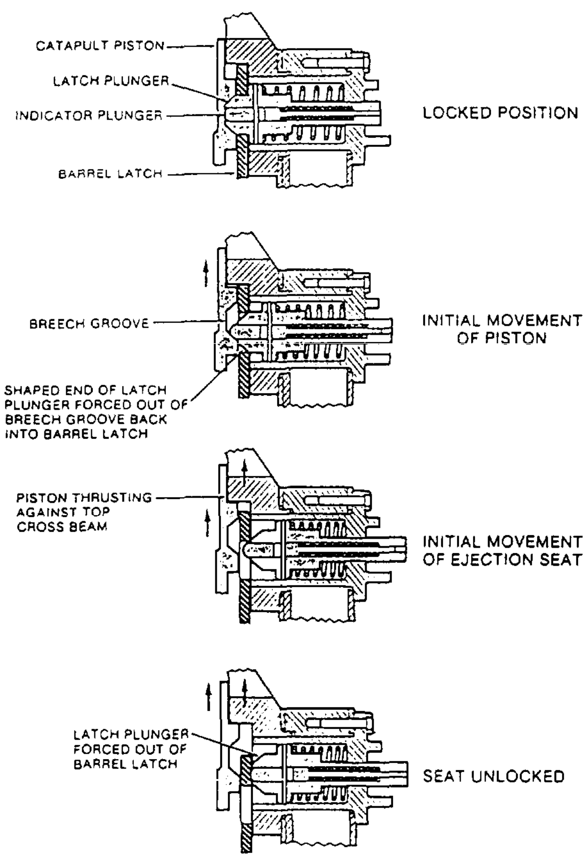


Figure 5-6.-Operation of top latch assembly.

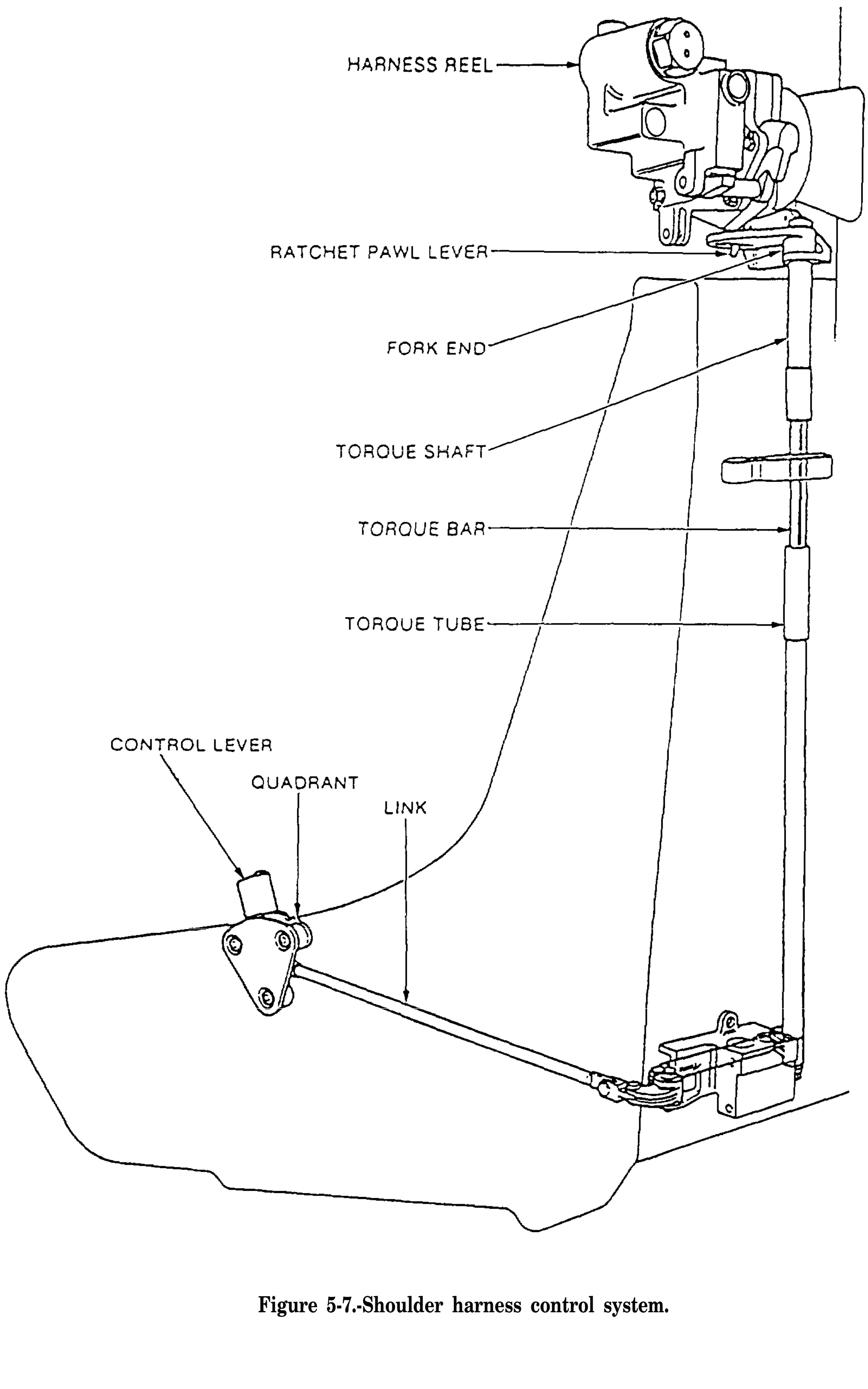


Figure 5-7.-Shoulder harness control system.

to the catapult and the handwheel removed, the latch plunger passes through the top crossbeam and engages with the barrel latch. The shaped end of the plunger protrudes still further to engage the groove of the catapult piston.

SHOULDER HARNESS CONTROL HANDLE.— The shoulder harness control handle (fig. 5-7) is located on the left side of the seat bucket. The handle is connected to the inertia reel. In the aft position, the reel is allowed to rotate freely. When the forward position is selected, straps will ratchet in, allowing no forward movement.

SHOULDER HARNESS REEL.— The shoulder harness reel (fig. 5-8, view A) is fitted horizontally across the front faces of the main beams and serves as a center crossbeam for the main beams assembly, as well as a means of securing the upper harness. It ensures that the occupant will be brought to, and locked in, the correct posture for ejection. For normal flight operations, the shoulder harness is free to extend and retract as the occupant moves in the ejection seat. The shoulder harness control lever on the LH side of the seat bucket can be moved to the forward (locked) position, which will permit the

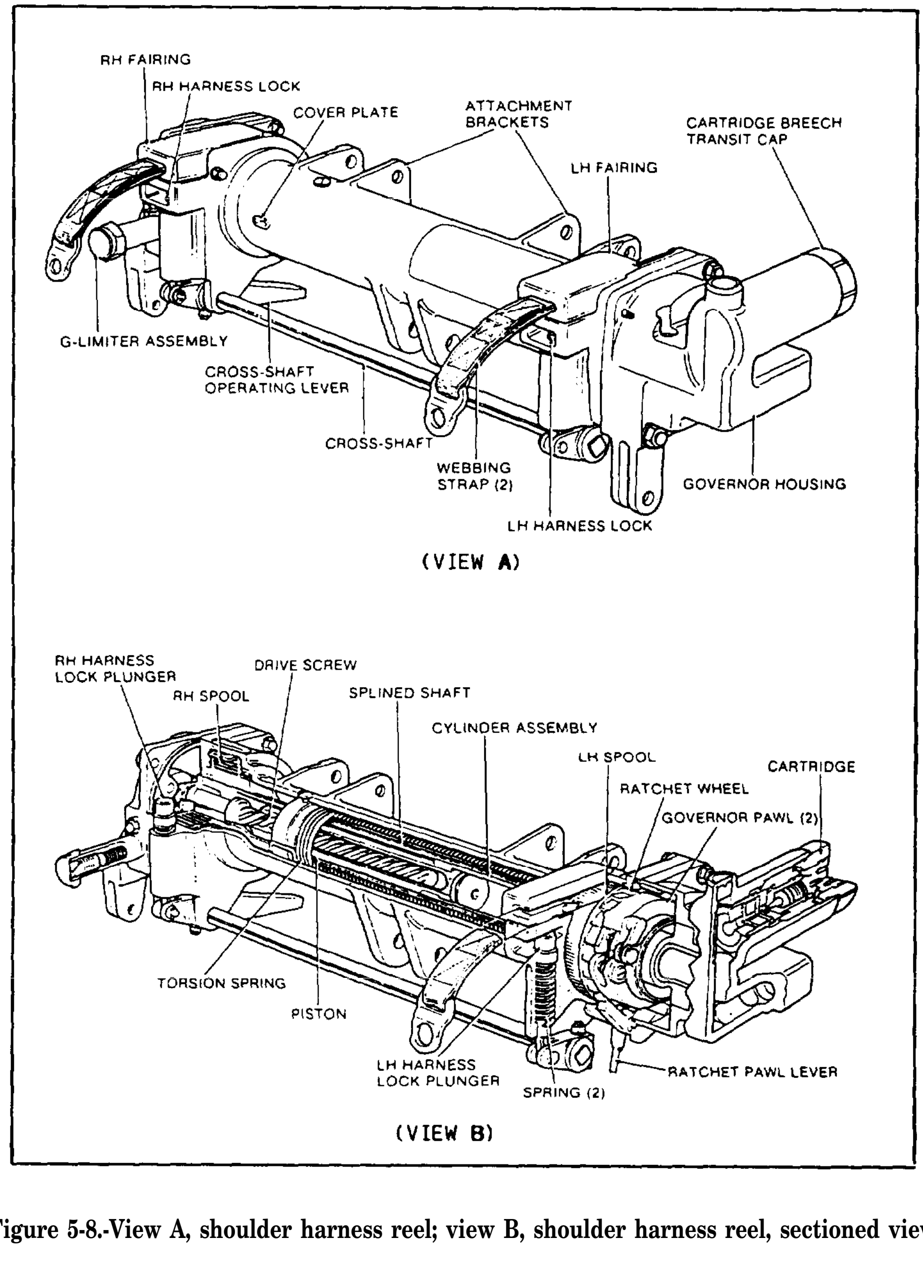


Figure 5-8.-View A, shoulder harness reel; view B, shoulder harness reel, sectioned view.

harness straps to retract but prevent them from extending. When in the normal unlocked state, automatic locks protect the occupant against rapid forward movement under high g-loading.

PARACHUTE DEPLOYMENT ROCKET MOTOR MK 122 MOD 0.— The parachute deployment rocket motor (PDRM) (fig. 5-9) is mounted on the LH main beam of the seat. When initiated by the sequencer, restraint release unit, or manual override (MOR) system, the PDRM extracts the personnel parachute from its stowage by means of a withdrawal line attached to the deployment sleeve.

The PDRM is a sealed unit. It consists of a cylindrical body that contains a gas-operated secondary cartridge in a breech at the lower end and a rocket with an integral gas-operated igniter cartridge in a barrel at the upper end. In a parallel connected chamber is an electrically initiated primary cartridge. A gas inlet is connected by a gas pipe to the harness release system.

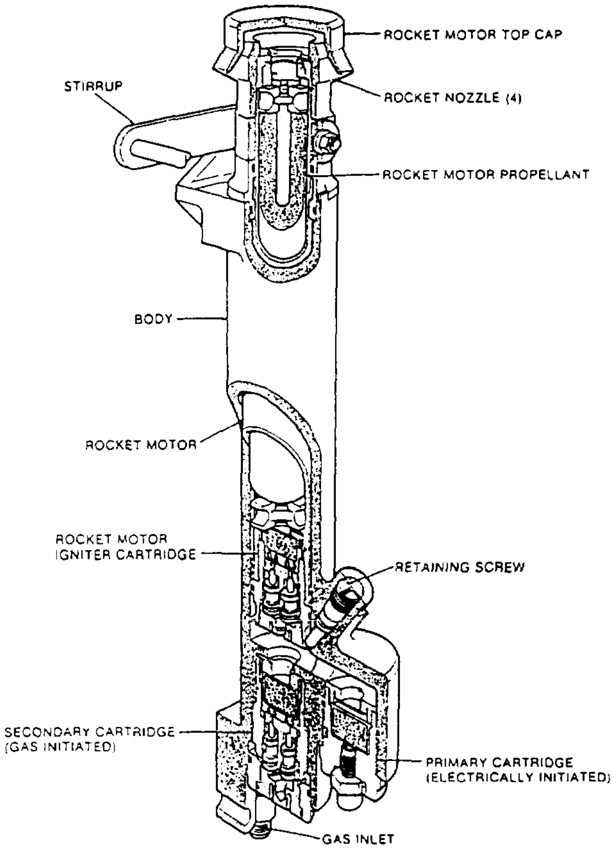


Figure 5-9.-Parachute deployment rocket motor (Mk 122 Mod 0).

Fitted around the rocket is a sliding stirrup, which is connected to the parachute withdrawal line and is free to slide down the rocket as it leaves the barrel.

ELECTRONIC SEQUENCER.— The NACES sequencer assembly (fig. 5-10) is composed of the sequencer, connectors to the interface with pitot static and dynamic pressure sources, and cable loom sleeving. It is mounted across the main beam assembly, below the parachute assembly. Upon activation, the sequencer determines the ejection mode and controls the functions of the drogue release, parachute deployment, and seat/man separation.

BAROSTATIC RELEASE UNIT (BRU).— The barostatic release unit (fig. 5-11) provides a housing for the cartridge that provides the gas flow to initiate harness release and parachute rocket deployment. The cartridge is activated either electrically by the sequencer or by the right-hand start switch (via the delay mechanism). The cartridge incorporates an aneroid capsule to prevent mechanical initiation above a preset altitude. The cartridge may also be initiated by operation of the MOR handle after ejection.

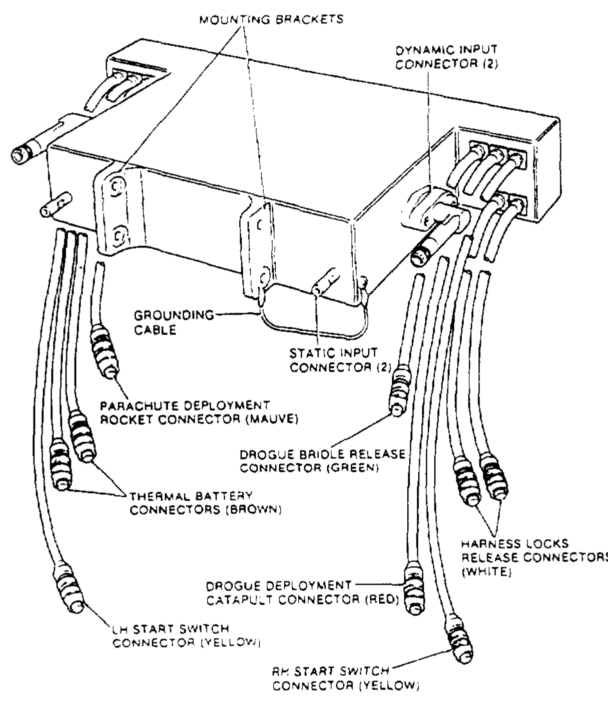


Figure 5-10.-Electronic sequencer.

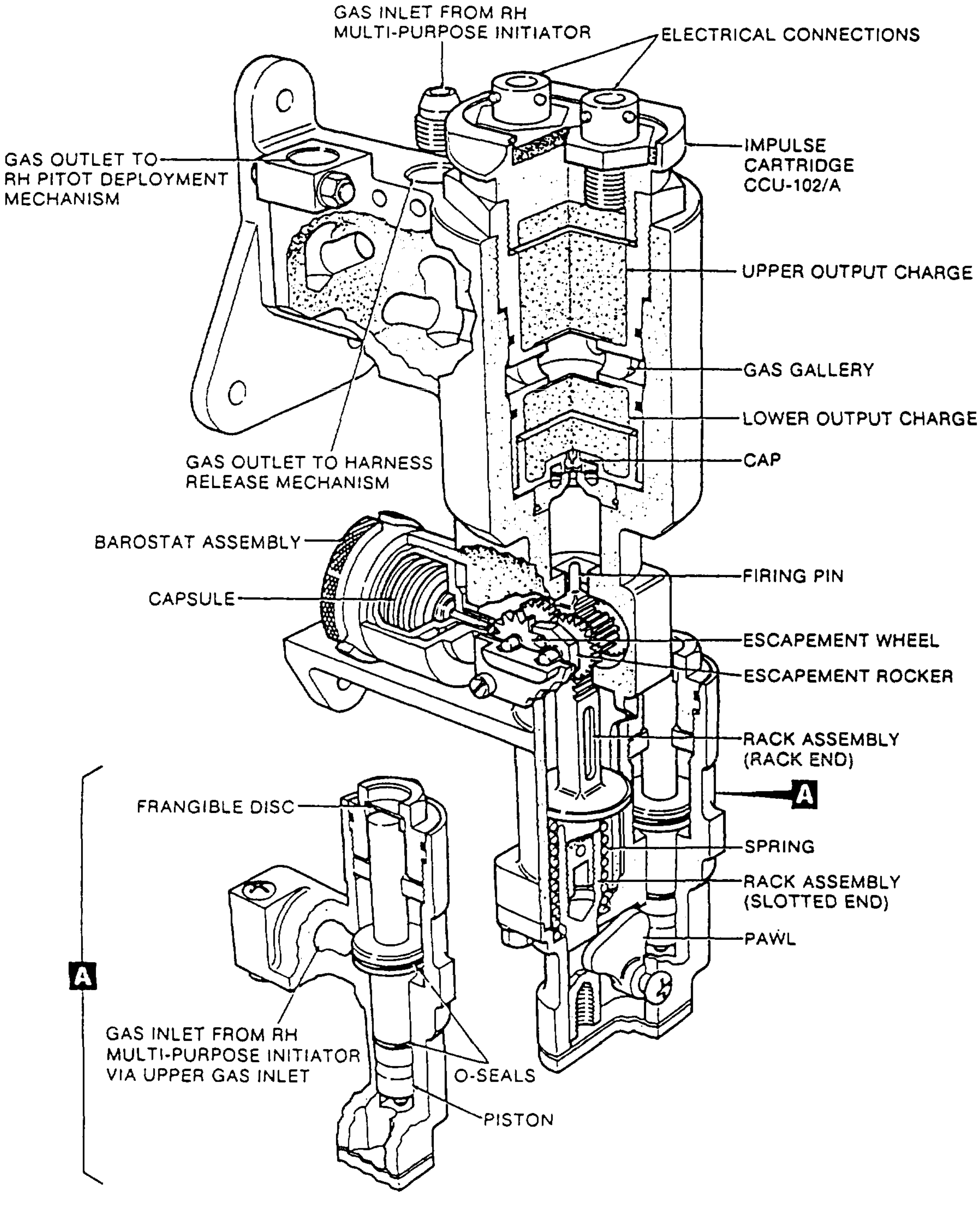


Figure 5-11.-Barostatic release unit.

Barostat Assembly.— The barostat consists of an aneroid capsule in a housing that is screwed into the release unit in a position that allows a peg attached to the capsule to engage a star wheel in the delay mechanism. At altitudes in excess of the barostat rating, the peg engages the star wheel and prevents the delay mechanism from operating. As altitude decreases, the capsule peg retracts and allows the mechanism to function.

Impulse Cartridge.— The impulse cartridge (CCU-102/A) provides the gas necessary for the functions of the restraint release assembly.

DROGUE DEPLOYMENT CATAPULT.— The drogue deployment catapult (fig. 5-12) is mounted outboard of the RH main beam of the ejection seat. Its function is to deploy the stabilization drogue and bridle assembly rapidly without becoming entangled with the seat. The firing of the drogue deployment catapult is controlled by the electronic sequencer to ensure that the seat has cleared the aircraft before the drogue is deployed. The drogue deployment catapult consists of a cylindrical body containing an electrically operated impulse cartridge (CCU-101/A), a two-piece telescopic piston assembly, and an enlarged upper end, into which is fitted a drogue and canister assembly.

The drogue and canister assembly contains a 1.45mm (57-inch) diameter ribbon drogue, pressure packed into a 210mm (8.25-inch) long light alloy cylinder, closed at the upper end. The canister assembly is closed by an end cap attached to the drogue strap. At the lower end of the end cap, a link assembly is attached by the same bolt that secures the drogue strap. When installed on the ejection seat, the link assembly attaches to the drogue bridle, and the canister assembly is retained in the body by a threaded locking ring. At the upper end of the catapult body is riveted a threaded ring on to which the locking ring is screwed when installing the drogue canister.

MULTIPURPOSE INITIATORS.— Two multipurpose initiators (IMP) (fig. 5-13) are attached to the lower outer faces of the seat's main beams. During the ejection sequence, the IMPs supply gas pressure to operate the barostatic release unit delay mechanism, the underseat rocket motor, the pitot deployment mechanisms, and the internally mounted start switch assemblies.

Each IMP comprises a body, machined and drilled to accept a start switch, a static lanyard

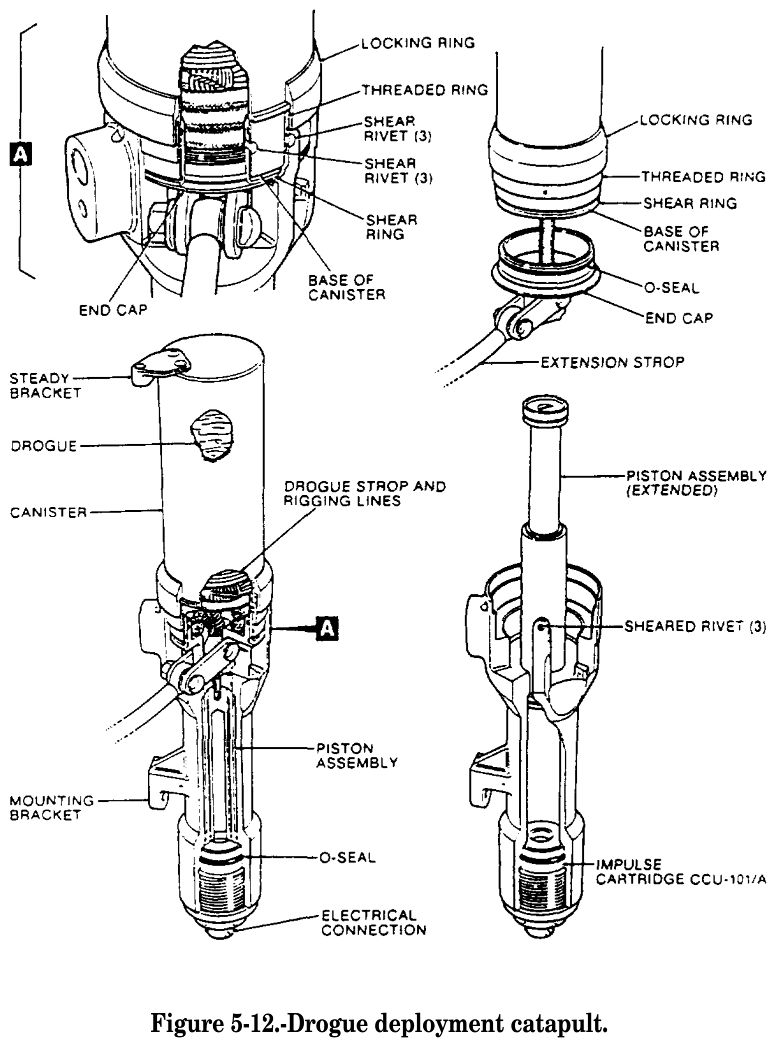


Figure 5-12.-Drogue deployment catapult.

