NONRESIDENT
TRAINING
COURSE

June 1993

Aviation Boatswain's Mate F

NAVEDTRA 14003

NOTICE

Pages 3-7 and 3-13, must be printed on a **COLOR** printer.

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.

COURSE OVERVIEW: In completing this nonresident training course, you will demonstrate a knowledge of afloat and ashore fuels division organization, general maintenance equipment, quality surveillance, JP-5 afloat below deck systems and operations, JP-5 afloat flight deck systems and operations, afloat lube oil and MOGAS systems and operations, ashore systems and operations, and administration.

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.

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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

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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:

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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
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Phone: Toll Free: 877-264-8583
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FAX: (850) 452-1370
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NAVAL RESERVE RETIREMENT CREDIT

If you are a member of the Naval Reserve, you may earn retirement points for successfully completing this course, if authorized under current directives governing retirement of Naval Reserve personnel. For Naval Reserve retirement, this course is evaluated at 9 points. (Refer to *Administrative Procedures for Naval Reservists on Inactive Duty,* BUPERSINST 1001.39, for more information about retirement points.)

Student Comments

Course Title: *Aviation Boatswain's Mate F* ______________________

NAVEDTRA: 14003 ______________________ **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

AFLOAT AND ASHORE FUELS DIVISION ORGANIZATION

Advancement . . . are you ready? Did you study enough? Did you study the correct manuals? Many did; others didn't; and some just don't know.

Everyone should be well aware of the personal advantages of advancement: higher pay, greater prestige, more interesting and challenging work, and the satisfaction of getting ahead in your chosen field.

The Navy also profits by your advancement. Highly trained personnel are essential to the functioning of the Navy. By advancing, you increase your value to the Navy in two ways: First, you become more valuable as a person who can supervise, lead, and train others. Second, you become more valuable as a technical specialist.

The primary purpose of this training manual is to aid personnel in meeting the professional (technical) qualifications for advancement in the Aviation Boatswain's Mate (Fuels) rating. A secondary purpose is to help improve job skills. You can achieve these goals through use of this manual as a study aid along with on-the-job training.

The information contained in this manual is based on the occupational standards for the ABF rating, which are found in *Aviation Boatswain's Mate, Fuels (ABF) Advancement Handbook For Petty Officers*, NAVEDTRA 71201. Take note that occupational standards are regularly evaluated and updated and any changes that occurred after March 1993 may not be reflected in this manual. **Always** check with the education services officer when preparing for advancement to make sure you meet the current requirements.

This chapter will explain the purpose of training manuals and nonresident training courses. It also will describe the ABF rating, the organization of afloat and ashore commands, and the responsibilities of various parts of each command.

TRAINING MANUALS AND NONRESIDENT TRAINING COURSES

LEARNING OBJECTIVE: Define the relationship between the ABF TRAMAN and specific occupational standards.

Training manuals (TRAMANs) are written to provide minimum coverage of rating-specific Occupational Standards. TRAMANs are also written to cover Naval Standards (MRPO1), which are the responsibilities of all Navy ratings. A TRAMAN may address a single rate *(AK3)*, multiple rates *(AO 3&2)*, or portion of a rating *(BM, volume 1)*. It may also be a generic manual that may be used by several ratings *(Basic Machines)*. This manual, *Aviation Boatswain's Mate (Fuels)*, will cover paygrades E-4 through E-7 in the ABF rating.

Nonresident Training Courses (NRTCs) are self-study courses that may include assigned exercises, lessons, or examinations designed to aid the student in gaining the knowledge or skills described in the associated text. This ABF TRAMAN will have two NRTCs: one for *ABF 3&2*, and one for *ABF 1&C*.

AVIATION BOATSWAIN'S MATE RATING

LEARNING OBJECTIVE: Identify the path for advancement in the AB rating. Describe the ABF rating.

The Aviation Boatswain's Mate rating is divided into three service ratings in paygrades E-4 through E-8. The service ratings are Aviation Boatswain's Mate H (Aircraft Handling), Aviation Boatswain's Mate E (Launch and Recovery Equipment), and Aviation Boatswain's Mate F (Fuels). The general rating, AB, applies at the E-9 level only.