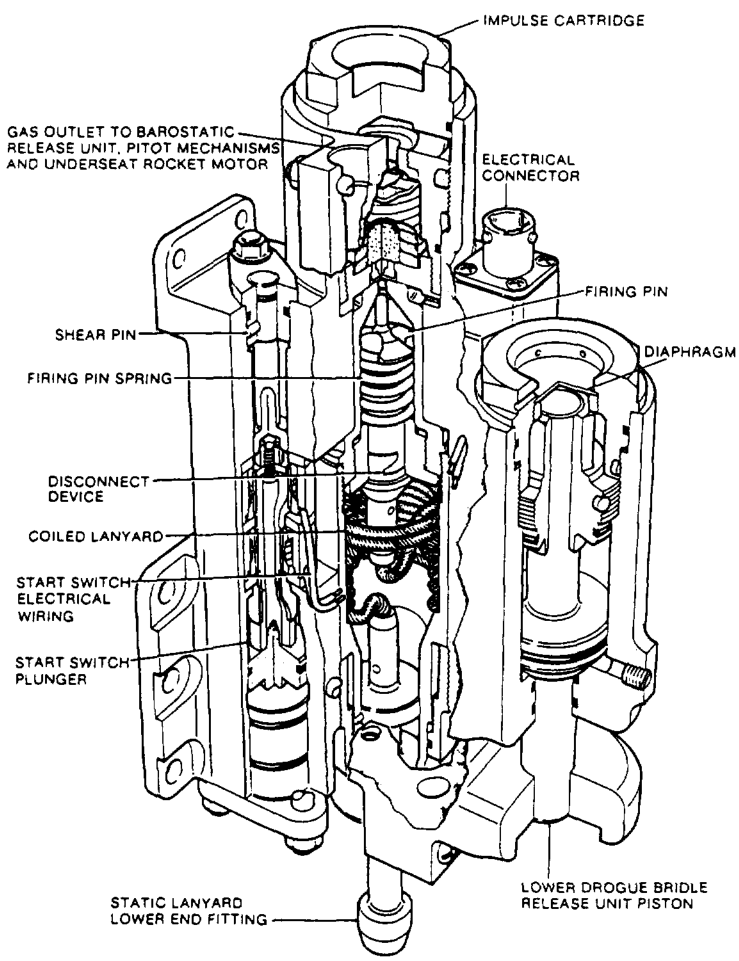


Figure 5-13.-Multipurpose initiator, left-hand.

assembly, a spring-loaded firing pin, and an impulse cartridge. A gas passage through the unit body connects the cartridge breech to the lower end of the start switch plunger. Incorporated into the unit body, but mechanically separate, is a lower drogue bridle release unit.

The static lanyard assembly comprises a lanyard, precoiled into a cylindrical container and with special fittings swaged on to each end. The upper end fitting incorporates a wedge-shaped disconnect device, which engages with the lower end (similarly wedge-shaped) of a spring-loaded firing pin positioned below the cartridge. The lower end fitting protrudes through the lower end of the body and is retained by a shear pin. When the seat is installed on a catapult, the protruding lower end fitting locates in one of the catapult-mounted ballistic latches.

The start switch assembly is installed vertically and comprises a series of metal sleeves and insulated sections to form an electrical switch assembly. An internal plunger is partially sleeved with insulating material, has a short gold-plated section, and incorporates a piston head at its lower end. Movement of the plunger before operation is prevented by a shear pin. Two start switch assemblies are incorporated into the multipurpose initiators. During ejection, the start switches supply a start signal to the sequencer at the correct time in the sequence.

The impulse cartridge is percussion operated by the firing pin and is screwed into a breech at the upper end of the body. A gas gallery machined in the upper part of the cartridge ensures even distribution of gas pressure when the cartridge fires.

TIME-DELAY MECHANISM.— The time-delay mechanism consists of a spring-loaded rack assembly in mesh with a gear train controlled by

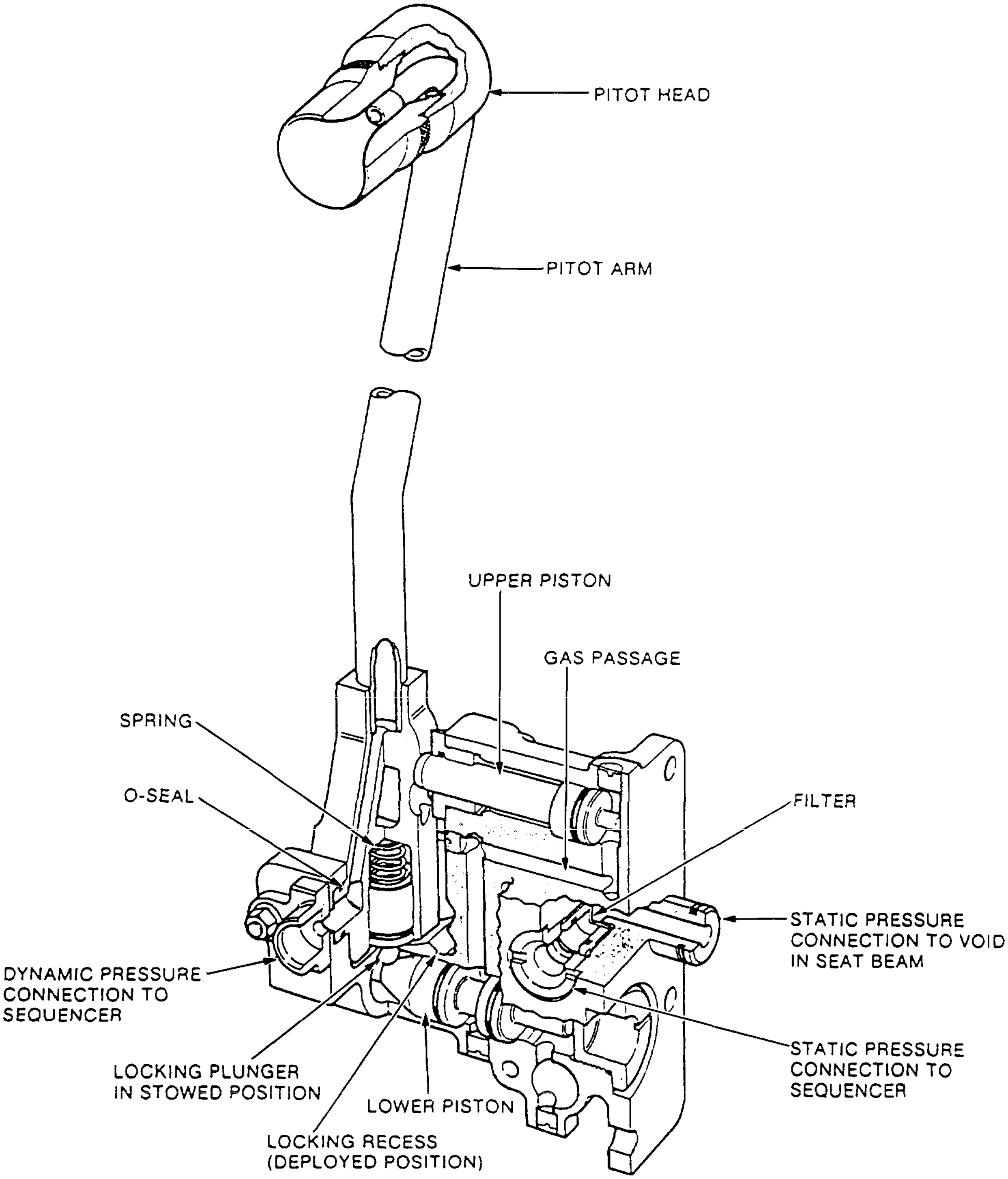


Figure 5-14.-Pitot assembly, right-hand.

an escapement. The gear train consists of a primary spur and pinion, a secondary spur and pinion, an idler wheel, an escapement wheel and an escapement rocker.

The rack assembly consists of a rack end screwed into a slotted end. The two components are secured together with a locking screw. The upper end of the rack end is shaped to form a firing pin.

To retain the rack in the cocked position, one face of a pawl in the bottom housing engages in the slotted end of the rack assembly. Another face of the pawl engages in a groove in a gas-operated piston installed in a housing attached to the lower part of the unit body. The piston is retained in position by a frangible disc.

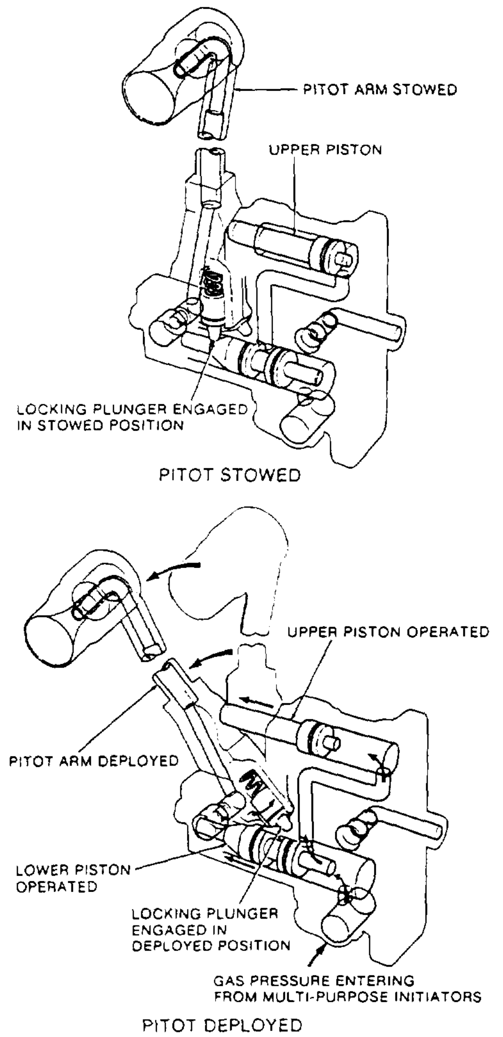


Figure 5-15.-Pitot assembly, operation.

PITOT ASSEMBLIES— Two pitot assemblies (figs. 5-14 and 5-15) incorporating deployable pitot heads are mounted on the main beams behind the parachute container. Removable covers are provided to prevent entry of foreign bodies,

The pitot heads are maintained in the stowed position by locking mechanisms that are released during seat ejection, as the seat separates from the catapult, by gas pressure from the multipurpose initiator cartridges. When deployed, the pitot head assemblies supply dynamic pressure inputs to the electronic sequencer. Static (base) pressure is supplied to the sequencer from the voids within the LH and RH main beams.

Each pitot assembly comprises a body, drilled and plugged to form a series of gas passages, and two cylinders containing upper and lower pistons. A deployable pitot arm incorporating a pitot head is attached to the aft face of a bracket, forming part of the body. Attached to the forward face of the bracket is a pitot connector that is connected to the pitot head. A spring-loaded locking plunger, which locates in one of two holes in the body, is installed inside the lower end of the pitot arm. The locking plunger locks the pitot arm in the stowed or deployed positions. A separate passage in the body, incorporating connectors at each end and a filter, forms part of the static pressure supply system for the sequencer.

BALLISTIC MANIFOLDS.— There are two ballistic manifold assemblies-right-hand and left-hand.

Manifold Assembly Right-Hand.— The right-hand (RH) assembly is a gas distribution center that is connected to the seat bucket trombone tubes and incorporates the upper harness release piston, the ejection gas line quick disconnect, and a housing for the bridle release cartridge. The assembly also provides a mounting for a delay cartridge. The drogue bridle release impulse cartridge is installed in a threaded housing on the upper face. The upper harness release piston protrudes from the manifold upper face.

The lower face of the RH ballistic manifold (fig. 5-16) has four connectors. Two of these connectors accommodate the RH seat initiation trombone tube (outboard) and the harness locks to release the trombone tube (inboard). The connections are secured by a key-operated, quick-release pin that passes through a hole in the manifold and cutouts in the trombone tubes. The other two connectors accommodate the gas pipe from the barostatic release unit and the gas pipe to the lower drogue bridle release mechanisms.

Manifold Assembly Left-Hand.— The left-hand (LH) assembly is a gas distribution center that is connected to the seat bucket trombone tubes and houses a seat rocket initiation system check valve. The assembly also provides a mounting for a delay cartridge.

The upper face of the LH ballistic manifold (fig. 5-17) has three socket connectors, to which are connected a flexible hose to the LH pitot deployment mechanism, a rigid pipe from the RH multipurpose initiator, and a delay initiator.

The lower face of the LH ballistic manifold has three socket connectors. Two of these connectors accommodate the LH seat initiation trombone tube (outboard) and the underseat rocket motor trombone tube (inboard). The other connector accommodates a gas pipe to the thermal batteries. A bracket on the front face of the manifold accommodates the shoulder harness control mechanism torque shaft. A connection on the aft face accepts a gas pipe from the LH multipurpose initiator.

THERMAL BATTERIES.— Two thermal batteries (fig. 5-18) supplying power for sequencer operation are mounted together in a manifold on the LH main beam.

Seat Bucket Assembly

The seat bucket assembly (fig. 5-19) fits onto the lower portion of the main beams and

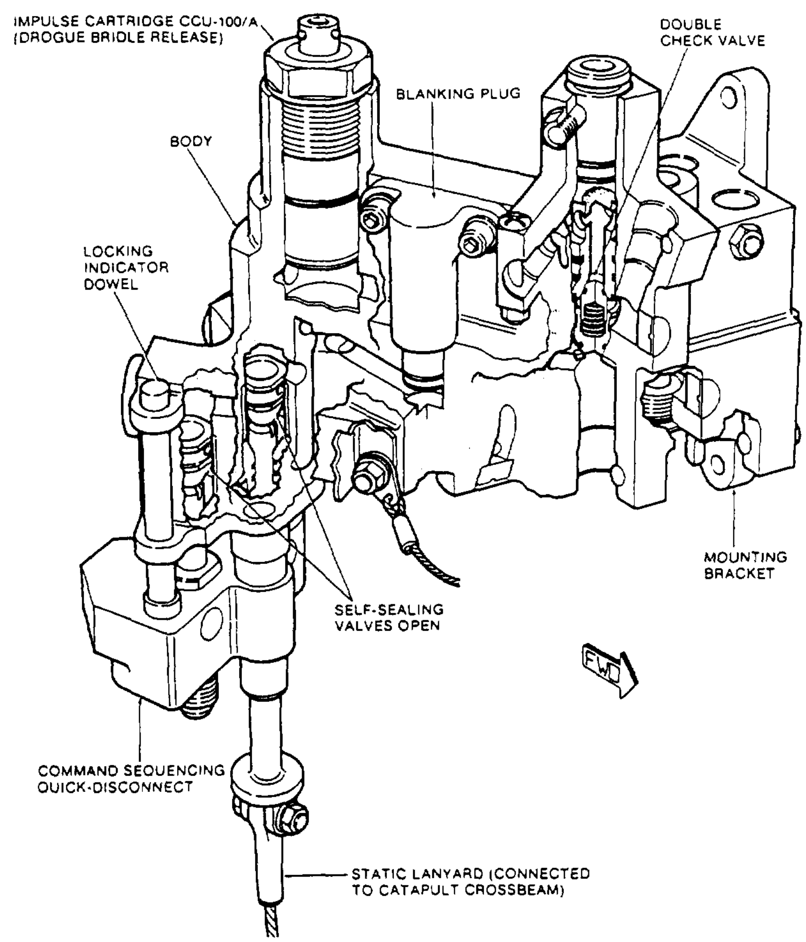


Figure 5-16.-Right-hand ballistic manifold.

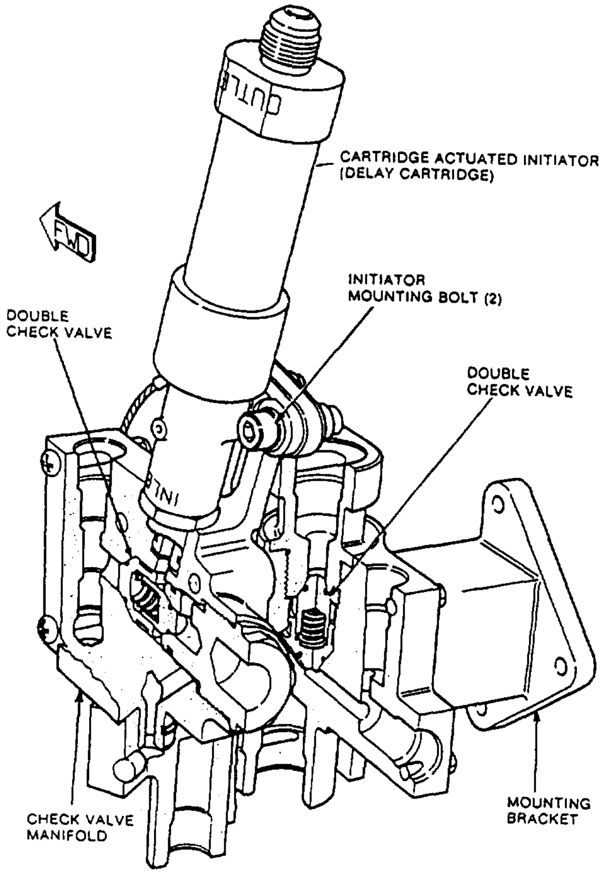


Figure 5-17.-Left-hand ballistic manifold, (F/A-18D).

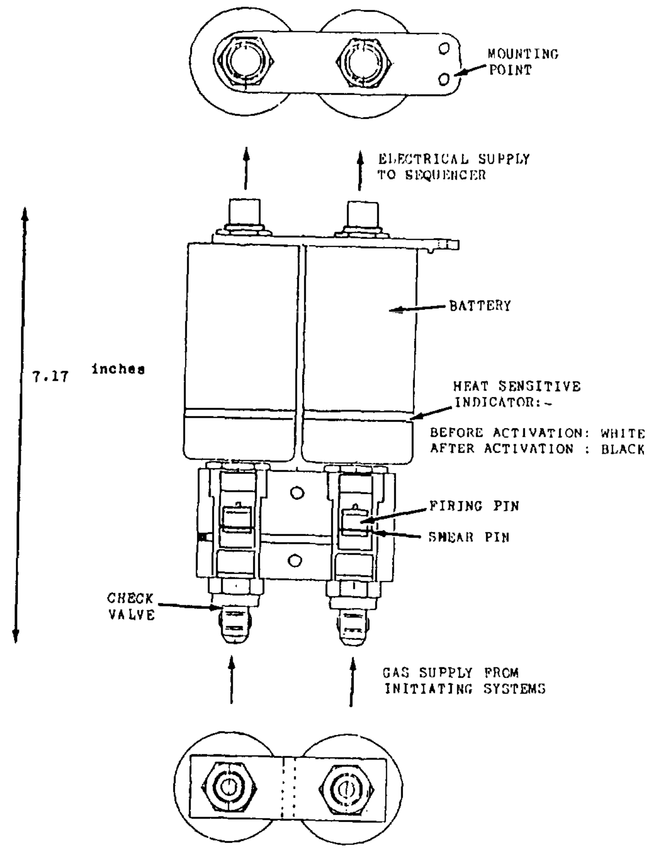


Figure 5-18.-Thermal battery assembly.

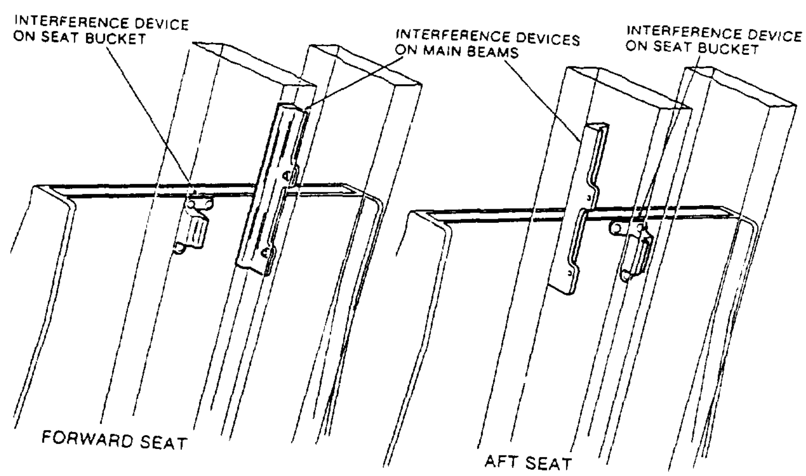


Figure 5-19.-Seat buckets to main beams.

mechanisms and provides a mounting for the survival kit assembly, rocket motor, and backpad assembly. The seat bucket assembly is configured for a particular seat by adding application-peculiar components, such as a seat height actuator. The bucket is secured by four nuts to studs incorporated into sliding runners on the seat's main beams. Interference devices on the rear of the seat bucket and on the main beams assembly ensure that only the correct seat bucket is installed in forward and aft cockpits.

The back of the seat bucket contains a rigid, molded pad that forms the back rest. It is contoured so that when the seat occupant is automatically pulled back by the shoulder harness reel when ejection is initiated, he/she assumes the correct posture. A cushion attached to the backrest provides additional comfort for the seat occupant.

Contained within the lower rear corners of the seat bucket are the lower harness locks and release mechanism. These are connected by a cross shaft and connecting links to the leg restraint line locks located in the side plates. The same connecting links connect the negative-g strap lock that is situated in the floor of the seat bucket to the rear of the seat firing handle. Half way up the inner face of the seat bucket sides are sticker clips. The pin puller is mounted at the rear of the seat bucket on the lower right-hand side (fig. 5-2).

UNDERSEAT ROCKET MOTOR.— The underseat rocket motor (fig. 5-20) is a sealed unit and consists of a manifold (machined, drilled, and threaded to accept ten propellant tubes), a lateral thrust motor tube, a cartridge tube, and four efflux nozzles. The propellant tubes are

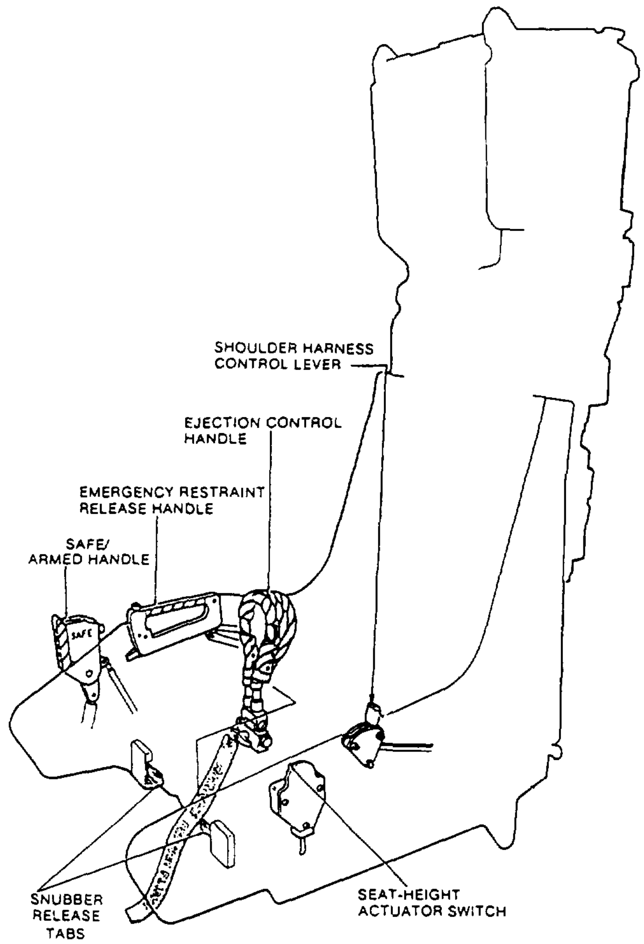


Figure 5-21.-Operating controls.

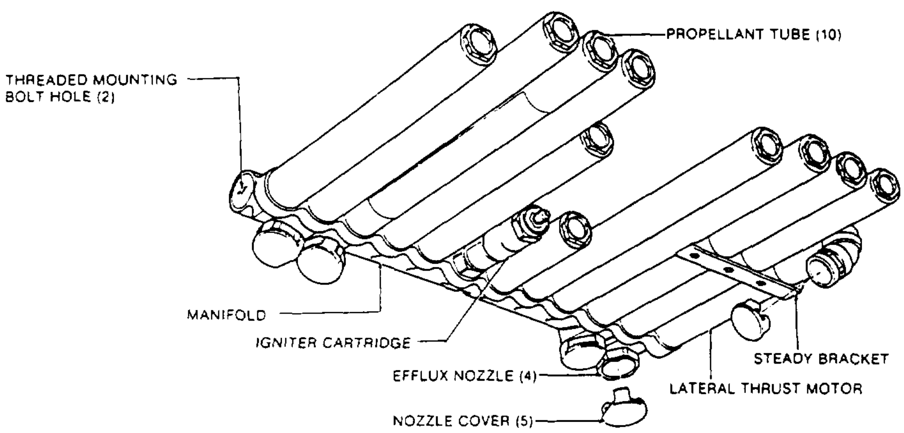


Figure 5-20.-Underseat rocket motor Mk 123 Mod 0 (forward seat).

manufactured from seamless steel. The tubes contain solid propellant drilled lengthwise through the center and having three equally spaced ribs to provide rapid and even burning. A cross-shape grid is positioned between the propellant and the manifold to ensure that the gas generated can pass unrestricted to the manifold. The cartridge tube is internally threaded to accept a gas-operated igniter cartridge incorporating twin firing pins and twin primers. A lateral thrust motor with an integral cartridge is screwed into the manifold at the LH end (forward seat) or RH end (aft seat). The efflux nozzles are fitted under the manifold and are sealed at the inner end by flanged blow-out discs, which cause a pressure build-up to ensure rapid and even burning of the propellant and an even thrust from the motor. Threaded holes in the manifold end plugs and a steady bracket clamped to the lateral thrust motor are used to secure the motor under the seat bucket, The threaded holes in the manifold end plugs vary in size between forward and aft seats to ensure location in the correct cockpit.

LATERAL THRUST MOTOR.— The lateral thrust motor (fig. 5-20) forms an integral part of the main rocket motor, being screwed into the manifold. An igniter cartridge is initiated by gas pressure from the rocket motor propellant and ignites the propellant in the lateral thrust motor to permit a divergent trajectory to the ejected seat.

EJECTION CONTROL HANDLE.— The ejection control handle (figs. 5-21 and 5-22) is located on the front of the seat bucket. It is the only means by which ejection can be initiated. The handle is molded in the shape of a loop, and is connected to the sears of the ejection seat initiators. The seat initiators have two rigid lines that connect to the trombone fittings. An upward pull of the loop removes both sears from the dual initiators to initiate ejection. Either initiator can fire the seat. After ejection the handle remains attached to the seat. The ejection control handle is safetied by using the ejection seat safe/arm handle and safety pin.

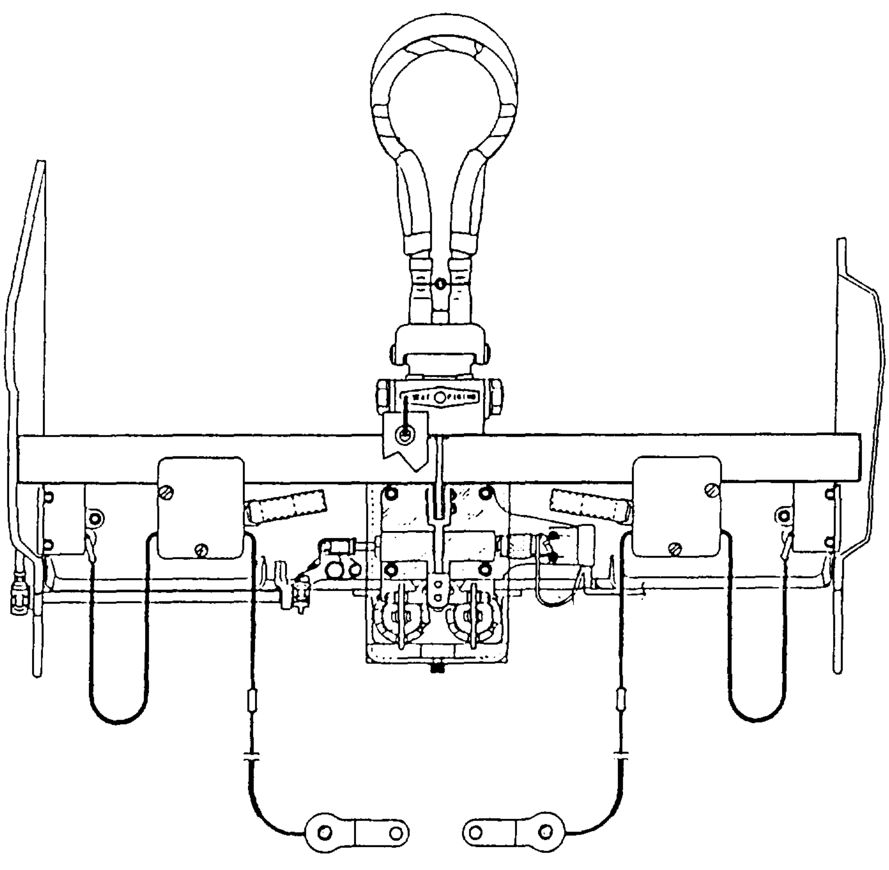


Figure 5-22.-Ejection control handle.

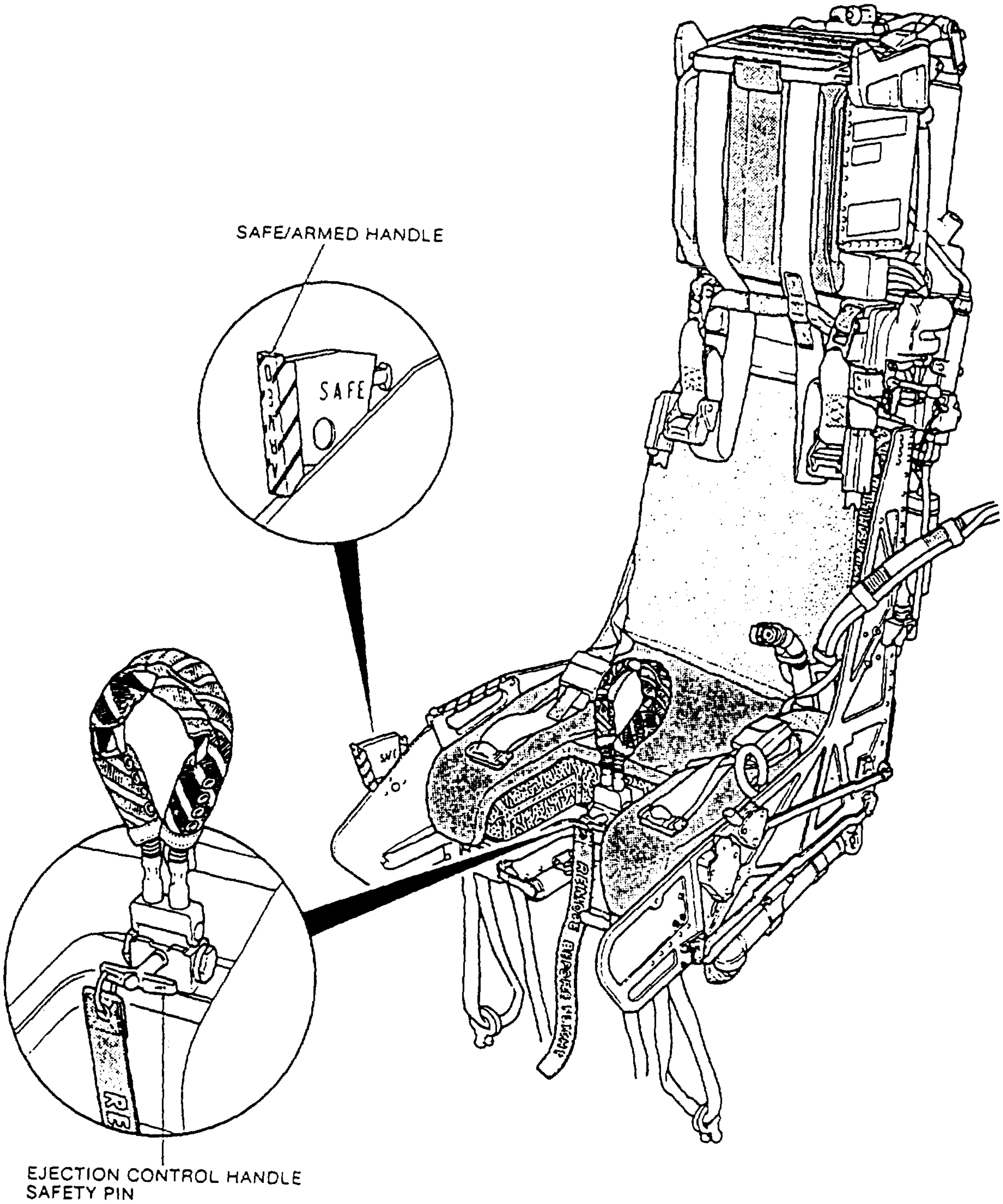


Figure 5-23.-Locations of safety devices.

SAFE/ARMED HANDLE.— The SAFE/ARMED handle (figs. 5-21 and 5-23) is located on the RH side of the seat bucket immediately forward of the emergency restraint release handle. Contained within the handle is a catch that locks the handle in either the ARMED or SAFE position. The handle is connected to a linkage that terminates in a safety plunger, which passes through the link of the ejection control handle when the handle is in the SAFE position and prevents operation of the ejection control handle. When in the ARMED position, the visible portion of the handle is colored yellow and black stripes and engraved ARMED; when in the safe position, the visible portion is colored white and engraved SAFE. An electrical visual SAFE/ARMED indicator is incorporated in the cockpit central warning panel, and is operated by a microswitch actuated by the safety plunger.

LEG RESTRAINT SNUBBERS.— Two leg restraint line snubbers (fig. 5-24), each with a leg restraint line, are attached to the front face of the seat bucket. Release of the leg restraint line snubbers to adjust the leg lines is effected by pulling inboard on the fabric loops attached to the release plungers on the inboard side of each snubber. The leg restraint lines taper plugs are secured in locks positioned on the seat bucket side plates.

EMERGENCY RESTRAINT RELEASE HANDLE.— The emergency restraint release

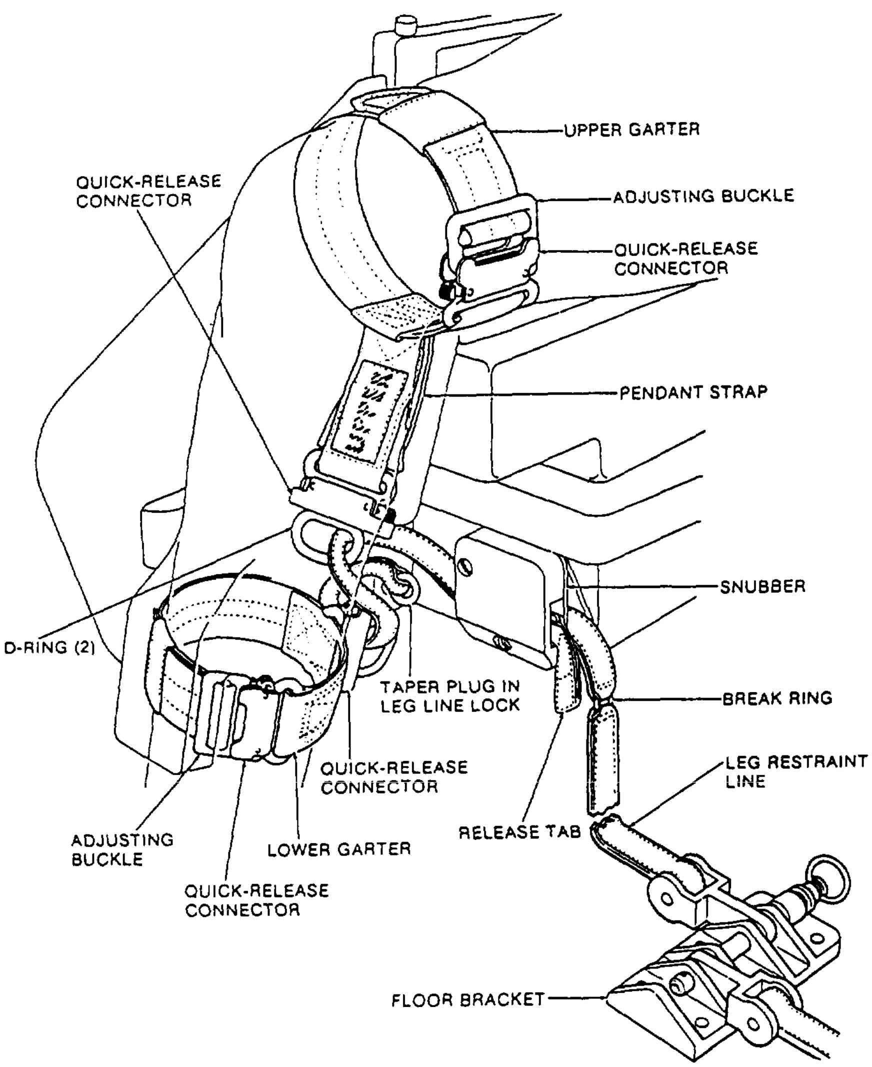


Figure 5-24.-Leg restraint system.

handle (figs. 5-21, 5-25, and 5-26) is connected by two link assemblies to the lower harness lock release mechanism and to a firing mechanism housed in the rear lower RH side of the seat bucket. The handle is locked in the down position by a catch operated by a thumb button situated at the forward end of the handle; depression of the thumb button allows the handle to be rotated rearward. Operation of the handle when the seat is installed in the aircraft is restricted by the pin puller, and releases only the lower torso restraint and leg restraint lines to permit emergency ground egress. On ejection, the pin puller is automatically disengaged from the handle operating link.

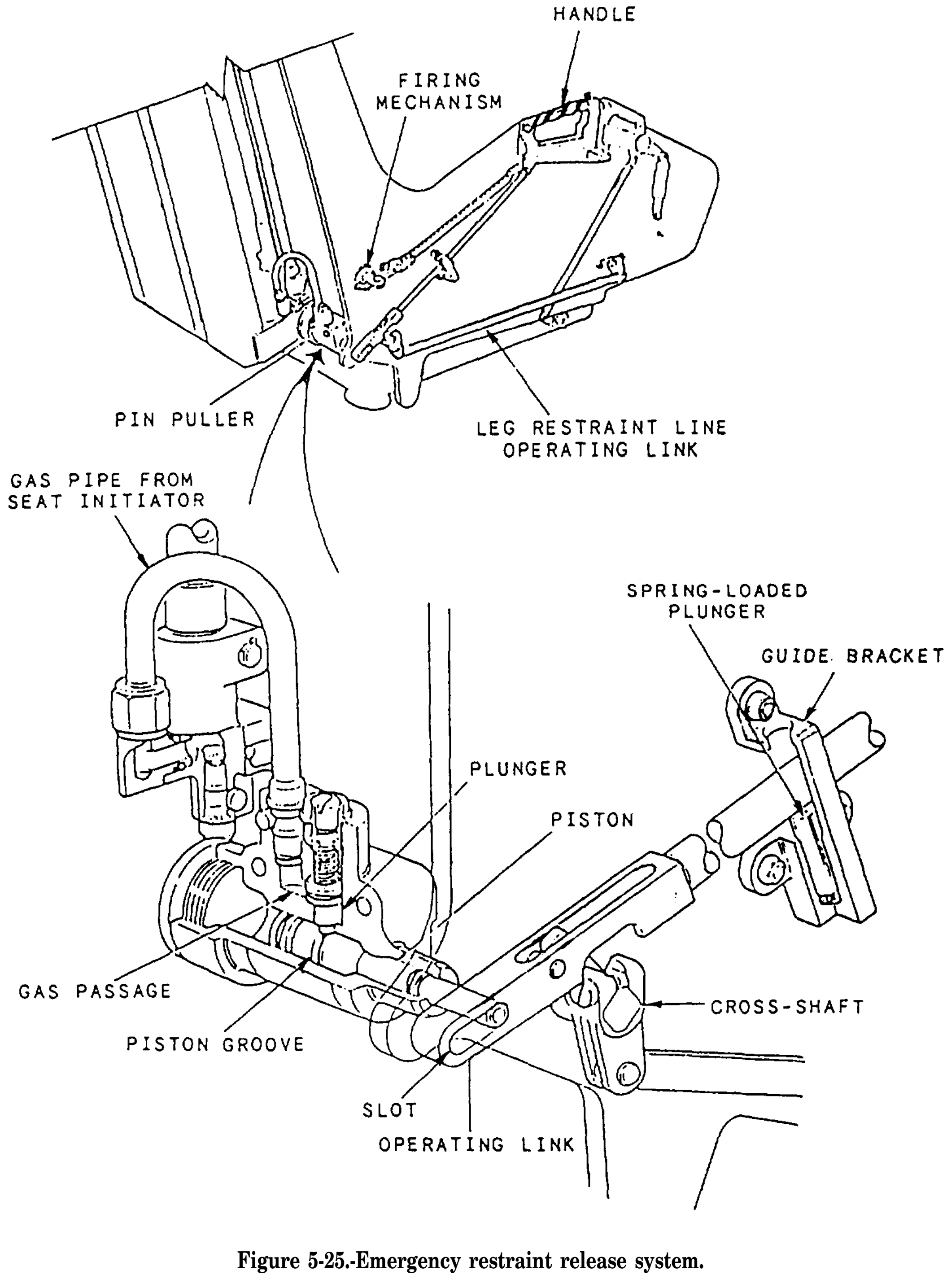


Figure 5-25.-Emergency restraint release system.

Operation of the emergency restraint release handle simultaneously operates the SAFE/ ARMED handle to the SAFE position. In the event of automatic sequence failure, operation of the emergency restraint release handle subsequent to ejection will fire a cartridge to operate the upper and lower harness locks and the parachute deployment rocket motor.

SHOULDER HARNESS CONTROL LEVER.– The shoulder harness control lever (fig. 5-21) is attached to the LH side of the seat bucket and is connected to the shoulder harness reel. When the lever is in the forward position, the shoulder harness reel is locked, preventing all forward movement of the seat occupant. When moved to the rear position, the seat occupant is free to move forward and backward. Should the seat occupant move forward rapidly, however, the shoulder harness reel will lock and remain locked until the load on the webbing straps is eased.

SEAT HEIGHT ACTUATOR SWITCH.— The seat height actuator switch (fig. 5-21) is situated immediately forward of the shoulder harness control lever. Forward movement of the switch toggle lowers the seat bucket, and rearward movement raises the seat bucket. When released, the toggle assumes the center OFF position.

PIN PULLER.— The pin puller (figs. 5-25 and 5-26) is installed on the aft right side of the seat bucket. Full aft rotation of the manual override handle is prevented by the pin puller. A pin extended from the pin puller engages a slot in the manual override linkage. During the ejection sequence, gas pressure from the right-hand seat initiator cartridge retracts the pin.

LOWER HARNESS RELEASE MECHANISM.— The lower harness release mechanism (fig. 5-26) includes the two lower harness locks, the two leg restraint line locks, the negative-g strap lock, the emergency restraint release piston housing, and associated connecting levers and linkages.

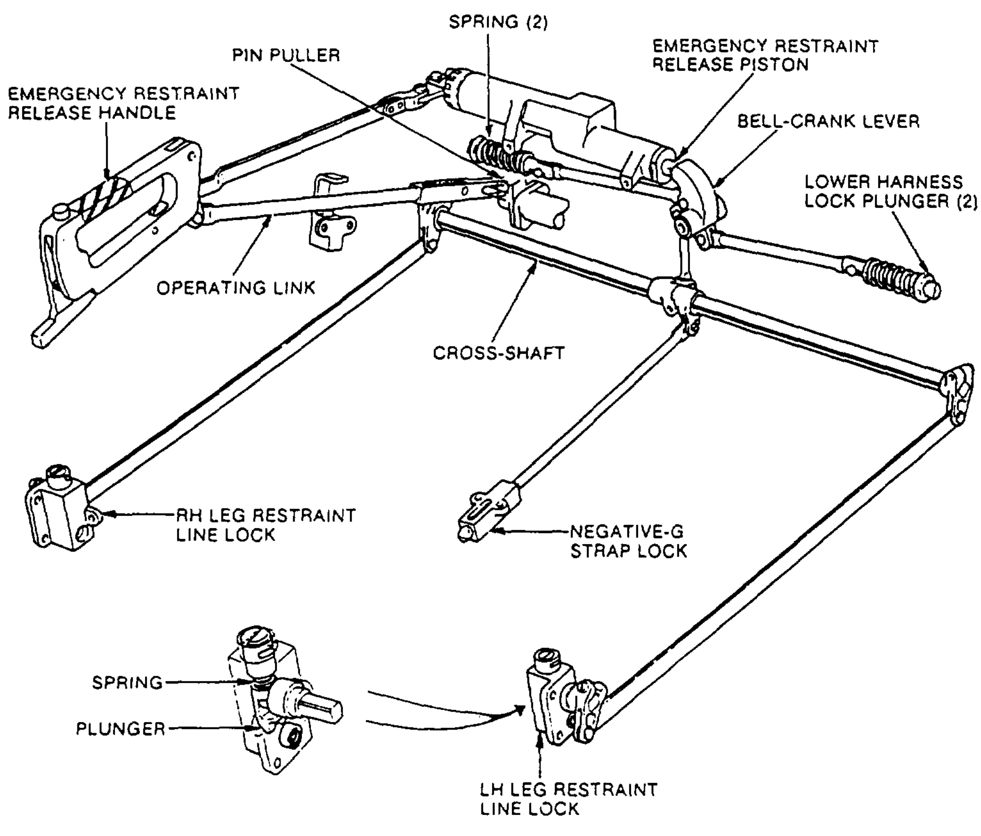


Figure 5-26.-Lower harness release mechanism.