Figure 1-1 illustrates paths of advancement for an Airman Recruit to Master Chief Aviation Boatswain's Mate, Commissioned Warrant Officer (W-4), and Limited Duty Officer. Shaded areas show career stages where qualified enlisted personnel may advance to Commissioned Warrant Officer (W-2), and Limited Duty Officer.

Personnel in the ABF rating operate, maintain, and perform organizational maintenance on aviation fueling, automotive gasoline (MOGAS), and lubricating oil systems on CVs, CVNs, LHAs, LPHs, and LPDs. Included are aviation fuel, MOGAS, and catapult lubricating oil service stations and pumprooms, piping, valves. pumps, tanks, and portable equipment related to the fuel system. ABFs also operate, maintain, and repair the valves and piping of purging and protective systems within the Air Department spaces aboard ship.

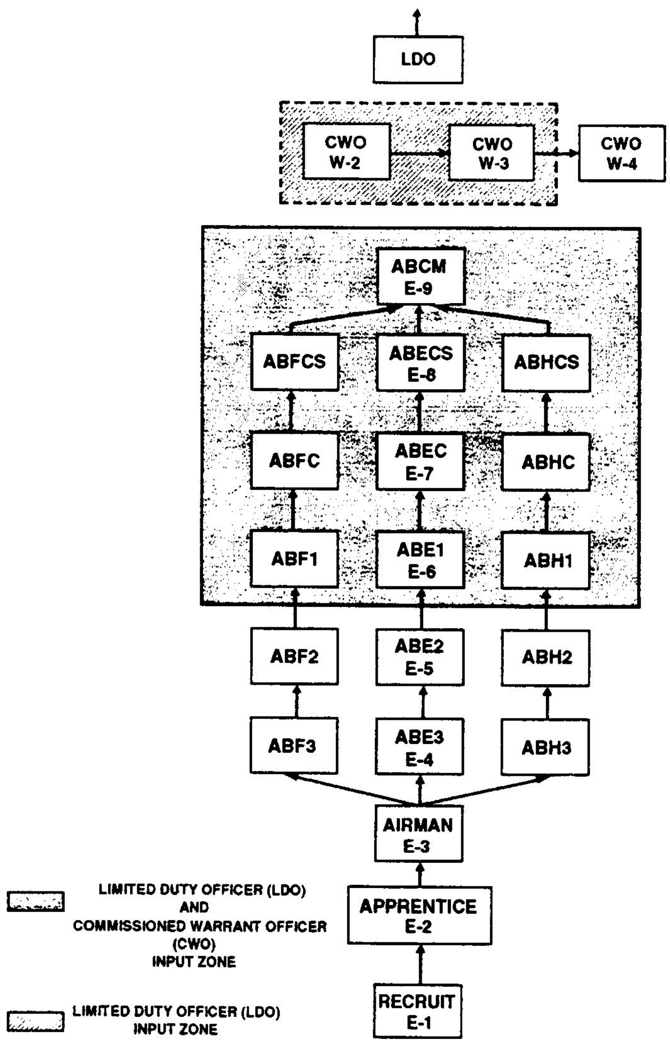


Figure 1-1.—Paths of advancement.

Additionally, ABFs operate and service motorized fueling equipment, maintain quality surveillance, and supervise the operations and servicing of fuel farms and equipment associated with the fueling and defueling of aircraft ashore.

They also may train, direct, and supervise fire-fighting crews, fire rescue teams, and damage control parties in assigned fuel and catapult lubricating oil spaces. And they **ALWAYS** observe and enforce fuel-handling safety precautions.

AVIATION FUELS DIVISION AFLOAT

LEARNING OBJECTIVE: Describe the organization and responsibilities of the major work-centers of a typical Aviation Fuels Division Afloat.

Figure 1-2 illustrates the typical AvFuels Division Afloat organization. However, it must be emphasized that you will encounter many variations of AvFuels Divisions. This is due to the many different types of ships used by the Navy that have the capability of fueling and defueling aircraft.

The variations you will see in the organization of a division include the number of personnel assigned to the division, the number and types of aircraft embarked, and the tactical employment of your ship. You may also encounter slightly different organizations even on the same-class ships. Regardless of the type of ship, keep in mind that the basic mission of the division remains the same; therefore, the basic division structure does not change.