Parachute Assembly

The parachute assembly (fig. 5-27) comprises a 6.2m (20-foot) GQ type 2000 personnel parachute packed, together with a ribbon drogue, into a rigid container and connected to the parachute risers. The parachute risers incorporate seawater activated release switches (SEAWARS) for attachment to the upper torso harness. These switches will automatically release the occupant from his/her parachute following descent into seawater. The parachute assembly is attached to the upper forward face of the ejection seat main beams. Some seats may contain the GQ-5000 type parachute, depending on date of manufacture.

PARACHUTE CONTAINER.— The parachute container is of light alloy construction, with canopy breakers fitted to each upper outboard side. The breakers on the forward seat are longer than those on the aft seat. Two hooked brackets on the lower rear face of the container locate over pins on the main beams. Brackets, integral with the rear of the canopy breakers, are bolted to brackets on the main beams. A shaped headpad is attached to the front face of the container to provide head location during ejection. A hook and pile fastener is fitted to the front face of the headpad to locate the parachute risers. The container is closed by a rigid top cover, with a single lug on the RH side and two lugs on the LH side. The LH lugs deform during parachute extraction, releasing the cover to permit rapid parachute deployment. A fairing on the LH rear corner of the cover protects the parachute withdrawal line where it leaves the container.

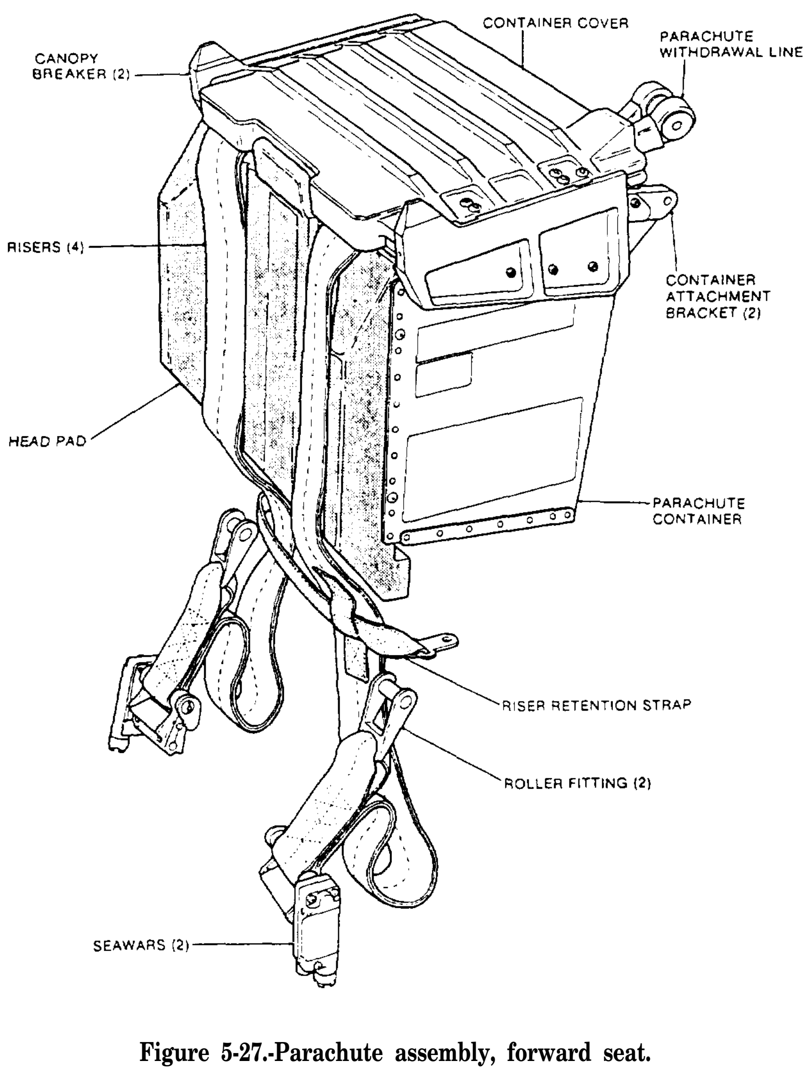


Figure 5-27.-Parachute assembly, forward seat.

PARACHUTE CANOPY AND DROGUE.— The parachute canopy incorporates a crown bridle, at the apex of which is attached, via a short strap, a 1.5m (60-inch) ribbon drogue. The parachute canopy and drogue are packed, drogue first, into a deployment bag, the closed end of which is attached via a withdrawal line to the stirrup on the parachute deployment rocket.

Seat Survival Kit Assembly

The survival kit assembly (fig. 5-28) fits into the seat bucket and comprises a contoured rigid platform (lid assembly), to which are attached an emergency oxygen system and a fabric survival package. A cushion on top of the platform provides a firm and comfortable seat for the occupant.

The lid assembly is a rigid platform that incorporates the emergency oxygen system and lap belts. The lid assembly also provides stowage for the radio beacon and mountings for the rucksack assembly. The lid assembly is retained in position in the seat bucket by brackets at the front and lugs secured in the lower harness locks at the rear, Attached to the lugs are two adjustable lap belts with integral quick-release fittings.

EMERGENCY OXYGEN SYSTEM.— An emergency oxygen cylinder, a pressure reducer, and associated hardware are mounted on the underside of the lid assembly. A green manual-operating handle is mounted on the LH side of the assembly, and a cylinder contents gauge is on the inside face of the left-hand thigh support. The

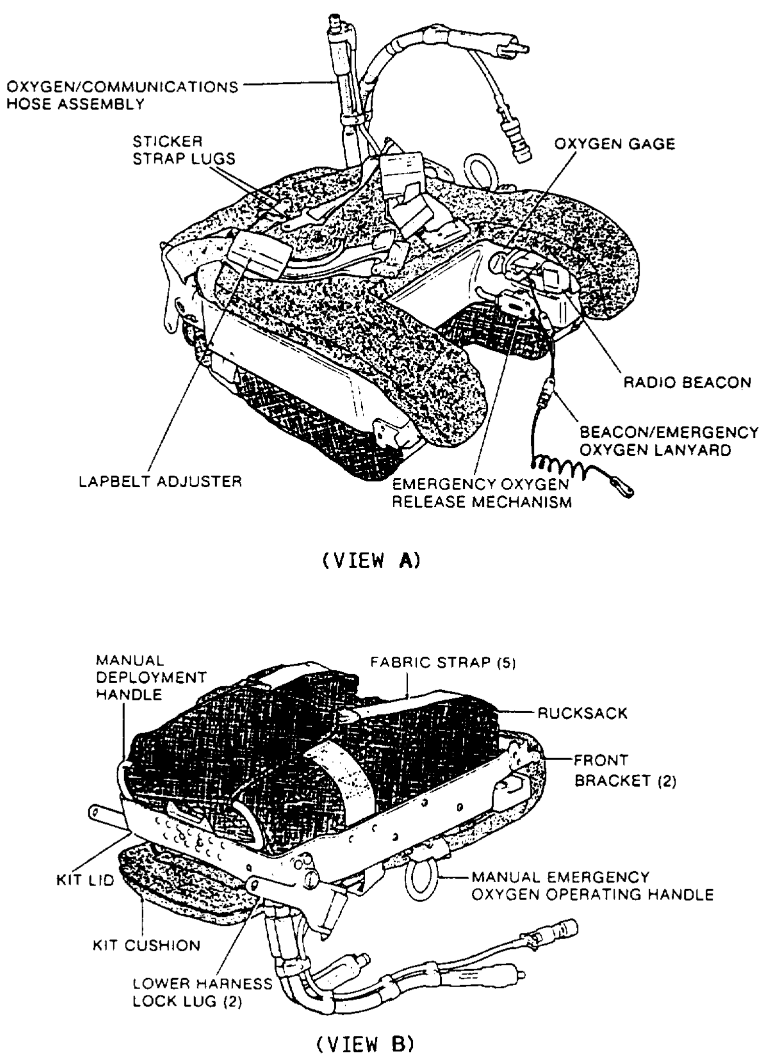


Figure 5-28.-Seat survival kit assembly; (A) top view; (B) bottom view.

emergency oxygen system is automatically activated during ejection by a lanyard connected to the cockpit floor. An oxygen/communications hose is connected to unions on the LH rear top of the lid assembly, and provides connections between the seat occupant and the aircraft and survival kit systems.

RADIO LOCATOR BEACON.— A URT-33A radio locator beacon is located in a cutout in the left thigh support. The beacon is actuated during ejection by a lanyard connected to a common anchorage point with the emergency oxygen lanyard.

RUCKSACK ASSEMBLY.— The rucksack assembly is attached to the underside of the lid assembly by five fabric straps and a double cone and pin release system. The rucksack contains a life raft and the survival aids. Yellow manual deployment handles mounted on the kit enable the occupant to deploy the rucksack and contents onto a lowering line after seat/man separation. The LRU-23/P life raft inflates automatically on rucksack assembly deployment.

COMPONENT OPERATION

The operation of each component and subsystem is discussed in the following paragraphs. The operation of the system as a whole is discussed later in the chapter.

Catapult Assembly

Explosive charges are contained in an ejection gun initiator, JAU-56/A (figs. 5-3 and 5-4), and a secondary cartridge. Gas pressure from the seat firing system or the aircraft command sequencing system operates twin firing pins in the ejection gun initiator to fire the explosive charge.

Gas enters the manifold valve through one or both of the inlet ports, depresses the check valves, and passes down through the vertical bore into the initiator. Gas pressure acts upon the twin firing pins in the initiator, shearing the shear pins and forcing the firing pins down to strike the percussion caps and ignite the explosive filling. The gas pressure generated within the catapult—

1. Passes to the ballistic latches to operate the pistons, which retain the multipurpose initiator static lanyards.
2. Propels the catapult piston upwards. The initial movement of the piston forces the spring-loaded top latch plunger out of the breech groove back into the barrel latch (fig. 5-4). The piston continues to rise, thrusting against the top crossbeam of the seat, the upward movement causing the shaped end of the top latch plunger to ride out of, and disengage from, the barrel latch. Further upward movement of the piston uncovers the secondary cartridge, which is fired by the pressure and heat of the initiator gas. After approximately 38 inches (965mm) of travel, the piston head strikes the guide bushing and shears the three dowel screws. After a further 4 inches (101mm) of travel, the piston separates from the barrel and moves away with the ejected seat.

Main Beams Assembly

The main beams assembly supports the major components of the ejection seat. The operation of the components supported by the main beams assembly is discussed in the following paragraphs.

SHOULDER HARNESS CONTROL SYSTEM.— When the ejection control handle is pulled, gas from the RH seat initiation system is piped into the breech to operate the cartridge. The gas also passes to the operating piston in the governor housing, forcing it upwards to operate the trip lever and bring the locking pawl into contact with the ratchet wheel.

The gas from the impulse cartridge in the breech impinges on the end of the piston forcing it along the cylinder. Horizontal movement of the piston is transmitted via the threaded drive screw to rotate the splined shaft, spool assemblies, and ratchet wheel, which winds in the webbing straps to pull back and restrain the occupant's shoulders. The engaged locking pawl locks the spools in the restrained position.

Withdrawal of the webbing straps at excessive speed causes the two governor pawls to rotate outwards under centrifugal force and engage the teeth on the housing, preventing rotation of the splined shaft and spool assemblies and further withdrawal of the straps. This system prevents the occupant from being thrown forward on crash landing or sudden deceleration if the shoulder harness control lever is in the disengaged position. Easing of tension on the webbing straps allows the pawl springs to reassert themselves and disengage the pawls from the teeth, permitting free withdrawal of the straps again.

PARACHUTE DEPLOYMENT ROCKET MOTOR.— Upon seat ejection, gas pressure from the primary and secondary cartridges passes to the rocket igniter cartridge to fire the rocket, shearing the flange of the rocket igniter cartridge. As the rocket moves upward, the stirrup slides down the rocket and aligns itself directly below the thrust axis line to extract and deploy the personnel parachute.

In the event of sequencer failure, gas entering the unit through the gas inlet ports from the harness release unit cartridge or the emergency restraint release cartridge will initiate the secondary cartridge to face fire the primary.

ELECTRONIC SEQUENCER.— When the ejection seat is fired, two onboard thermal batteries are immediately energized, supplying usable electrical power to the sequencer after just 100 milliseconds, with the seat having travelled about 5 inches up the ejection catapult. The sequencer's microprocessors then run through an initialization routine, and by 120 milliseconds the sequencer is ready and waiting to perform.

As the seat rises from the cockpit, two steel cables (approximately 42 inches) are pulled from the multipurpose initiators, actuating two pyrotechnic cartridges. The gas generated by these two cartridges is piped around the seat to perform the following functions:

- Initiate the underseat rocket motor.
- Deploy the pitot tubes from the sides of the seat headbox.
- Close two electrical switches (sequencer "start" switches).

The sequencer responds to the closure of either start switch by changing to the "ejection" mode. The switch starts an electronic clock, and all subsequent events are timed from this point. In the absence of a start switch signal, the sequencer will simply continue in the "wait" mode. This mode is a safety feature designed to ensure that the drogue and parachute can only be deployed after the seat has physically separated from the aircraft.

The ignition of the underseat rocket motor is timed to occur just as the seat separates from the ejection catapult, at about 200 milliseconds, so as to maintain a uniform vertical acceleration profile on the seat and occupant. The motor has a burn time of 250 milliseconds. Once the sequencer is switched into the "ejection" mode, its first action is to electrically fire the drogue deployment canister, which occurs precisely 40 milliseconds after start switch (approximately 220 milliseconds from seat initiation), while the seat rocket motor is burning. This happens regardless of the speed and altitude conditions.

The sequencer then enters its most crucial period, when it will sense the seat's airspeed and altitude and choose the appropriate timings from a set of five available sequences. This is done during a 60 millisecond "environmental sensing time window" that starts just after the drogue canister is fired, and is completed before the drogue is fully deployed and pulling on the back of the seat. The sequencer measures the speed and altitude from the information it receives from three types of sensor: pitot pressure, base pressure, and accelerometer.

Several samples of each parameter are taken during the environmental window. These are used to determine the ejection conditions. The sequencer then selects the appropriate timings for the remaining events, known as "mode selection," and completes the sequence accordingly.

Overview of Sequencer Electronics and Hardware.— The electronic sequencer and its thermal batteries are packaged in two separate units. The sequencer and associated electronics are contained in a cast aluminum enclosure, which is mounted between the main seat beams directly beneath the parachute container headbox. A total of nine shielded cables attached to the housing transmit electrical signals to and from the sequencer. The input and output actions are as follows :

Input—

- thermal battery power supply lines (2)
- start switch circuits (2)

output—

- drogue deployment canister squib-fire circuit
- drogue bridle release squib-fire circuit
- parachute extractor squib-fire circuit
- seat harness release squib-fire circuit
- seat harness release (backup) squib-fire circuit

The sequencer also has air pressure couplings to connect it to the two pitot pressure tubes on the headbox and the two base pressure sensing points inside the main seat beams. A functional block diagram of the electronic circuitry is given in fig. 5-29.

Modes of Operation.— The operational envelope of the NACES is divided into five zones, each of which is associated with a particular timing sequence, known as modes. These timings provide the optimum seat performance under all ejection conditions, both in terms of maximizing the survivable escape envelope and minimizing the risk of occupant injury. Figure 5-30 shows the five zones on the speed versus altitude chart, and table 5-1 gives the corresponding squib-fire timings.

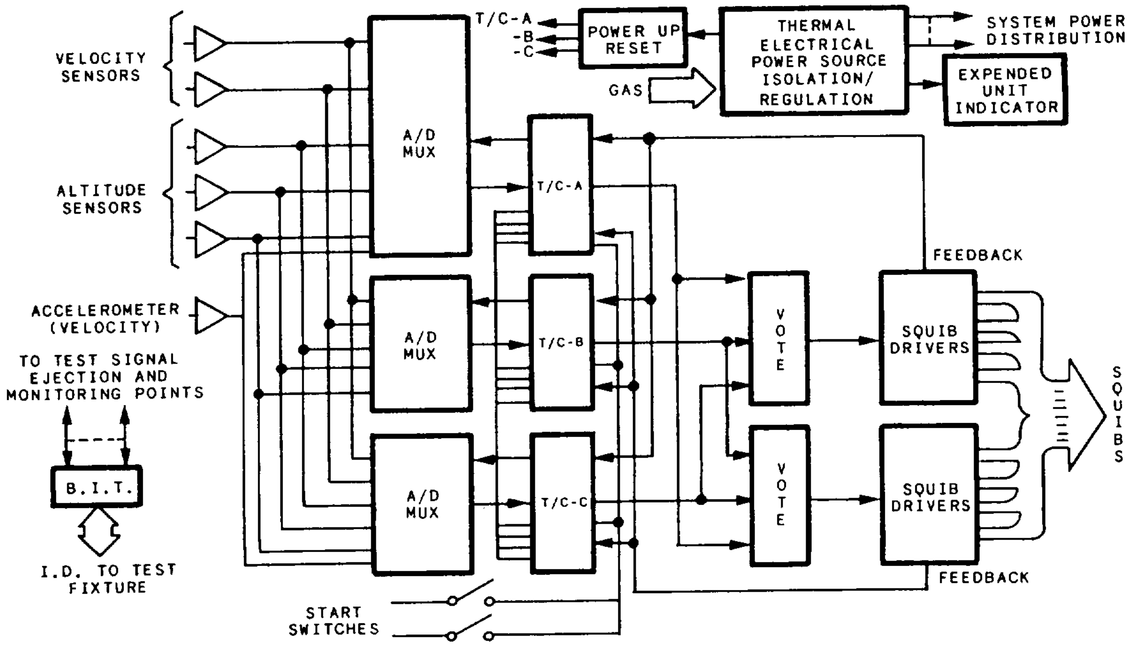


Figure 5-29.-NACES functional block diagram.

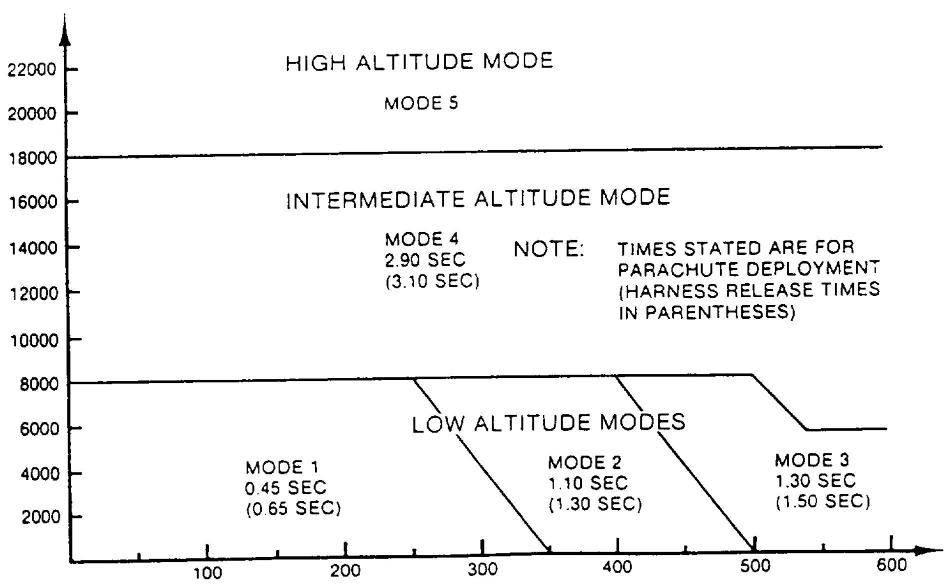


Figure 5-30.-Ejection modes.

Table 5-1.-Squib-Fire Event Times

SQUIB-FIRE EVENT TIMES
IN MODES 1 to 5

Altitude (ft)	0—8K			8K—18K	18K+
KEAS	0—350	350—500	500—600	ALL	ALL
MODE	1	2	3	4	5
1 Gas pressure from seat initiator cartridges, delay cartridge or command sequencing system initiates catapult and thermal batteries	0.00	0.00	0.00	0.00	0.00
2 Start switches close after 39 inches of seat travel	0.18	0.18	0.18	0.18	0.18
3 Sequencer supplies dual pulse to fire drogue deployment catapult	0.22	0.22	0.22	0.22	0.22
	Environmental sensing time window 0.245 — 0.305 seconds				
4 Sequencer supplies dual pulse to fire drogue bridle release cartridge and release drogue bridle	0.32	—	—	—	4.80 +t (See Note 3)
5 Sequencer supplies dual pulse to fire parachute deployment rocket	0.45	1.10	1,30	2.90	4.87 +t
6 Sequencer supplies dual pulse to fire drogue bridle release cartridge and release drogue bridle	—	1.25	1.45	3.05	—
7 Sequencer supplies dual pulse to fire barostatic release unit cartridge and release harness locks	0.65	1.30	1.50	3.10	5.07 +t
8 Sequencer supplies dual pulse to fire barostatic release unit cartridge (backup)	0.66	1.31	1.51	3.11	5.08 +t

All times are references to ejection seat initiation. The start switches operated approximately 0.18 seconds after initiation. N. B: This is a nominal time. The actual time will vary between 0.13 and 0.19 seconds.

In Mode 5 operation, altitude sensing is to recommence at 4.80 seconds, continuing until fall-through-condition (below 18,000 ft) is detected.

t = time interval between 4.80 seconds and fall-through-condition.

Mode 1 is designed for low-speed/low-altitude ejection conditions. The aim is to deploy the main parachute as soon as practicable after the seat has separated from the aircraft. A drogue deceleration phase is not required so the bridle releases are operated very quickly, thus ensuring that the deploying drogue and bridle assembly moves rapidly clear of the seat in readiness for the immediate main parachute deployment.

Modes 2, 3, and 4 cater for high-speed ejections at low and medium altitudes. These ejection conditions require a delay before the parachute is deployed, to allow the velocity of the seat to reduce. The stabilizer drogue provides maximum deceleration while maintaining the seat in the optimum attitude for the occupant. The sequence timings of modes 2, 3, and 4 progressively extend the drogue phase with increasing speed and altitude so as to ensure that the parachute extractor is fired only when the seat velocity has reduced to a suitable level. The drogue bridle is jettisoned shortly after the parachute starts to deploy, both to avoid an entanglement and to allow the seat to fall clear of the occupant.

Mode 5 is the high-altitude ejection sequence, in which deployment of the main parachute is delayed until the drogue-stabilized seat falls through the 18,000-feet altitude boundary. This allows the occupant to be brought down to a safer atmospheric condition in the shortest possible time. Once the parachute deployment sequence is initiated, the seat performs in an identical manner to that of modes 2, 3, and 4.

BAROSTATIC RELEASE UNIT (BRU).— When the RH multipurpose initiator cartridge fires during ejection, gas pressure from the cartridge enters the piston housing and moves the piston upwards, rupturing the frangible disc and allowing the pawl to pivot clear of the rack assembly slotted end. When the altitude is such that the barostat is not restraining the mechanism, the rack assembly will rise under the action of its spring, the rate of ascent being governed by the delay mechanism. After the delay has elapsed, the rack disengages from the gear train and the firing pin rises rapidly to strike the cartridge. If the cartridge has not previously been fired electrically by the sequencer, the gas produced by the cartridge passes out of the BRU to operate the upper- and lower-harness locks and the secondary cartridge in the parachute deployment rocket motor.

DROGUE DEPLOYMENT CATAPULT.— During ejection, the drogue deployment catapult fires and ejects the drogue and canister. As the drogue deploys, the bridle breaks out of the frangible container and detaches from the channels on the main beams. The drogue stabilizes and decelerates the seat. In the high-altitude mode, the seat descends rapidly on the drogue to a predetermined altitude. The drogue bridle releases then operate, the personnel parachute deploys, and the occupant separates from the seat. In all other modes, the upper and lower drogue bridle releases operate after a short predetermined delay, as the personnel parachute deploys and seat/man separation occurs.

The impulse cartridge is fired by an electrical signal from the sequencer. Gas from the cartridge propels the telescopic piston upwards, shearing the end cap rivets. Continued movement of the piston thrusts the canister upwards, shearing the rivets in the threaded ring and propelling the canister and drogue assembly away from the seat. The bridle is pulled from its frangible container and out of the channels on the seat's main beams. As the bridle reaches full extension, inertia causes the canister to fly clear, and the drogue is extracted and deployed to stabilize and decelerate the seat.

MULTIPURPOSE INITIATOR.— When ejection is initiated, the catapult ballistic latches operate to retain both multipurpose initiator lanyard spigots. As the seat moves up the guide rails, the static lanyard spigots break the shear pins and the lanyards pay out from the housings. When the lanyards become taut, the upper fittings withdraw the firing pins against spring pressure until the wedge-shaped disconnect devices separate. The firing pins move rapidly upward under spring pressure to fire the cartridges. The gas generated passes to the underside of the piston heads on the start switch plungers. The plungers move up, shearing the shear pins, until the gold-plated portions of the plungers complete an electrical connection in the switch assemblies. Sequencer timing then commences.

Gas from the cartridges also passes out of the units to the barostatic release unit (RH side only), the pitot deployment mechanisms, and the underseat rocket motor.

PITOT ASSEMBLY.— When the pitot assembly is installed on the seat beam, the inboard static pressure connector connects to a void in the seat beam. The sequencer is installed on the forward face of both pitot assemblies and connects to the dynamic and forward static pressure connectors.

On ejection, gas pressure from the impulse cartridges in the multipurpose initiators enters the body and operates the lower piston. Movement of the lower piston pushes the pitot arm locking plunger out of engagement with the hole in the body, and at the same time, opens a gas passage to the upper piston. The upper piston moves outward to move the pitot arm to the deployed position. The pitot arm locking plunger engages with the second hole in the body and locks the pitot arm in the deployed position.

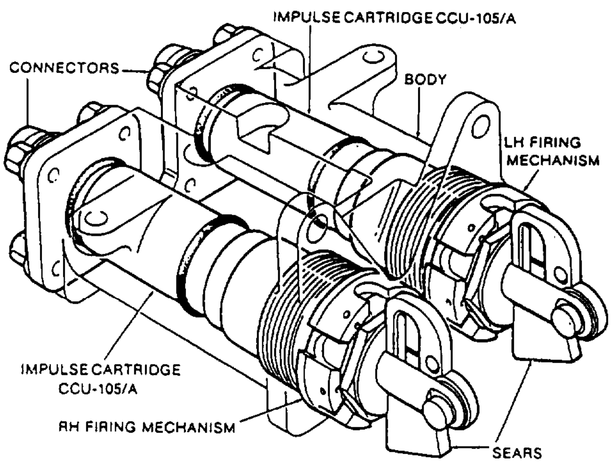


Figure 5-31.-Seat initiator.

RH AND LH BALLISTIC MANIFOLDS.— Pulling the ejection control handle withdraws the handle from its housing and both sears from the seat initiator firing mechanisms to fire both impulse cartridges (fig. 5-31).

Gas pressure from the RH initiator cartridge withdraws the pin puller, freeing the emergency harness restraint release linkage (figs. 5-32 and 5-33). RH gas pressure also passes to the following:

1. The shoulder harness reel to initiate harness retraction.
2. The thermal batteries.
3. The 0.75-second (forward seat) delay cartridge-actuated initiator mounted on the LH ballistic manifold.
4. The 0.30-second (aft seat) delay cartridge-actuated initiator mounted on the RH ballistic manifold.

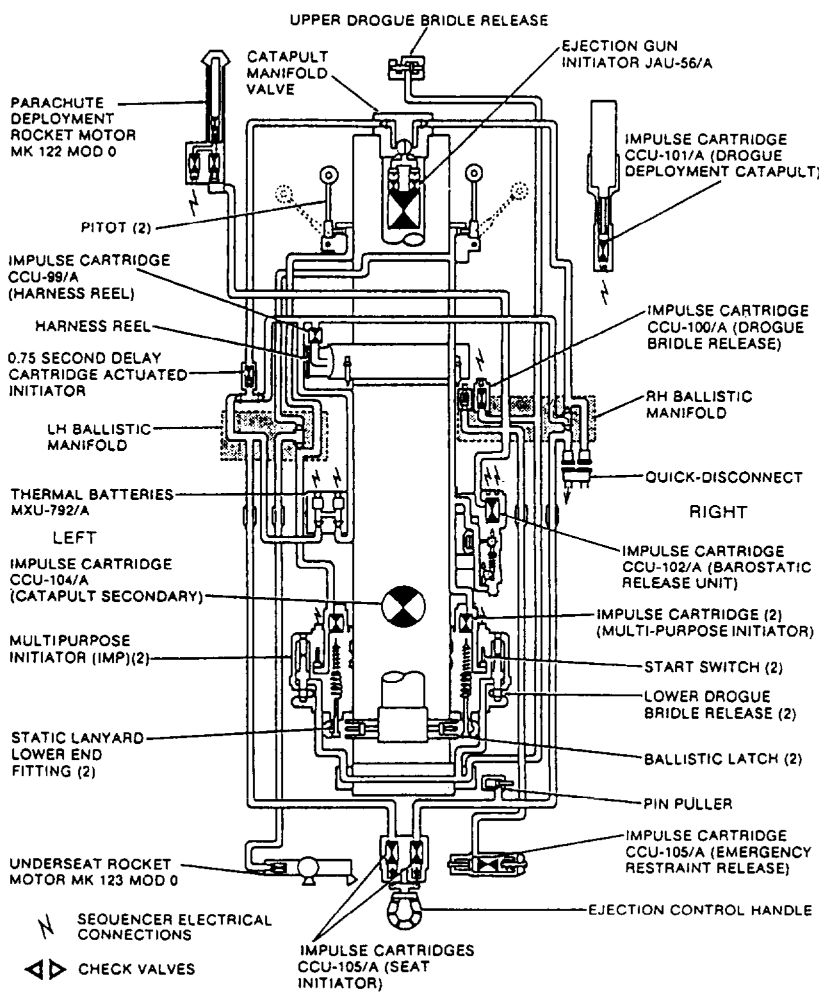


Figure 5-32.-Forward ejection seat gas flow diagram.

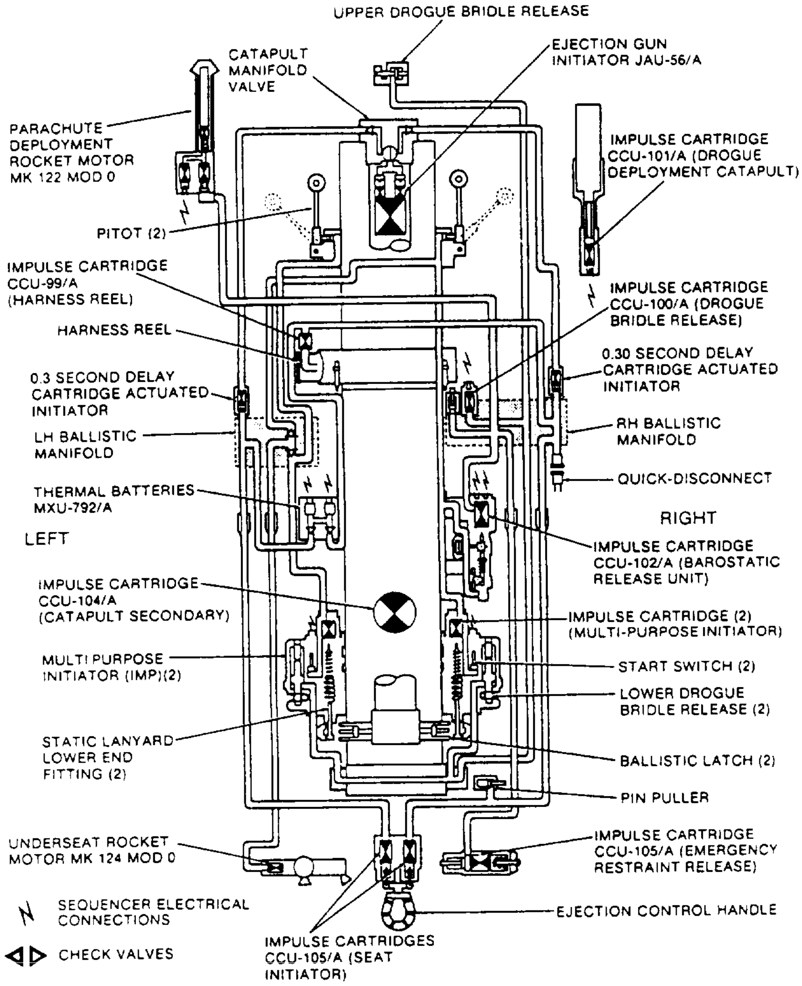


Figure 5-33.-Aft ejection seat gas flow diagram.

Gas pressure from the LH impulse cartridge passes to the following:

1. The thermal batteries.
2. The 0.75-second (forward seat) or 0.30-second (aft seat) delay cartridge-actuated initiator mounted on the LH ballistic manifold, which passes gas to the LH inlet of the catapult manifold valve to initiate the catapult.

THERMAL BATTERIES.— To provide system redundancy, each battery is initiated independently by a manifold-mounted, gas-operated firing mechanism. Both firing mechanisms are initiated by gas pressure from the seat initiator cartridges.

Seat Bucket Assembly

The ejection seat is fitted with a seat bucket assembly. The operation of the components supported by the seat bucket assembly is discussed in the following paragraphs.

UNDERSEAT ROCKET MOTOR/LATERAL THRUST MOTOR.— The underseat rocket motor Mk 123 Mod 0 (forward seat) or Mk 124 Mod 0 (aft seat) is secured under the seat bucket, and is ignited as the catapult nears the end of its stroke. The thrust is approximately 4,800 pounds for 0.25 second, and sustains the thrust of the catapult to carry the seat to a height sufficient for a safe ejection. The thrust also provides the zero-zero capabilities that ensure a safe ejection.

EJECTION SEAT SAFE/ARM HANDLE.— To prevent inadvertent seat ejection, an ejection seat safe/arm handle is installed. To safety the seat, you must rotate the handle up and forward.

To arm the seat, you rotate the handle down and aft. When in the ARMED position, the portion of the handle that is visible to the pilot is colored yellow and black, with the word ARMED showing. In the SAFE position, the visible portion of the handle is colored white, with the word SAFE showing. By placing the handle to the SAFE position, it causes a pin to be inserted into the ejection firing mechanism. This prevents withdrawal of the sears from the dual-seat initiators.

LEG RESTRAINT SNUBBERS.— As the seat travels up the guide rails during ejection, the leg restraint lines, which are fixed to a floor bracket, are drawn through the snubbers. Inertia draws the legs against the front of the seat bucket, and the legs are retained in this position by the leg restraint lines. When the lines become taut and a pre-determined load is attained, the special break rings fail and release the lines, leaving only a short loose end protruding from the snubbers. The leg lines are restrained by the snubbers, and the legs secured until the taper plugs are released from their locks when harness release occurs.

EMERGENCY RESTRAINT RELEASE HANDLE.— Rotation of the emergency restraint release handle to permit emergency ground egress will rotate the cross shaft of the lower harness release mechanism to release the lower harness locks, leg restraint line locks, and negative-g strap lock. Full rotation of the handle to withdraw the sear of the firing unit is prevented by the pin puller engaging the rear end of the slot in the emergency restraint release operating link.

SHOULDER HARNESS CONTROL LEVER.– The shoulder harness control lever, mounted on the left side of the seat bucket, is connected to the inertia reel, and provides manual control for the shoulder straps. In the forward position, the shoulder straps will be locked, and in the aft position, the shoulder straps will be unlocked so the occupant will be free to turn and move about.

SEAT HEIGHT ACTUATOR SWITCH.— The seat height actuator switch controls electrical power to raise and lower the seat bucket to suit the needs of the occupant.

PIN PULLER.— During ejection, gas from the RH seat initiator cartridge enters the pin puller plunger housing and lifts the plunger out of engagement with the groove in the piston. Movement of the plunger allows gas to enter the cylinder and withdraw the piston out of engagement with the slot in the emergency restraint release operating link, the piston being held in the operated position by residual gas pressure. The operating link is then disengaged from the lower harness release cross shaft by the action of a spring-loaded plunger in the operating link guide bracket mounted on the seat bucket side.

LOWER HARNESS RELEASE MECHANISM.— When the sequencer fires the barostatic release unit cartridge, the piston in the RH ballistic manifold acts on the harness reel cross-shaft lever. It rotates the cross shaft to withdraw the plungers in the upper harness locks and release the shoulder harness reel straps. At the same time, gas passes via the RH ballistic manifold down the RH trombone tube assembly, entering the emergency restraint release piston housing and face-firing the cartridge. The combined gas pressure from the two cartridges operates the emergency restraint release piston, operating the linkages to release the lower harness locks, the leg restraint line locks, and the negative-g strap lock.

Parachute Canopy and Drogue

During the ejection sequence, the parachute deployment rocket motor fires, extends the withdrawal line, and withdraws the parachute in its bag. The parachute canopy emerges from the bag, periphery first, followed progressively by the remainder of the canopy and the drogue. The extractor rocket and bag clear the area. The drogue and crown bridle impart a force on the canopy, proportional to airspeed, to inhibit full canopy inflation until g-forces are reduced.

Rotation of the emergency restraint release handle to permit emergency ground egress will rotate the cross shaft of the lower harness release mechanism to release the lower harness locks, leg restraint line locks, and negative-g strap lock. Full rotation of the handle to withdraw the sear of the firing unit is prevented by the pin puller engaging the rear end of the slot in the emergency restraint release operating link.

During ejection, gas from the RH seat initiator impulse cartridge enters the pin puller plunger housing and lifts the plunger out of engagement with the groove in the piston. Movement of the plunger allows gas to enter the cylinder and withdraw the piston out of engagement with the slot in the emergency restraint release operating link, the piston being held in the operated position by residual gas pressure. The operating link is then disengaged from the lower harness release cross shaft by the action of a spring-loaded plunger in the operating link guide bracket mounted on the seat bucket side.

Seat Survival Kit

The seat survival kit (SKU-7/A) operates automatically upon seat ejection. Kit components are maintained by the PR rating. The SKU-7/A contains new equipment. Specific information on the new items was not available at the time of development of this manual.

EJECTION SEQUENCE

When the ejection control handle is pulled (fig. 5-34), the sears are withdrawn from the seat initiator firing mechanisms and the two impulse cartridges are fired.

Gas from the RH cartridge is piped as follows:

1. To the pin puller, which withdraws a piston from engagement in the lower operating link of the emergency restraint release mechanism.
2. To the inboard connector of the command sequencing quick-disconnect on the RH ballistic

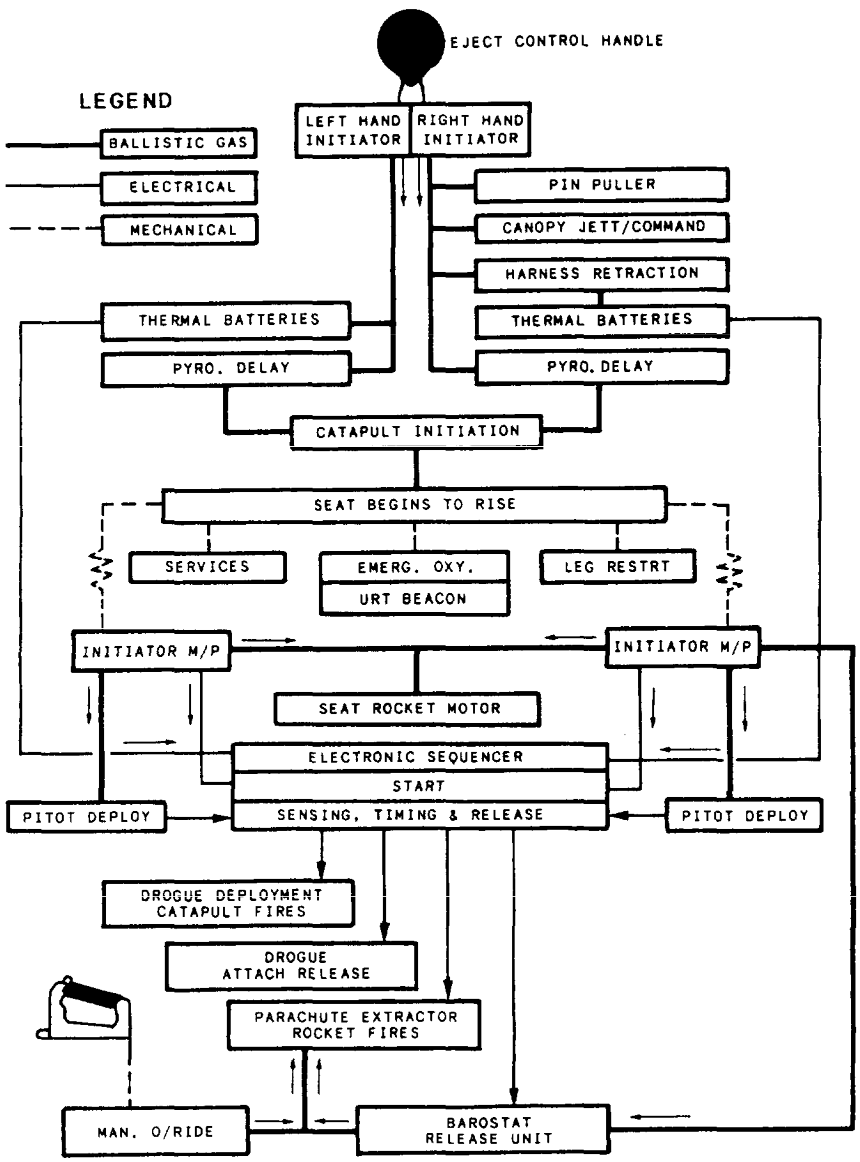


Figure 5-34.-Ejection seat gas flow (block diagram).

manifold to operate the command sequencing and canopy jettison systems.

3. To the 0.30-second delay cartridge-actuated initiator (aft seat only) on the RH ballistic manifold. Gas from the initiator passes to the RH inlet of the catapult manifold valve to initiate the catapult.

4. To the breech of the shoulder harness reel, where it fires the impulse cartridge to pull the seat occupant into the correct position for ejection.

5. To the thermal batteries.

6. Via a check valve to the 0.75-second delay cartridge-actuated initiator on the LH ballistic manifold. Gas from the initiator passes to the LH inlet of the catapult manifold valve to initiate the catapult.

7. If the seat (F/A-18D only) is command ejected (i.e., the ejection control handle on the other seat has been pulled), gas from the command sequencing system enters the RH seat initiating system through the inboard connector of the command sequencing quick-disconnect on the RH ballistic manifold, and operates as described in 1 through 6 above. On the forward seat only, gas pressure also enters the outboard connector of the command sequencing quick-disconnect and is passed to the catapult manifold valve to initiate the catapult. This gas pressure is also piped, via a check valve, to the shoulder harness reel and thermal batteries.

Gas from the LH cartridge is piped as follows:

1. To the thermal batteries.

2. To the 0.75-second delay, cartridge-actuated initiator on the LH ballistic manifold. Gas from the initiator passes to the LH inlet of the catapult manifold valve to initiate the catapult.

Gas from the delay initiator is piped to the ejection gun initiator via the manifold valve. Gas pressure developed by the initiator passes down the catapult to operate the ballistic latches, retaining the IMP lanyard end fittings. As the pressure increases within the catapult, the catapult piston rises, releases the top latch, and begins to move the seat upwards. Further movement of the piston uncovers the catapult secondary impulse cartridge, which is fired by the heat and pressure of the ejection gun initiator gas. Staggered firing of the catapult cartridges provides a relatively even increase in gas pressure during catapult stroke to eliminate excessive g-forces during ejection.

As the seat goes up the guide rails:

1. The IMP lanyards begin to withdraw.

2. Personal services between seat and aircraft are disconnected.

3. The emergency oxygen supply is initiated.

4. The URT-33A beacon is activated.

5. The leg restraint lines are drawn through the snubbers and restrain the occupants legs to the front of the seat bucket. When the leg restraint lines become taut, the special break ring incorporated in each leg line fails, and the lines are freed from the aircraft. Forward movement of the legs is prevented by the lines being restrained by the snubbers.

Near the end of the catapult stroke, the IMP lanyards become taut and operate the firing mechanisms. Gas pressure from the IMP cartridge passes:

1. To the start switch plungers. Closure of the start switches commences sequencer timing.

2. To the barostatic release unit release piston (from the RH IMP only).

3. To the pitot mechanisms to deploy the pitot heads.

4. Via the LH ballistic manifold and trombone tube to the underseat rocket motor. The rocket motor ignites, sustaining the thrust of the catapult to carry the seat clear of the aircraft.

SEQUENCER MODES

Electronic sequencer timing (table 5-2) commences when the start switches close. Mode selection is dependent on altitude and airspeed parameters. (See figure 5-35.)

All modes. The start switches close after approximately 39 inches of seat travel and, after 0.04 second, the drogue deploys onto the bridle to stabilize and decelerate the seat.