The AvFuels Division Afloat is normally made up of the V-4 Division Office, the Flight Deck workcenter (which includes flight deck repair and the quality surveillance lab), and the Below Decks workcenter. Some divisions will have a maintenance workcenter that combines the maintenance and repair of the flight and below decks workcenters. Most will have a Damage Control workcenter. Again, it depends on the needs and manning of the command.

Another integral part of the AvFuels Division Afloat is the Aviation Fuels Security Watch. This watch is stood 24 hours a day when the ship is not at flight quarters. Personnel standing this watch must be properly trained, familiar with the AvFuels system, and fully PQS-qualified as an AvFuels Security

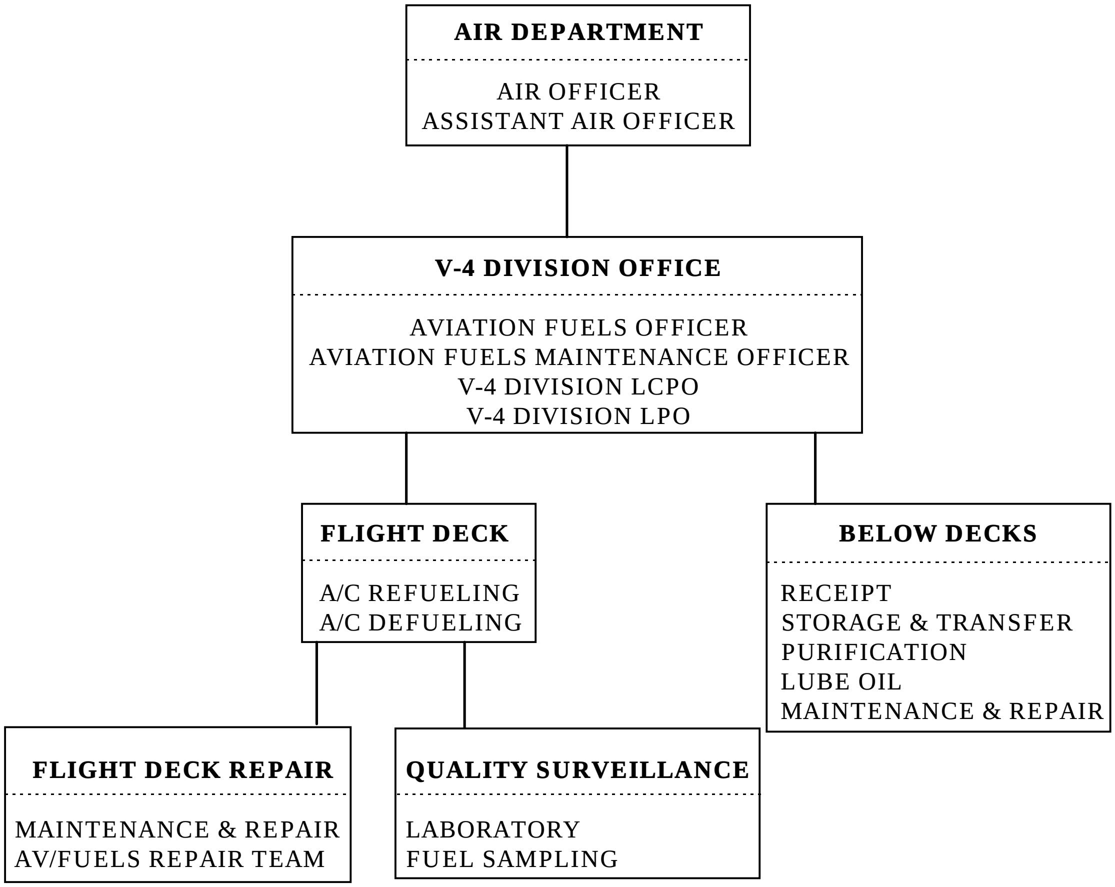


Figure 1-2.—Typical Aviation Fuels Division Afloat.

Watch. Every effort should be put forth by senior ABFs to make sure watchstanders understand the importance of this watch. The AvFuels security watch is responsible for the security of the AvFuels system, and ultimately, the ship.