Mode 1, low speed - low altitude. The drogue bridle is released, the parachute deployment rocket motor fires to deploy the personnel parachute, and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat bucket by the sticker straps.

Modes 2, 3, and 4, medium and high speeds - low altitude and all speeds - medium altitude. The parachute deployment rocket motor fires to deploy the parachute, the drogue bridle is released, and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat bucket by the sticker straps.

Table 5-2.-Sequencer Timings

Altitude (ft)	0–8K			8K—18K	18K+
KEAS	0—350	350—500	500-600	ALL	ALL
MODE	1	2	3	4	5
1 Gas pressure from seat initiator cartridges, delay cartridge or command sequencing system initiates catapult and thermal batteries	0.00	0.00	0.00	0.00	0.00
2 Start switches close after 39 inches of seat travel	0.18	0.18	0.18	0.18	0.18
3 Sequencer supplies dual pulse to fire drogue deployment catapult	0.22	0.22	0.22	0.22	0.22
4 Sequencer supplies dual pulse to fire drogue bridle release cartridge and release drogue bridle	0.32	—	—	—	4.80 +t (See Note 3)
5 Sequencer supplies dual pulse to fire parachute deployment rocket	0.45	1.10	1.30	2.90	4.87 +t
6 Sequencer supplies dual pulse to fire drogue bridle release cartridge and release drogue bridle	—	1.25	1.45	3.05	
7 Sequencer supplies dual pulse to fire barostatic release unit cartridge and release harness locks	0.65	1.30	1.50	3.10	5.07 +t
8 Sequencer supplies dual pulse to fire barostatic release unit cartridge backup)	0.66	1.31	1.51	3.11	5.08 +t

NOTES TO TABLE 5-2

1. All times are referenced to seat catapult initiation. To obtain times referenced to sequencer start switches, subtract 0.18 sec.

2. Mode selection environmental sensing takes place between 0.245 sec and 0.305 sec (8 microprocessor cycles).

3. In Mode 5 operation, altitude sensing recommences at 4.80 see, continuing until the seat falls to 18000 ft. ´t´ = time interval between 4.80 sec and falling to 18000 ft.

4. Mode decision parameter values are stored in the on-board NOVRAM.

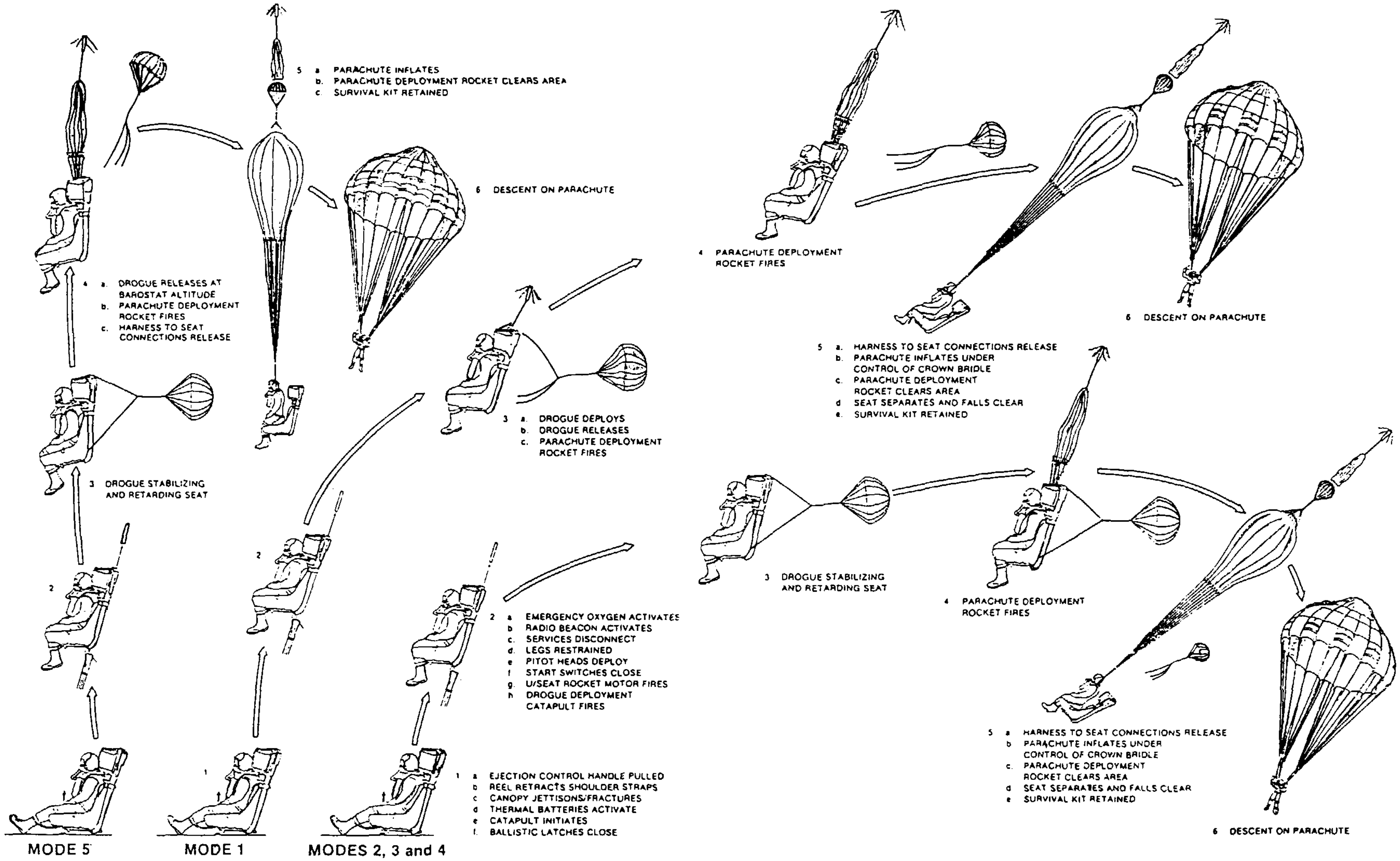


Figure 5-35.—Ejection sequence.

Mode 5, all speeds - high altitude. The drogue bridle remains connected until the seat has descended to 18,000 feet. This arrangement prevents prolonged exposure to low temperature and thin air and enables the occupant to ride down in the seat, controlled by the drogue and supplied with emergency oxygen, to a more tolerable altitude. The seat attitude will be horizontal with the occupant facing down. When the seat has descended to 18,000 feet, the drogue bridle is released, the parachute deployment rocket motor fires to deploy the personnel parachute, and the harness release system operates to free the occupant from the seat. The occupant is momentarily held in the seat bucket by the sticker clips.

All modes. The personnel parachute, when developed, lifts the occupant and survival kit from the seat, pulling the sticker lugs from their clips. This arrangement ensures that there is no possibility of collision between seat and occupant after separation.

ORGANIZATIONAL-LEVEL MAINTENANCE

Learning Objective: *Identify the organizational-level maintenance philosophy for the NACES system.*

The primary task of maintenance technicians is to keep the systems they are responsible for in an operational condition. To achieve this goal, the technician must be proficient in the maintenance, removal, installation, testing, and adjustment of system components. All of this must be performed in accordance with applicable technical publications. Most importantly, all these functions must be done "safely."

Ejection seats and associated components are carefully designated, manufactured, and tested to ensure dependable operation. This equipment must function properly the first time. Malfunction or failure to operate usually results in severe injury or death to crew members. You must always use the utmost care in maintaining escape system equipment. Strict compliance with the maintenance procedures presented in the MIMs and the maintenance requirement cards (MRCs) are mandatory and cannot be overemphasized.

NOTE: The information presented in this chapter must NOT be used in place of information provided in the MIMs.

With the increasing use of diverse and exotic (composite) materials in the manufacture of aircraft components, it is imperative that the proper methods and materials be used to prevent and/or correct corrosion. NAVAIR 13-1-36, *Organizational Maintenance with Illustrated Parts Breakdown Manual*, has been developed to provide specific instructions and repair actions for NACES seat components. It is an in-shop manual written to provide the most complete and technically correct information available to the maintenance technician in one publication. Remember, these manuals are your primary source of maintenance information.

SUMMARY

The Martin-Baker Navy Aircrew Common Ejection Seat (NACES) represents the very latest in escape system technology. It has been designed to provide maximum personnel survivability, a high level of escape comfort, total reliability, and ease of maintainability. For the first time in this field, the power of the microchip has been harnessed to give the seat the unique ability to respond to the variable demands of an ejection situation in a manner far more flexible than was possible with earlier mechanically controlled seats.

APPENDIX I

GLOSSARY

ABO—Aviators breathing oxygen.

ACM—Air-cycle machine.

ACS—Air-conditioning system.

ADC—Air data computer.

AFC—Airframes change.

AIMD—Aircraft intermediate maintenance department.

ALLOY—A metal that is a mixture of two or more metals.

AMBIENT—Surrounding; adjacent to; next to. For example, ambient conditions are physical conditions of the immediate area such as ambient temperature, ambient humidity, ambient pressure, etc.

AN—Air Force—Navy (standard or specification).

ANOXIA—A complete lack of oxygen in the blood stream.

APU—Auxiliary power unit.

BIT—Built-in tester.

BLEED AIR—Hot, high-pressure air, taken from the compressor section of a jet engine.

BRU—Barastatic release unit.

CAD—Cartridge and cartridge-actuated devices.

CAUTION—An operating procedure, practice, etc., that if not strictly observed could result in damage to or destruction of equipment.

CCU—Component control unit.

CDI—Collateral duty inspector.

CELSIUS—A temperature scale using 0 as the freezing point of water and 100 as the boiling point. The scale has 100 equal divisions between the 0 and 100 with each division designated a degree. A reading is usually written in an abbreviated form; for example, 75°C. This scale was formerly known as the centigrade scale, but it was renamed in recognition of Anders Celsius, the Swedish astronomer who devised the scale.

CF_3Br—The chemical symbol for trifluorobromomethane.

CNO—Chief of Naval Operations.

CONTAMINANT—An impurity such as harmful foreign matter in a fluid.

DODIC—Department of Defence Information Code.

DTG—Date-time group.

ECS—Environmental control systems.

EI—Engineering investigation.

FCDC—Flexible confined detonating cord.

FLSC—Flexible linear shaped charge.

GPM—gallons per minute.

Hg—Mercury.

IMA—Intermediate maintenance activity.

IMP—Initiator multi-purpose.

IPB—Illustrated parts breakdown.

JULIAN DATE—The year and numerical day of the year identified by four numeric characters. The first character indicates the year, and the remaining three characters specify the day of the year. For example, 3030 indicates the 30th day of 1983.

KINKED—A twist or curl, as in cable, wire, or tubing, caused by its doubling or bending upon itself.

LOX—Liquid oxygen.

LRU—Leg restraint unit.

MAINTENANCE—The function of retaining material in or restoring it to a serviceable condition.

MBEU—Martin-Baker Ejection Unit (seat).

MIM—Maintenance Instruction Manual.

MRC—Maintenance Requirement Card.

MULTIMETER—An instrument used for measuring resistance, voltage, or amperage.

NACES—Naval aircrew escape system.

NADEP—Naval Aviation Depot.

NATOPS—Naval Air Training and Operating Procedures Standardization.

NAVAIRSYSCOM—NAVAIR; NA (Naval Air Systems Command).

NFO—Naval flight officer.

NOMENCLATURE—A system of names; systematic naming.

NOTE—An operating procedure, condition, etc., which, because of its importance, is essential to highlight.

NSN—National stock number.

OPNAV—Office of the Chief of Naval Operations.

OXIDATION—That process by which oxygen unites with some other substance, causing rust or corrosion.

PHYSIOLOGICAL—Of or pertaining to the body.

PRESSURE—The amount of force distributed over each unit of area. Pressure is expressed in pounds per square inch (psi).

PSI—Pounds per square inch.

PSIA—Pounds per square inch absolute.

PSIG—Pounds per square inch gauge.

PSYCHOLOGICAL—Pertaining to, or derived from the mind or emotions.

RAC—Rapid action change.

SAFETY WIRE/LOCKWIRE—A wire set into a component to lock movable parts into a safe, secure position.

SDLM—Standard depot-level maintenance.

SE—Support equipment. All the equipment on the ground needed to support aircraft in a state of readiness for flight. Formerly ground support equipment (GSE).

SERVICING—The filling of an aircraft with consumables such as fuel, oil, and compressed gases to predetermined levels, pressure, quantities, or weights.

SJU—Seat jettison unit.

SMDC—Shielded mild detonating cord.

SOLVENT—A liquid that dissolves other substances.

SPCC—Ships Parts Control Center.

TENSION—A force or pressure exerting a pull or resistance.

TM—Type maintenance.

T/M/S—Type/model/series.

TORQUE—A turning or twisting force.

TOXIC—Harmful, destructive, deadly; poisonous.

VOLATILE LIQUIDS—Liquids that are readily vaporizable at relatively low temperatures. Explosive liquids.

WARNING—An operating procedure, practice, etc., that if not followed correctly could result in personal injury or loss or life.

WORK—The transference of energy from one body or system to another. That which is accomplished by a force acting through a distance.

APPENDIX II

REFERENCES

CHAPTER 1

Aviators Breathing Oxygen Surveillance Program and Field Guide, AG-332AO-GYD-000, Naval Air Systems Command, Washington, D.C., October 1985.

General Use Cartridges and Cartridge-Actuated Devices (CADS) for Aircraft and Associated Equipment, NAVAIR 11-100-1.1, Naval Air Systems Command, Washington, D.C., September 1984.

Cartridges and Cartridge-Actuated Devices (CADS) for Unique Aircraft Systems, NAVAIR 11-100-1.2, Naval Air Systems Command, Washington, D.C., September 1984.

Naval Aviation Maintenance Program (NAMP), OPNAVINST 4790.2 (series), Vol II, Office of the Chief of Naval Operations, Washington, D.C., January 1989.

NAVOSH Programs Manual for Forces Afloat, OPNAVINST 5100.19B, Department of the Navy, Office of the Chief of Naval Operations, Washington, D.C., April 1989.

NAVAIROSH Requirements for the Shore Establishment, NAVAIR A1-NASOH-SAF-0001P-5100.1, Naval Air Systems Command, Washington, D.C., February 1986.

CHAPTER 2

F/A-18 Seat, Canopy, Survival Equipment, and Boarding Ladder, A1-F18AC-120-100, Naval Air Systems Command, Washington, D.C., August 1988.

F/A-18 Seat, Canopy, Survival Equipment, and Boarding Ladder, A1-F18AC-120-300, Naval Air Systems Command, Washington, D.C., August 1988.

General Use Cartridges and Cartridge-Actuated Devices for Aircraft and Associated Equipment, NAVAIR 11-100-1.1, Chapter 1, Naval Air Systems Command, Washington, D.C., September 1984.

Principles of Operation Environmental Control System, A1-F18AA-410-100, Work Packages 008 00,012 00, and 013 00, Naval Air Systems Command, Washington, D.C., March 1980.

CHAPTER 3

P-3 Utility Systems, NAVAIR 01-75PAA-2-2.4, Naval Air Systems Command, Washington, D.C., January 1988.

A-6 Environmental Control Systems, NAVAIR 01-85ADF-2-2.5.1, Naval Air Systems Command, Washington, D.C., August 1988.

Escape and Survival Systems, NAVAIR 01-85ADF-2-2.4, Naval Air Systems Command, Washington, D.C., May 1987.

Utility, Environmental and Personnel Survival Equipment, NAVAIR 01-85WBA-2-2.4, Section II, Naval Air Systems Command, Washington, D.C., April 1981.

CHAPTER 4

Navy Electricity and Electronics Training Series, NAVEDTRA 172-03-00-85, Module 3, Chapter 1, Naval Education and Training Program Development Center, Pensacola, Fla., 1985. (The Naval Education and Training Program Development Center became the Naval Education and Training Program Management Support Activity on 1 Sep 1986.)

Principles of Operation Environmental Control System, NAVAIR 01-S3AAA-2-2.7, Naval Air Systems Command, Washington, D.C., September 1985.

Principles of Operation Propulsion System, NAVAIR 01-S3AAA-2-2.6, Work Package 00408, Naval Air Systems Command, Washington, D.C., April 1980.

Principles of Operation Airframe Group Systems, NAVAIR 01-S3AAA-2-2.2, Work Packages 00307, 00308, 00309, and 013 13, Naval Air Systems Command, Washington, D.C., July 1977.

S-3 Testing and Troubleshooting Environmental Control System, NAVAIR 01-S3AAA-2-3.7, Naval Air Systems Command, Washington, D.C., September 1985.

CHAPTER 5

Organization Maintenance With IPB Aircraft Ejection Seat SJU-17(V)1/A and SJU-17(V)2/A, F/A-18C and F/A-18D Aircraft, NAVAIR 13-1-29, Preliminary Technical Manual, Naval Air Systems Command, Washington, D.C., April 1990.

NATOPS Flight Manual F/A-18C and F/A-18D Aircraft Ejection Seats, Al-F18AE-NFM-000, Preliminary Technical Manual, Martin-Baker Aircraft Company, Oxford, England, January 1990.

Description and Principles of Operation, Navy Aircrew Common Ejection Seats (NACES) SJU-17(V)1/A and SJU-17(V)2/A, F/A-18C and F/A-18D Aircraft, A1-F18AE-120-100, Preliminary Technical Manual, Martin-Baker Aircraft Company, Oxford, England, January 1990.

Turnaround Check List, F/A-18C and F/A-18D Aircraft, A1-F18AE-MRC-100, Preliminary Technical Manual, Martin-Baker Aircraft Company, Oxford, England, January 1990.

INDEX

G

H

L

M

N

R

S

U

Assignment Questions

Information: The text pages that you are to study are provided at the beginning of the assignment questions.

A S S I G N M E N T   1

Textbook Assignment: "Management Safety and Supervision," chapter 1, pages 1-1 through 1-13.

1-1. What manual contains Navy enlisted manpower and personnel classifications and occupational standards?

1. NAVPERS 18086
2. NAVPERS 18084-1
3. NAVPERS 18068
4. NAVPERS 18068-1

1-2. Because of the inherent dangers associated with duties, senior AME personnel should be concerned with which of the following safety factors?

1. Personnel safety
2. Equipment safety
3. Both 1 and 2 above
4. Shop/flight line safety

1-3. The absence of which of the following factors accounts for most accidents with and around safety and survival equipment?

1. Supervision and leadership only
2. Education and training only
3. Supervision and training only
4. Training, supervision, and leadership

1-4. Who has the basic responsibility to promote and adhere to safety rules and regulations?

1. The safety petty officer
2. The individual
3. The work center supervisor
4. The commanding officer

1-5. It is only necessary to provide safeguards, safety will take care of itself.

1. True
2. False

1-6. What does the term safety mean as discussed in this course?

1. Freedom from injury
2. Freedom from danger
3. Providing protection
4. Freedom from risk

1-7. What is the objective of the work environment?

1. To operate with maximum efficiency and safety
2. To operate with minimum efficiency and waste
3. To operate freely from interruption and difficulty
4. To eliminate hazards and provide safeguards

1-8. Which of the following is an objective of supervision?

1. To operate with minimum efficiency and waste
2. To operate free from interruption and difficulty
3. To operate with maximum efficiency and safety
4. Each of the above

1-9. To establish a good safety record requires a good safety program.

1. True
2. False

1-10. Ninety-eight percent of all accidents can be prevented. The remaining 2 percent are caused by what factor?

1. Faulty equipment
2. Poor supervision
3. Natural elements
4. Lack of communication

1-11. How is enforcement defined as it applies to safety?

1. Reprimanding violators
2. Monitoring a continuous safety program
3. Formulating rules and regulations and a safety policy

1-12. Supervisors must enforce safety rules without fear or favor.

1. True
2. False

1-13. When determining the requirements for forward or advance base operations, you must consider what factors?

1. Safety, mission, and environment only
2. Operating factors and facilities only
3. Safety and mission only
4. Safety, mission, environment, operating factors, and facilities

1-14. According to its primary function, a functional component is formed from what total number of major groups?

1. 10
2. 11
3. 12
4. 13

1-15. Which of the following items is one of 300 standardized Navy units used to build and operate advanced bases?

1. Expenditure
2. Functional
3. Planning
4. Logistic

1-16. What is the major group designation for aviation?

1. H
2. I
3. J
4. K

1-17. What factors are included on the list of requirements for the performance of a specific task at an advance base?

1. A combination of material and equipment only
2. A combination of equipment and personnel only
3. A combination of equipment, material, and/or personnel
4. A combination of equipment, supplies, and repair parts

1-18. Other necessary repair parts, supplies, and equipment may be determined from the outfitting list for what activity or action?

1. The type aircraft and mission to be supported
2. The mission and weapon system to be supported
3. The type aircraft and weapon system to be supported
4. All of the above

1-19. What section of the Advanced Base and Initial Outfitting List provides complete information and data requirements?

1. Abridged and supply
2. Index
3. Outfitting and support
4. Abridged and detailed outfitting for functional components

1-20. What instruction is used to implement the NAVOSH program ashore?

1. OPNAVINST 4790.2E, Vol. IV
2. OPNAVINST 5100.19B, Vol. I
3. OPNAVINST 5100.19B, Vol. II
4. OPNAVINST 5100,23B, Vol. III

1-21. An AME must deal with what three major hazardous substances?

1. CADs, LOX, rocket motors
2. CADs, nitrogen, hot bleed air
3. High-pressure air, CADs, LOX
4. High-pressure air, LOX, gaseous oxygen

1-22. What are the two states of aviators breathing oxygen?

1. Type I Liquid, Type II Gaseous
2. Type I Gaseous, Type II Gaseous
3. Type I Liquid, Type II Liquid
4. Type I Gaseous, Type II Liquid

1-23. What publication should be used to follow established safety procedures for the handling of LOX?

1. NAVAIR 06-03-501
2. NAVAIR 06-30-501
3. NAVAIR 06-03-509
4. NAVAIR 06-30-509

1-24. At atmospheric pressure, oxygen exists as a solid at what temperature below its melting point?

1. -297°F
2. -297°C
3. -361°C
4. -361°F

1-25. Which of the following type designators is classed as liquid oxygen?

1. I
2. II
3. III
4. IV

1-26. What is the critical temperature of gaseous oxygen?

1. -119°C
2. -183°c
3. -297°C
4. -281°C

1-27. Gaseous oxygen will turn into a liquid at atmospheric pressure by raising the temperature above -297°F.

1. True
2. False

1-28. What is the critical pressure required to liquify oxygen?

1. 736 psia
2. 736 psig
3. 736.5 psia
4. 736.3 psig

1-29. Gaseous oxygen will condense to a liquid under which, if any, of the following conditions?

1. Temperatures above it's critical temperature
2. Atmospheric pressure
3. Pressure above it's critical pressure
4. None of the above

1-30. What are the physical characteristics of gaseous oxygen?

1. Odorless, tasteless, colorless
2. Pale blue fluid that flows like water
3. 1.5 times heavier than air
4. None of the above

1-31. How much heavier is 1 gallon of liquid oxygen than 1 gallon of water?

1. 1.10 lb
2. 1.12 lb
3. 1.13 lb
4. 1.14 lb

1-32. What is the total weight of 1 gallon of liquid oxygen?

1. 9.159 lb
2. 9.519 lb
3. 9.5 lb
4. 9.1 lb

1-33. What are the two most important factors a supervisor looks for in an individual before assigning him/her duties and responsibilities of handling LOX?

1. An understanding of safety and LOX cart operation
2. A current LOX license and knowledge of LOX cart operation
3. Consciousness, safety, and first aid ability
4. An understanding of safety and a history of reliable performance

1-34. How often should an aircraft LOX converter system be sampled and tested?

1. Every 210 days
2. Every 30 days
3. As soon as possible after a report of in-flight odors by aircrew personnel
4. When the AME suspects the system doesn't smell right

1-35. What contaminants must be prevented from entering a LOX system during the handling and transfer process?

1. Water
2. FOD
3. Oil
4. Atmospheric gases

1-36. Reports concerning LOX contamination will be submitted in accordance with what OPNAVINST?

1. 3750.6
2. 4790.2
3. 5100.19
4. 8023.1

1-37. Under which of the following conditions must a LOX converter or oxygen system be purged?

1. If the system is left open to the atmosphere
2. Whenever contamination is suspected
3. When empty
4. All of the above

1-38. An aircraft oxygen system or LOX converter must be purged in accordance with what publications?

1. OPNNAVINST 4790.2 and the MIMs
2. OPNAVINST 3750.6 and the MIMs
3. NAVAIR 01-LOX-6.4 and the MIMs
4. NAVAIR 01-13-1-6.4 and/or the MIMs

1-39. What type of test is used for station monitoring of aviators gaseous breathing oxygen?

1. Liquid sample
2. Cryogenic
3. MICRO contamination
4. Sniff-odor

1-40. The on-station procurement of aviators gaseous breathing oxygen must meet the requirements of what publication?

1. OPNAVINST 4790.2
2. OPNAVINST 5100.19
3. NAVAIR 13-1-6.4
4. MIL-0-27210

1-41. What publication will be used in the performance of sample testing of gaseous oxygen?

1. MIL-0-27210
2. A6-332AO-QYD-000
3. NAVAIR 13-1-6.4
4. NAVAIR 06-30-501

1-42. Cylinders used for aviators gaseous breathing oxygen that are found with open valves and/or a positive internal pressure of less than 25 psig should be tagged with what information?

1. Empty
2. Needs filling
3. Dry before filling
4. Needs purging

1-43. Which of the following is a method for providing high-pressure compressed air?

1. Portable cylinder
2. Pump station air compressor
3. Cascade-type cylinder
4. Each of the above

1-44. A malfunctioning pressure regulator should be disconnected from the line by what method?

1. Removing the line
2. Removing the regulator
3. Closing the associated shut-off valve
4. Closing the associated bottle by turning the bottle valve

1-45. Under which, if any, of the following circumstances, may an unmarked or unidentified cartridge be installed in an ejection seat?

1. When directed by the commanding officer
2. When directed by the maintenance officer
3. Only in emergency situations
4. None of the above

1-46. When must newly assigned personnel receive an ejection seat check-out?

1. Within 60 days of reporting
2. Within 90 days of reporting
3. Within 180 days of reporting
4. Prior to performing any maintenance tasks

1-47. Each AME must receive a seat check-out a minimum of how often?

1. Once per assignment
2. Once every 6 months
3. Once every 9 months
4. Once a year

1-48. What information must be listed on an individual's records for having received a seat check-out?

1. Date due, date given, signature of individual
2. Date due, date given, signature of supervisor
3. Date due, date given, signature of AME supervisor
4. Date due, date qiven, signature of AME giving check-out

A. Description, Preparation for Use, and Handling Instructions, Aircrew Escape Propulsion System (AEPS) Devices
B. General Use Cartridges and Cartridge Actuated Devices for Aircraft and Associated Equipment
C. Ammunition Afloat
D. Ammunition and Explosives Ashore

Figure 1.--Ordnance Publications

IN ANSWERING QUESTIONS 1-49 THROUQH 1-52, SELECT THE PUBLICATION TITLE FROM FIGURE 1 THAT RELATES TO THE PUBLICATION NUMBER USED AS THE QUESTION. USE EACH TITLE ONLY ONCE.

1-49. NAVAIR 11-85-1.

1. A
2. B
3. C
4. D

1-50. OP 4.

1. A
2. B
3. C
4. D

1-51. OP 5.

1. A
2. B
3. C
4. D

1-52. NAVAIR 11-100-1.

1. A
2. B
3. C
4. D

1-53. The specific period of time that a CAD is allowed to be used is known as its

1. shelf life
2. service life
3. installed life
4. removed life

1-54. What date must be checked prior to installing a CAD into any system?

1. Open
2. Expiration
3. Installed
4. Manufacture

1-55. To determine the service-life expiration date of a CAD, what date(s) must be computed?

1. Aircraft life
2. Shelf life
3. Installed life
4. Both 2 and 3 above

1-56. If the date of manufacture of a CAD is 0981 and the shelf life is 6 years, what is the shelf-life expiration date?

1. 0985
2. 0986
3. 0987
4. 0988

1-57. To which of the following manuals should you refer to determine the installed-life expiration date of a CAD?

1. NAVAIR 11-100-1
2. NAVAIR 11-85-1
3. OP 4
4. OP 5

1-58. To determine the installed-life expiration date, the installed-life date is added to the date what action was performed on the container?

1. Opened
2. Received from supply
3. Received from the manufacturer
4. Sealed by the manufacturer

1-59. If the installed life is 66 months, what is the installed-life expiration date of a CAD whose container was opened during 1183?

1. 0588
2. 0688
3. 0589
4. 0689

1-60. A hermetically sealed container was opened on 15 March. Which of the following dates is used to compute the expiration date?

1. 1 January
2. 1 March
3. 15 March
4. 31 March

1-61. Which of the following is an approved method for marking expiration dates on CADs?

1. Paint
2. Scribe
3. Permanent ink
4. Electroetch

1-62. Which of the following dates must be marked on a CAD that is being installed in an aircraft?

1. Installed
2. Shelf-life
3. Container opened
4. Installed-life

1-63. A logbook entry for a CAD must be made when which of the following events occurs?

1. Actuation
2. Replacement
3. Reinstallation
4. Refurbishment

1-64. A contingency service-life extension for a CAD granted by the commanding officer may not exceed what maximum number of days?

1. 15
2. 30
3. 45
4. 60

1-65. For an additional service-life extension beyond the contingency extension, a message reply will be received from which of the following activities?

1. NAVORDSTA
2. NAVAIRLANT
3. NAVAIRSYSCOM
4. NAVORDSYSCOM

1-66. A change to NAVAIR 11-100-1 may change the permanent service life of CADs. Which of the following methods is used to change NAVAIR 11-100-1?

1. Rapid action change
2. Interim rapid action change
3. Formal change
4. Each of the above

1-67. What associated attachment determines the service life of wire-braid, Teflon®-lined hoses?

1. The initiator to which it is attached
2. The aircraft in which it is installed
3. The CAD to which it leads
4. The rocket motor to which it leads

1-68. When should the hoses in an escape system be inspected?

1. At every phased inspection
2. Upon removal of the seat
3. After the hoses are disconnected
4. All of the above

1-69. For safety reasons, which of the following devices will be installed in CADs when they are removed from the aircraft?

1. Caps
2. Plugs
3. Safety pins
4. All of the above

1-70. What OPNAVINST provides the guidelines for reporting ordnance malfunctions, discrepancies, and accidents?

1. 8023.3
2. 5100.19
3. 4790.2
4. 3750.6

1-71. What OPNAV form is used in the aircraft logbook/AESR for recording all explosive safety devices?

1. 4790/21A
2. 4790/25A
3. 4790/26A
4. 4790/26B

1 -72. The best assurance of personnel safety lies in the safety education of the people themselves.

1. True
2. False

A S S I G N M E N T 2

Textbook assignment 1: "Electrically Operated Canopy System," chapter 2, pages 2-1 through 2-13.

2-1. What function does the canopy serve on the F/A-18C?

1. Protection from the elements
2. Entry and exit for the cockpit
3. Both 1 and 2 above
4. A means for total visibility

2-2. The F/A-18C canopy is normally operated in which of the following modes?

1. Pneumatic
2. Hydraulic
3. Electrical
4. Manual

2-3. Under normal conditions, the canopy is controlled by which of the following devices?

1. Internal canopy control switch
2. External canopy control switch
3. Both 1 and 2 above
4. Manual canopy control handle

2-4. When the canopy actuation control system has failed, what method will be used to open and close the canopy?

1. Manual back-up mode
2. External electrical power
3. Internal electrical power
4. Utility battery power

2-5. Which of the following components is mounted on the canopy?

1. Canopy unlatch thruster
2. Canopy contactor
3. Canopy actuator
4. Canopy actuation link

2-6. The canopy actuator, used to open and close the canopy, is protected by a thermal device that senses an overheat condition.

1. True
2. False

2-7. What total number of manual methods are available to open and close the canopy?

1. One
2. Two
3. Three
4. Four

2-8. What total number of canopy control switches are provided for normal electrical operation of the canopy?

1. One
2. Two
3. Three
4. Four

2-9. What canopy contactor supplies power to the close windings of the canopy actuator motor?

1. Up
2. Down
3. Open
4. Close

2-10. In what canopy latch retainer is the canopy position switch mounted?

1. Number 1
2. Number 2
3. Number 3
4. Number 4

2-11. What switch(es) must be depressed to extinguish the master caution light?

1. Canopy position switch
2. Canopy locked switch
3. Both 1 and 2 above
4. Canopy caution switch

2-12. How much power does the F/A-18 aircraft electrical system supply for canopy operation?

1. 24 volts ac
2. 24 volts dc
3. 28 volts dc
4. 28 volts ac

2-13. The air-cycle air-conditioning system supplies cold air for the inflation of the canopy pressure seal.

1. True
2. False

2-14. Both canopy switch plungers must be depressed within what maximum number of seconds?

1. 5
2. 10
3. 15
4. 20

2-15. If you use the internal manual canopy handle, what maximum number of turns may be required to close the canopy?

1. 70±1
2. 75±1
3. 80±1
4. 85±1

2-16. What component transfers the mechanical motion of the manual drive unit to the canopy actuator?

1. Handle assembly
2. Actuator arm
3. Shaft assembly
4. Torque limiter

2-17. What maximum number of turns may be required to externally operate the canopy actuator manual drive unit?

1. 5±1
2. 15±1
3. 25±1
4. 35±1

2-18. What component prevents damage to the actuator if excessive force is applied in the manual back-up control mode?

1. Handle assembly
2. Actuator arm
3. Shaft assembly
4. Torque limiter

2-19. Which of the following handles will cause the canopy to be jettisoned?

1. Internal jettison
2. External jettison
3. Ejection control
4. Each of the above

2-20. What device(s) prevents the backflow of an SMDC detonation from reaching the seat components?

1. Emergency escape disconnect
2. One-way transfer valve
3. SMDC initiator
4. Both 2 and 3 above

2-21. What component provides the ballistic gas that fires the canopy jettison rocket motor?

1. Canopy jettison SMDC initiator
2. Emergency escape disconnect
3. Canopy unlatch thruster
4. Canopy jettison FCDC initiator

2-22. What component provides the vertical thrust needed to separate the canopy from the aircraft?

1. Canopy actuator
2. Rocket motor
3. Unlatch thruster
4. SMDC initiator

2-23. Which of the following devices is used to protect SMDCs?

1. Metallic sheath
2. Braid overwrap
3. Stainless steel tubing
4. Aluminum tubing

2-24. What is the approximate length of the external jettison initiator cable?

1. 6 feet
2. 8 feet
3. 10 feet
4. 12 feet

2-25. What device prevents the internal jettison handle from being squeezed and pulled?

1. Shear pin
2. Safety pin
3. Shear wire

2-26. The rocket motor initiators convert ballistic-gas pressure to what force?

1. Explosive canopy thrust
2. Explosive stimulus
3. Explosive energy
4. Mechanical energy

2-27. What total number of SMDC initiators are in the F-18C canopy jettison system?

1. One
2. Two
3. Three
4. Four

2-28. How many methods are available to jettison the canopy on the F-18C aircraft?

1. One
2. Two
3. Three
4. Four

2-29. On the F-18 aircraft, how much time must elapse+before the thermal protection device will reset after sensing an overheat condition?

1. 15 seconds
2. 39 seconds
3. 60 seconds
4. 90 seconds

IN ANSWERING QUESTIONS 2-30 THROUGH 2-35, REFER TO THE CANOPY JETTISON SYSTEM SCHEMATIC AT FIG. 2-12 IN THE TEXT. SELECT FROM COLUMN B THE CORRECT MEANING OF THE SYMBOLS IN COLUMN A.

COLUMN A

2-30. 

1. 5
2. 6
3. 7
4. Both 6 and 7

2-31. ------

1. 5
2. 2
3. 3
4. 4

2-32. 

1. 1
2. 2
3. 3
4. 4

2-33. 

1. 7
2. 6
3. 5
4. 4

2-34. 

1. 1
2. 2
3. 3
4. 4

COLUMN B

1. Shielded mild detonating cord
2. Flexible confined detonating cord
3. Ballistic gas
4. Structural pivot point
5. Mechanical linkage
6. Ejection seat
7. Emergency escape sequencing system

IN ANSWERING QUESTION 2-35, REFER TO THE CANOPY JETTISON SYSTEM SCHEMATIC AT FIG. 2-12 IN THE TEXT. SELECT FROM COLUMN B THE CORRECT MEANING OF THE SYMBOL IN COLUMN A.

COLUMN A

2-35. 

1. 2
2. 3
3. 5
4. 4

COLUMN B

1. Shielded mild detonating cord
2. Flexible confined detonating cord
3. Ballistic gas
4. Structural pivot point
5. Mechanical linkage
6. Ejection seat
7. Emergency escape sequencing system

2-36. What component(s) act(s) as a solid link during normal canopy operation?

1. Canopy actuation connecting link
2. Canopy actuator
3. Both 1 and 2 above
4. Canopy unlatch thruster

2-37. What maintenance code is displayed on the nosewheel well DDI in the event the canopy switches disagree?

1. 888
2. 889
3. 890
4. 898

2-38. The electrical inputs supplied to the canopy actuator are transformed into what type energy?

1. Electrical
2. Direct power source
3. Mechanical motion
4. Logic circuit power

IN ANSWERING QUESTIONS 2-39 THROUGH 2-42, REFER TO FIGURE 2-9 IN THE TEXT.

2-39. The canopy system will be removed from the battery circuit when battery voltage drops below

1. 19 Vac
2. 19±1 Vac
3. 19 Vdc
4. 19±1 Vdc

2-40. When is the left main landing gear WOW relay #2 energized?

1. With weight on wheels
2. With external power applied
3. With weight off wheels
4. With battery power applied

2-41. From what circuit breaker/relay panel does the canopy control receive its power?

1. 6
2. 2
3. 8
4. 4

2-42. What component houses the thermal protection device?

1. Canopy control switch
2. Canopy actuator
3. #3 relay panel
4. #8 relay panel

IN ANSWERING QUESTIONS 2-43 THROUGH 2-49, REFER TO FIGURE 2A, BELOW, AND FIGURE 2-9 IN THE TEXT. MATCH THE COMPONENT NAME IN THE QUESTION WITH THE ALPHABETIC INDICATOR IN FIGURE 2A.

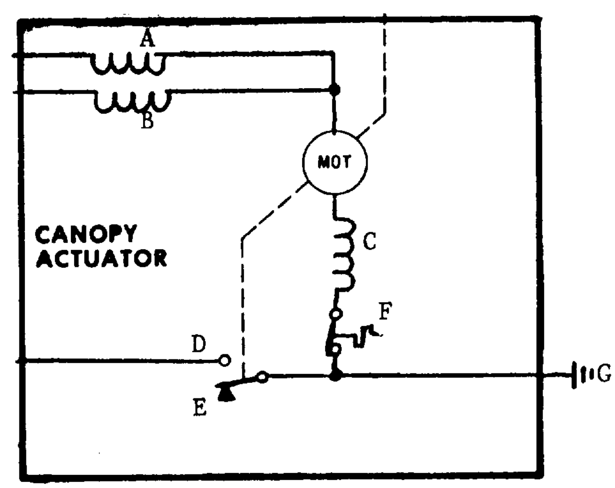


Figure 2A.--Canopy Actuator

2-43. Canopy up limit switch--up contact.

1. B
2. C
3. D
4. E

2-44. Canopy actuator electrical ground.

1. A
2. C
3. E
4. G

2-45. Canopy actuator field windings--open.

1. A
2. B
3. C
4. F

2-46. Canopy actuator brake winding.

1. D
2. C
3. B
4. A

2-47. Canopy actuator thermal protection device.

1. D
2. E
3. F
4. G

2-48. Canopy up-travel-limit switch--not up contact.

1. B
2. C
3. D
4. E

2-49. Canopy actuator field windings--close.

1. A
2. B
3. C
4. G

2-50. How many systems and components are related to the electrical canopy system?

1. Seven
2. Nine
3. Three
4. Four

2-51. Unlike the external canopy control switch, the internal canopy control switch has only two positions, open and close.

1. True
2. False

IN ANSWERING QUESTION 2-52, REFER TO FIGURE 12-9 IN THE TEXT.

2-52. Which of the following switches is/are a double pole double throw switch(es)?

1. Canopy position switch
2. Internal canopy control switch
3. External canopy control switch
4. Both 2 and 3 above

2-53. Explosive stimulus produced by the initiator is transferred through the SMDC to what component?

1. Canopy unlatch thruster
2. Emergency escape disconnect
3. Flexible confined detonating cord
4. Rocket motors

2-54. What component prevents explosive stimulus from continuing toward the ejection seat components during internal canopy jettison?

1. FCDC
2. Canopy unlatch thruster
3. Emergency escape disconnect
4. One way transfer valve

2-55. What action does each rocket motor produce to separate the canopy from the aircraft?

1. Thrust aft and up
2. Sufficient burn time
3. Vertical thrust
4. Horizontal thrust

2-56. During canopy jettison, the thruster unlocks internally and forces the canopy aft to disengage the canopy latches.

1. True
2. False

IN ANSWERING QUESTIONS 2-57 THROUGH 2-60, REFER TO FIGURE 2-9 IN THE TEXT. IDENTIFY THE TYPE SWITCHES USED IN THE ELECTRICAL CANOPY SYSTEM.

2-57. Canopy locked switch.

1. Single pole double throw momentary contacts
2. Single pole double throw
3. Double pole double throw momentary contacts
4. Double pole double throw

2-58. External canopy control switch.

1. Double pole double throw
2. Single pole three position
3. Double pole double throw momentary on
4. Single pole double throw three position

2-59. Canopy up contactor.

1. Single contact
2. Momentary on
3. Double contact
4. None of the above

2-60. Holding coil.

1. Single pole double throw normal or momentary contacts
2. Single pole double throw
3. Single pole single throw
4. Single pole single throw normal or momentary contacts on

A S S I G N M E N T 3

Textbook Assignment: "Utility Systems," chapter 3, page 3-1 through 3-10 and "Air-Conditioning Systems," chapter 4, pages 4-1 through 4-19.

3-1. Which of the following systems is used to prevent ice from forming on an aircraft?

1. Anti-ice
2. Deice
3. Rain-removal
4. Defrost

3-2. The P-3 aircraft uses what source of heat for its deicing system?

1. Electrical energy
2. Bleed air
3. Hydraulic pumps
4. Solar energy

3-3. What total number of bleed-air shutoff valves are on the P-3 aircraft?

1. Five
2. Six
3. Three
4. Four

3-4. By what method are the deicing system modulating valves controlled?

1. Pneumatic
2. Hydraulic
3. Electric
4. Thermostatic

3-5 . What component causes the modulating valve to close when the pressure is reduced on the modulating valve diaphragm?

1. Spring
2. Solenoid
3. Sensor
4. Spoon

3-6. Which of the following conditions will cause high temperature within the leading edge of the wing?

1. Solar radiation
2. Bleed-air leakage
3. Malfunctioning modulating valve
4. Both 2 and 3 above

3-7. The fusalage bleed-air shutoff valves are normally open during deicing operations.

1. True
2. False

3-8. To perform a deicing leak test, the manifold pressure must reach what minimum psi reading?

1. 40
2. 55
3. 70
4. 85

3-9. What should be the maximum number of seconds required for the accept light to Illuminate during a leak test?

1. 8
2. 12
3. 15
4. 20

3-10. The P-3C wing deice system uses bleed-air from what stage(s) of the engine compressor?

1. 12th
2. 13th
3. 14th
4. Both 2 and 3 above

3-11. Where is the wing leading edge pneumatic thermostat located?

1. Wing leading edge tips
2. Adjacent to each modulating valve
3. Adjacent to shut-off valve
4. Wing leading edge ducting

3-12. What component allows pressure from the modulating valve diaphragm to vent?

1. Leading edge temperature and overheat circuit
2. Overheat thermal switch
3. Fuselage bleed-air shutoff valve
4. Wing leading edge thermostat

3-13. At what temperature will the leading edge caution hot light illuminate?

1. 210°F
2. 220°F
3. 230°F
4. 240°F

3-14. The ducting overheat switches are explosiveproof, thermally actuated electrical switches with an integral temperature sensing element.

1. True
2. False

3-15. At what temperature will the outboard leading edge overheat warning switch open?

1. 205°F
2. 210°F
3. 215°F
4. 220°F

3-16. Where is the rotary selector switch located?

1. Bleed-air coated panel
2. Leading edge caution panel
3. Ice control panel box
4. Ice control protection panel

3-17. What total number of duct overheat thermal switches are installed in the P-3C aircraft?

1. Three
2. Six
3. Nine
4. Twelve

3-18. What will cause the OPEN light on the ice control protection panel to illuminate?

1. Failure of system components
2. When the air-conditioning valve is open
3. When the bleed-air valve opens more than 2 degrees
4. When the modulating valve opens more than 2 degrees

3-19. Either one or both fuselage bleed-air shutoff valves must be open to direct air to the wing anti-icing ducting?

1. True
2. False

3-20. How many modulating valve control switches are located on the left side of the wing and empennage ice panel?

1. One
2. Two
3. Three
4. Four

3-21. What switch(s) on the wing and empennage ice panel controls the outboard modulating valve on the left and right wings?

1. Inboard
2. Outboard
3. Center
4. Both 1 and 2 above

3-22. What switches will open when an overheat is sensed at 175°F and closes at 190°F?

1. Leading edge overheat warning switches
2. Wing overheat warning switches only
3. Fuselage overheat warning switches only
4. Wing and fuselage overheat warning switches

3-23. During normal operation of the de-icing system, two of the four engine bleed-air valves are open to supply bleed-air to the cross-ship manifold?

1. True
2. False

3-24. When should the deicing manifold system be tested for leakage?

1. Before each flight
2. Before each engine turn
3. During each flight
4. Both two and three above

3-25. The involvement of the AME 1 and AMEC in the maintenance of the deicing system normally consists of supervision only.

1. True
2. False

3-26. The A-6 rain-removal system uses bleed-air from what stage of the engine compressor?

1. 12th
2. 13th
3. 14th
4. 15th

3-27. Upon loss of electrical power, the nosewheel well bleed-air shutoff valve will be in what position?

1. Open
2. Closed
3. In the last selected position
4. In the manual position

3-28. What type of power is used to operate the rain-removal pressure-regulator shutoff valve?

1. Hydraulic
2. Pneumatic
3. Electric
4. Manual

3-29. What shutoff valve controls the airflow from the rain-removal system to the windshield?

1. Nosewheel well bleed air
2. Rain-removal pressure regulator
3. Main-engine bleed air
4. Cabin bleed air

3-30. What total number of nozzles are on the A-6 windshield?

1. 22
2. 24
3. 26
4. 28

3-31. What rain-removal system component mixes cool air with hot bleed air?

1. Ejector
2. Plenum
3. Nozzle
4. Coupler

3-32. In what two positions may the nosewheel well bleed-air switch be placed?

1. ON and OFF
2. AUTO and ON
3. AUTO and OFF
4. MANUAL and OFF

3-33. When the windshield switch is placed in the AIR position, through what circuit breaker does the dc voltage flow?

1. Anti-ice
2. Air conditioning
3. Rain-removal
4. Windshield air

3-34. The windshield air caution light illuminates to indicate that the windshield switch is in what position?

1. ON
2. OFF
3. AUTO
4. AIR

3-35. Where is the nosewheel well bleed-air relay mounted for the rain-removal system?

1. Air-conditioning panel
2. Aft bay relay box no. 3
3. Left main landing gear
4. Cockpit center console

3-36. The windshield rain-removal warning relay is a single throw, double pole sealed relay?

1. True
2. False

3-37. What are the three positions of the windshield switch?

1. ON, OFF, AUTO
2. AUTO, MANUAL, OFF
3. AIR, WASH, AUTO
4. WASH, AIR, OFF

3-38. Where is the rain-removal nozzle assembly located?

1. Beneath the pilot's windshield
2. Beneath the b/n's windshield
3. Both 1 and 2 above
4. Inside and under the radome next to the windshield

3-39. What switch controls the rain-removal pressure-regulator shutoff valve?

1. Windshield wash
2. Rain removal
3. Windshield
4. Air conditioning

3-40. The rain-removal system removes rain by directing a flow of heated air across the windscreen. What is the function of this heated air?

1. It blows the water away
2. It drys the windscreen, keeps it dry
3. It breaks the raindrops into small particles
4. It evaporates the raindrops

3-41. The left main landing gear weight-on-wheels switch controls the nosewheel and bleed-air relay?

1. True
2. False

3-42. Under what condition(s) is the left main landing gear weight-on-wheels switch in the closed position?

1. When the strut is compressed
2. When the strut is extended
3. Neither of the above

3-43. What stage of the compressor is the primary source of bleed air for operation of the ECS?

1. 10th
2. 12th
3. 14th
4. 16th

3-44. Which of the following methods is used to (a) control and (b) actuate the bleed-air flow control and shutoff valve?

1. (a) Electric (b) pneumatic
2. (a) Electric (b) electric
3. (a) Pneumatic (b) electric
4. (a) Pneumatic (b) pneumatic

3-45. What air supply source(s) could be used for engine starting and ground operation of the air-conditioning system?

1. Ram air
2. Ground start air
3. APU air
4. Both 2 and 3 above

3-46. Which of the following conditions will cause the bleed-air shutoff valve to close?

1. Overtemperature
2. Overpressure
3. Loss of electrical power
4. All of the above

3-47. When operating the deicing system with one engine secured, what valve must be open to allow bleed air to both sides of the aircraft?

1. Bleed-air shutoff
2. Bleed-air flow control and shutoff
3. Engine bleed-air bypass and shutoff
4. Crossover duct isolation check

3-48. What valve will open because of a sensed pressure drop through the ice screen?

1. Bleed-air shutoff
2. Bleed-air flow control and shutoff
3. Engine bleed-air bypass and shutoff
4. Nonice and low-limit control

3-49. What do the lights for the bleed-air shutoff valves indicate?

1. Switch position
2. Valve position
3. Both 1 and 2 above
4. High temperature

3-50. In the event of a rupture in the left or right manifold, what valve will prevent overbleeding of the engines?

1. Bleed-air shutoff
2. 10th-stage check
3. High-stage check
4. Crossover duct isolation check

3-51. What is the total number of basic components in the refrigeration subsystem?

1. 7
2. 8
3. 9
4. 10

3-52. What component, if any, is used to check the oil level in the cooling turbine?

1. Dip stick
2. Pressure gauge
3. Siqht gauge
4. None

3-53. Which of the following conditions will cause the temperature indicator probe in the fan inlet to trip?

1. Obstruction of the ram-air inlet duct
2. Collapse of the ram-air inlet duct
3. Temperature above 440°F
4. All of the above

3-54. What component allows air to pass through the water separator if ice has accumulated in the coalescer bag?

1. Water separator ice screen
2. Coalescer cone
3. Swirl vanes
4. Water separate bypass valve

3-54. What name is given to the air used to cool the sonobuoy and weapons bays?

1. Refrigerated
2. Partially cooled
3. Cabin exhaust
4. Ram

3-56. What component prevents ram air from flooding the cabin when the aircraft is flying at high speeds?

1. Outflow valve
2. Cabin pressure regulator
3. Cabin air temperature control
4. Ram-air shutoff valve

3-57. When the air-conditioning switch is OFF, the AUX vent switch is ON, and the ram-air pressure does not meet cabin exhaust fan requirements, what valve will open?

1. Ram-air shutoff
2. Water separator bypass
3. Cabin outflow
4. Negative pressure relief

3-58. The torque motor in the cabin temperature control modulating valve converts electrical signals to what type signals?

1. Pneumatic
2. Mechanical
3. Magnetic
4. Hydraulic

3-59. What component provides the controlling signal for the cabin temperature control valve?

1. Cabin air thermistors
2. Cabin air sensor
3. Cabin air temperature control
4. Cabin air high-temperature thermostat

3-60. The opening of the cabin air high-temperature limit thermostat internal valve causes what valve(s) to close?

1. Cabin temperature control valve
2. Nonice and low-limit control valve
3. Both 1 and 2 above
4. Bleed-air flow control and shutoff valve

3-61. The cabin temperature control sensor is designed to control the cabin temperature within what number of degrees of the selected temperature?

1. ±3
2. ±7
3. ±10
4. ±11

3-62. In the ram-air augmentation mode, the ram-air shutoff valve regulates downstream pressure to what fixed differential above cabin pressure?

1. 7.5±2
2. 5.5±1
3. 3.0±.5
4. 4.0±1

3-63. During manual operation, what switch is used to position the ram-air shutoff valve?

1. Cabin pressurization
2. Air-conditioning
3. Auxiliary vent
4. Temperature select

3-64. When the air conditioning automatically shuts down and the ram-air shutoff valve is fully open, what action, if any, must be taken to restore normal operation?

1. Secure the AUX VENT switch
2. Turn the air-conditioning switch to OFF and then to ON
3. Turn the air-conditioning switch to OFF, then to RESET, and then to ON
4. None

3-65. What valve is controlled by the aux vent switch?

1. Cabin temperature modulating valve
2. Ram-air valve
3. Aux-vent valve
4. Cabin-outflow valve

3-66. What is the function of the environmental control panel?

1. To control temperature
2. To control pressurization
3. To control anti-icing function
4. All the above

3-67. The ground-aircheck valve is a split-flapper valve which is spring-loaded to the open position until engine start-up.

1. True
2. False

3-68. What component(s) interconnect with the ram-air high and low-temperature limit switch circuitry?

1. Auxiliary vent switch
2. Bleed-air flow control valve and ram-air shutoff switch
3. Both 1 and 2 above
4. Aux bent valve and aux vent switch

3-69. With the cabin air temperature selector in the automatic mode within what temperature range can the cabin temperature be selected?

1. 70°F to 90°F
2. 60°F to 80°F
3. 65°F to 85°F
4. 75°F to 95°F

3-70. What is the temperature limit on the cabin temperature control valve while in the automatic mode?

1. 160°±5°F
2. 160°±15°F
3. 185°±5°F
4. 185°±15°F

3-71. Icing of the water separator will only occur at low altitudes where mass airflow and temperature are relatively high.

1. True
2. False

3-72. What component in the refrigeration pack low-limit control senses duct air temperature and compares it with an internally generated reference?

1. Pneumatic pickups
2. Inlet air sensor
3. Thermistor
4. Temperature limit thermostat

3-73. What are the two physically separated packages of the refrigeration subsystem?

1. Refrigeration and air conditioning
2. Heating and air conditioning
3. Refrigeration and cabin air/water separator
4. Air conditioning and pressurization

3-74. Water vapor condenses as ice crystals when the turbine discharge air drops below what maximum temperature

1. 0°F
2. 15°F
3. 32°F
4. 40°F

3-75. In the bleed-air system, what component senses the bleed-air pressure in the duct upstream from the bleed-air flow control and shutoff valve?

1. Overtemperature pressure sensor
2. Temperature control orifice
3. Temperature sensor
4. Pressure transmitter

ASSIGNMENT 4

Textbook Assignment: "Navy Aircrew Common Ejection Seat (NACES)," chapter 5, pages 5-1 through 5-38.

4-1. What configuration is used in the NACES system to meet the exact requirements of the crew station designer?

1. Reversible
2. Flexible
3. Standard
4. State-of-the-art

4-2. What does the acronym NACES mean?

1. Navy Aircraft Ejection Seat
2. Navy Aircrew Common Ejection Seat
3. Naval Aircrew Escape System
4. Naval Automatic Control Escape System

4-3. What type ejection seat is used in the F/A-18C aircraft?

1. SJU-17(V) 1/A
2. SJU-17(V) 2/A
3. SJU-17(V) 3/A
4. SJU-17(V) 4/A

4-4. The NACES may be used in either the F/A-18C/D, F-14A or A-6E aircraft?

1. True
2. False

4-5. Who is responsible for removing and installing the ejection control handle safety pin prior to and after flight?

1. Plane captain only
2. Aircrew only
3. Plane captain prior to and aircrew after
4. Aircrew prior to and plane captain after

4-6. The SJU-17(V)1/A ejection seat provides escape capabilities within which of the following parameters?

1. All altitudes and airspeeds
2. A maximum of 600 knots speed and 50,000 feet altitude
3. Zero altitude and zero airspeed
4. Both 2 and 3 above

4-7. What is the primary purpose of the barostatic release unit?

1. To act as a backup in the event of electronic sequencer failure
2. To release the occupant from the seat
3. To release the personal parachute at a determined altitude
4. To provide automatic operation of the emergency restraint release

4-8. After seat ejection, the seat is stabilized and the forward speed is retarded by what component(s)?

1. Personal parachute
2. Drogue parachute
3. Bridle system
4. Both 2 and 3 above

4-9. What component automatically controls drogue deployment, seat/man separation, and parachute deployment after ejection?

1. Barostatic release unit
2. Time release mechanism
3. Drogue/bridle release system
4. Multimode electronic sequencer

4-10. The NACES consists of what total number of main assemblies?

1. Six
2. Five
3. Three
4. Four

4-11. What is the primary purpose of the catapult assembly?

1. To jettison the seat from the aircraft
2. To provide initial power for seat ejection
3. To secure the seat to the aircraft structure
4. Both 2 and 3 above

4-12. The seat bucket assembly consists of the underseat rocket motor, lateral thrust motor, leg restraint snubbers, two pitot assemblies, shoulder harness control lever, and pin puller.

1. True
2. False

4-13. When the ejection seat is installed in the aircraft, what component locks it to the catapult?

1. Upper right main beam
2. Upper left main beam
3. Top latch plunger
4. Barostatic release unit

4-14. What barrels make up the catapult ejection gun?

1. Inner, outer only
2. Inner, intermediate only
3. Intermediate, outer only
4. Inner, intermediate, outer

4-15. What crossbeam takes the full thrust of the catapult during ejection?

1. Top crossbeam
2. Center crossbeam
3. Bottom crossbeam

4-16. What services do the seat bucket slippers provide?

1. Attachment points for the seatbucket to the mainbeam
2. Damping out lateral movement
3. Smooth movement of the seat bucket

4-17. What total number of slippers are attached to the guide rails of the mainbeam assembly?

1. Five
2. Six
3. Three
4. Four

4-18. What handle is located on the left side of the seat bucket?

1. Safe/arm control
2. Seat height adjustment
3. Shoulder harness control
4. Manual override

4-19. What component on the NACES protects the occupant in the event of rapid forward deceleration?

1. Static lanyard
2. Spring loaded withdrawal plunger
3. Shoulder harness reel
4. Shoulder harness strap quadrant

4-20. Which of the following is a characteristic of the PRDM?

1. Has a cylindrical body
2. Has a gas operated secondary cartridge
3. Is a sealed unit
4. Each of the above

4-21. The PRDM primary cartridge is fired by what means?

1. Mechanically
2. Ballistically
3. Electrically
4. Gas

4-22. The PRDM can be initiated by which of the following means?

1. Electronic sequencer
2. Manual override system
3. Restraint release unit
4. Each of the above

4-23. The parachute withdrawal line is attached to the PDRM by what means?

1. By scissor mechanism
2. By a bolt and lock nut
3. By a sliding stirrup
4. By a spring-loaded quick release pin

4-24. The electronic sequencer is mounted on the NACES at what point?

1. Across the mainbeam assembly behind the seat bucket
2. Across the mainbeam assembly above the main parachute
3. Across the mainbeam assembly below the main parachute
4. Across the mainbeam assembly's lower aft end

4-25. Upon activation, the electronic sequencer determines the mode of ejection and supplies power to the start switches?

1. True
2. False

4-26. Which of the following is a function of the barostatic release unit impulse cartridge?

1. Provides the necessary gas for the restraint release assembly
2. Provides the necessary gas pressure to retract the capsule peg
3. Provides the necessary gas to prevent mechanical initiation

4-27. What component of the barostat assembly prevents the delay mechanism from operating at altitudes in excess of barostat ratings?

1. Quick release pin
2. Bellows device unit
3. Peg engagement mechanism
4. Diaphragm assembly

4-28. What action or component supplies the power source to fire the drogue deployment catapult cartridge?

1. Retraction of the capsule peg
2. Gas pressure from the primary initiators
3. The delay mechanism firing pin
4. The electrical inputs from the electronic sequencer

4-29. What is the primary function of the drogue deployment catapult?

1. To stabilize the ejection seat
2. To rapidly deploy the drogue and bridle assembly
3. To prevent parachute entanglement
4. To ensure a rapid escape from the ejection seat

4-30. Which of the following is a characteristic of the drogue deployment catapult assembly?

1. Contains a two-piece telescope piston
2. Contains an enlarged upper end
3. Is fitted with a drogue and canister
4. Each of the above

4-31. The drogue deployment catapult is mounted in what location on the ejection seat?

1. Aft RH aide of the seat structure
2. Aft LH side of the upper cross beam
3. Outboard of the LH lower cross beam
4. Outboard of the RH main beam

4-32. What size drogue chute is used in the NACES?

1. 1.45 mm
2. 2.10 mm
3. 2.50 mm
4. 8.25 mm

4-33. During the ejection sequence, what component(s) supplies the gas pressure to operate the barostatic release unit delay mechanism?

1. Primary initiators
2. Multipurpose initiators
3. Start switch assemblies
4. Electronic sequencer

4-34. Which of the following components houses the start switches?

1. Multipurpose initiator
2. Static lanyard assembly
3. Electronic sequencer

4-35. During ejection, the start switches provides what action?

1. Battery power
2. Initiation set-up
3. Start signal to the electronic sequencer
4. Time-delay start time

4-36. What is the primary purpose of the pitot assemblies?

1. To supply pressure to the start switches for ejection
2. To supply dynamic pressure inputs to the electronic sequencer
3. To supply static base pressure to the electronic sequencer

4-37. Which of the following components receives gas pressure from the upper face of the RH ballistic manifold?

1. Shoulder harness reel
2. Parachute deployment rocket motor
3. Upper drogue bridle release
4. Each of the above

4-38. What total number of ballistic manifolds is/are installed on the NACES seat?

1. One
2. Two
3. Three
4. Four

4-39. What item or action secures the pitot arms in the stowed or deployed positions?

1. Release piston
2. Locking plunger
3. Quick release pin
4. Static gas pressure

4-40. What total number of connectors is/are present on the upper face of the LH ballistic manifold?

1. One
2. Two
3. Three
4. Four

4-41. What is the primary purpose of the thermal batteries?

1. To supply power for seat operation
2. To supply backup power for sequencer operation
3. To supply initial power for sequencer operation
4. To supply initial power for the seawars

4-42. Thermal batteries are mounted in each of the main beam assemblies?

1. True
2. False

4-43. What total number of propellant tubes make up the underseat rocket motor?

1. Ten
2. Thirteen
3. Fifteen
4. Seventeen

4-44. What is the purpose of the lateral thrust motor?

1. Serves the same purpose as the underseat rocket motor
2. To provide additional boost to underseat rocket motor
3. Permits a divergent trajectory to the ejected seat

4-45. When the safe/arm handle is in the safe position, the pilot sees the handle as what color(s)?

1. Yellow
2. Black and yellow
3. White
4. Red

4-46. What total number of connectors are on the lower face of the RH ballistic manifold assembly?

1. Five
2. Two
3. Three
4. Four

4-47. Forward movement of the leg restraints is prevented by what component?

1. Seat bucket snubbers
2. Leg restraint locks
3. Leg restraint snubbers
4. Leg restraint control lever

4-48. What component restricts the operation of the manual override handle when the seat is installed in the aircraft?

1. Safety pin
2. Thumb button
3. Pin puller
4. Safe/arm handle

4-49. Operation of the manual override handle simultaneously operates the safe/armed handle to the safe position?

1. True
2. False

4-50. During ejection, what component(s) provides the gas pressure to operate the pin puller?

1. The right hand seat initiator only
2. The left hand seat initiator only
3. Both 1 and 2 above

4-51. Which of the following component(s) are part of the lower harness release mechanism?

1. Leg restraint line locks
2. Negative-g strap locks
3. Lower harness locks
4. Each of the above

4-52. The parachute container houses which of the following parachute?

1. Controller drogue
2. Main drogue
3. Personnel and ribbon drogue

4-53. In the NACES, what type drogue is attached to the parachute crown bridle apex?

1. 1.5m main
2. 1.5m personnel
3. 1.5m ribbon
4. 1.5m controller

4-54. What force actuates the firing pin in the catapult firing mechanism?

1. Ballistic gas
2. Mechanical
3. Electrical inputs

4-55. What maximum number of inches of travel is required before the piston head shears the three dowel screws in the guide bushing?

1. 38
2. 42
3. 60
4. 72

4-56. During ejection sequence, gas pressure from what cartridge is used to operate the shoulder harness release cartridge?

1. Multipurpose initiator
2. Shoulder harness impulse cartridge
3. Left hand seat initiator
4. Right hand seat initiator

4-57. Which of the following forces causes the secondary cartridge to face fire the parachute deployment rocket motor in the event of sequencer failure?

1. Ballistic gas from the harness release unit cartridge
2. Ballistic gas from the emergency restraint release cartridge
3. Both 1 and 2 above
4. Ballistic gas from the multipurpose initiator cartridge

4-58. After ejection has been initiated, what source supplies the electronic sequencer with electrical power?

1. A single on-board thermal battery
2. Two on-board thermal batteries
3. Internal aircraft power
4. Start switches

4-59. What source activates the multipurpose initiators upon ejection?

1. Ballistic gas pressure from primary initiators
2. Ballistic gas pressure from thermal batteries
3. Two pyrotechnic cartridges, after 42 inches of travel
4. Electronic sequencer, 120 milliseconds after activation

4-60. In the absence of a start switch signal, the electronic sequencer takes what action?

1. It continues in the "wait" mode
2. It activates automatically after approximately 200 milliseconds
3. It initiates the underseat rocket motor
4. It activates the start switch

4-61. What is the total burn time of the underseat rocket motor?

1. 200 milliseconds
2. 220 milliseconds
3. 250 milliseconds
4. 2 seconds

4-62. Which of the following is/are the critical actions for an electronic sequencer?

1. Sensing the seats altitude and airspeed
2. Choosing the appropriate timings from a set of available sequences
3. Both 1 and 2 above
4. Providing initial start-up from the thermal batteries

4-63. Speed and altitude are measured from the sequencer by what three types of sensors?

1. Pitot pressure, altitude, airspeed
2. Pitot pressure, altitude, base pressure,
3. Pitot pressure, base pressure, accelerometer
4. Altitude, airspeed, attitude

4-64. What total number of shielded cables are used to transmit electrical signals to and from the electronic sequencer?

1. Six
2. Seven
3. Eight
4. Nine

4-65. What is the total number of operational ejection modes of the NACES?

1. Five
2. Seven
3. Three
4. Nine

IN COMPLETING ITEMS 4-66 THROUGH 4-70, SELECT FROM COLUMN B THE AIRSPEED AND ALTITUDE INFORMATION THAT APPLIES TO THE MODE OF OPERATION IN COLUMN A. ITEMS IN COLUMN B MAY BE USED MORE THAN ONCE.

	A. Modes	B. Airspeeds/ Altitudes
4-66.	Mode 1	1. Airspeed above 500 knots and altitude below 8,000 feet
4-67.	Mode 2	2. Altitude above 18,000 feet
4-68.	Mode 3	3. Altitude between 8,000 and 18,000 feet
4-69.	Mode 4	4. Airspeed below 350 knots and altitude below 8,000 feet
4-70.	Mode 5	

4-71. During the ejection sequence, the PDRM fires and withdraws the parachute in its bag.

1. True
2. False

4-72. During ejection and shortly after the parachute starts to deploy, what parachute part is jettisoned to avoid entanglement and allow a clean seat/man separation?

1. Parachute extractor
2. Drogue bridle
3. Drogue chute
4. Stabilizer chute

4-73. What seat survival kit is used with the NACES?

1. SKU-7/A
2. SKU-8/A
3. RSSK-7
4. RSSK-8

4-74. At what time during ejection will electronic sequencer timing begin?

1. When the ejection control handle is pulled
2. After approximately five inches of seat upward travel
3. Immediately after seat ejection
4. When the start switches close

4-75. What NAVAIR manual should be used to order repairable/nonrepairable parts for the NACES?

1. A1-F18AE-44
2. 01-F18AE-4-1
3. 01-13-1-36
4. 13-1-36