V-4 DIVISION OFFICE

The V-4 Division Office is the administrative core of the AvFuels Division Afloat. The AvFuels division officer, AvFuels maintenance officer, leading chief petty officer, leading petty officer, and divisional yeomen work in this office.

FLIGHT DECK

The Flight Deck workcenter is responsible for the refueling and defueling of aircraft and for support equipment on the flight and hangar deck.

Flight Deck Repair

Flight Deck Repair is responsible for the maintenance and repair of the flight- and hangar-deck refueling stations and portable defueling equipment. Repair personnel also man sponsons during underway replenishment and perform damage control duties as the Aviation Fuels Repair Team.

Quality Surveillance Laboratory

The Quality Surveillance Laboratory is responsible for the monitoring of fuel quality in the entire AvFuels system. Lab personnel do extensive sampling and testing. While it is a branch of the flight deck workcenter, the lab is also responsible for testing fuel samples sent from Below Decks.

BELOW DECKS

The Below Decks workcenter is responsible for the receipt, stripping, transfer, purifying, and filtering of aviation fuels and catapult lubricating oils. In most divisions, below decks personnel do their own maintenance and repairs.

PERSONNEL QUALIFICATION STANDARDS

LEARNING OBJECTIVE: Describe the purpose of the PQS program. Identify the PQS watch stations for Aviation Fuels Afloat.

No matter what your job assignment is in V-4 Division, you must be qualified or under direct supervision by a qualified person, to perform that assignment. The PQS Program is used to qualify officer and enlisted personnel to perform their assigned duties. It is a written compilation of the knowledge and skills required to qualify for a specific watchstation, maintain specific equipment, or perform as a team member within your unit.

As the organization may vary from ship to ship, PQS will too. The PQS for Aviation Fuels Afloat can be tailored to fit any ship by adding items that are unique to, or deleting items that do not apply to your system.

Listed below are the current watchstations (job assignments) in the PQS for Aviation Fuels Afloat:

4301	Sound-Powered-Telephone Talker/ Operator
4302	Fuels Security Watch
4303	Refueling Crewman
4304	Checker
4305	Refueling Crew Leader
4306	Control Talker
4307	Quality Control Sentry
4308	Quality Control Supervisor
4309	Aviation Fuels Repairman
4310	Aviation Fuels Repair Supervisor
4311	Catapult Lube Oil Operator
4312	JP-5 Filter Operator
4313	JP-5 Pumproom Operator
4314	JP-5 Console Operator
4315	JP-5 Pumproom Supervisor
4316	Flight Deck Supervisor
4317	Below Decks Supervisor
4318	Division Supervisor

For complete information on the PQS for ABFs, consult *PQS for Air Department Aviation Fuels Afloat,* NAVEDTRA 43426-4A.

AVIATION FUELS DIVISION ASHORE

LEARNING OBJECTIVE: Describe the organization and responsibilities of the major branches of a typical Aviation Fuels Division Ashore.

Figure 1-3 illustrates the typical Aviation Fuels Division Ashore organization. The various air stations operated by the Navy differ considerably in size, arrangement, and mission. Therefore, the organization and operation of fuels divisions ashore will vary from station to station even more than afloat commands.

The AvFuels Division Ashore is a division of the Supply Department. Its typical organization is Fuels Management Officer (FMO). Administrative/Accounting, Distribution, Storage, and Quality Control.

FUELS MANAGEMENT OFFICER (FMO)

The FMO discharges the supply officer's fuel responsibilities through the planning, directing, training, and supervision of the fuel operations. Directly responsible to the FMO is administration and accounting.

DISTRIBUTION

Distribution is responsible for providing refueling and defueling services for all tenant and transient aircraft and other units such as fuel test cells at the air activity. An additional significant responsibility is performing operator maintenance on refueling equipment used by distribution personnel. Distribution will normally contain most of the military personnel assigned to the division.

QUALITY CONTROL

Quality Control is responsible for the inspection and quality assurance of ALL fuels received or issued by the fuel farm. Fuel samples taken from all stages of fuel-handling operations are delivered to Quality Control. They are also responsible for checking filter/separators and fuel monitors, and maintaining pres-

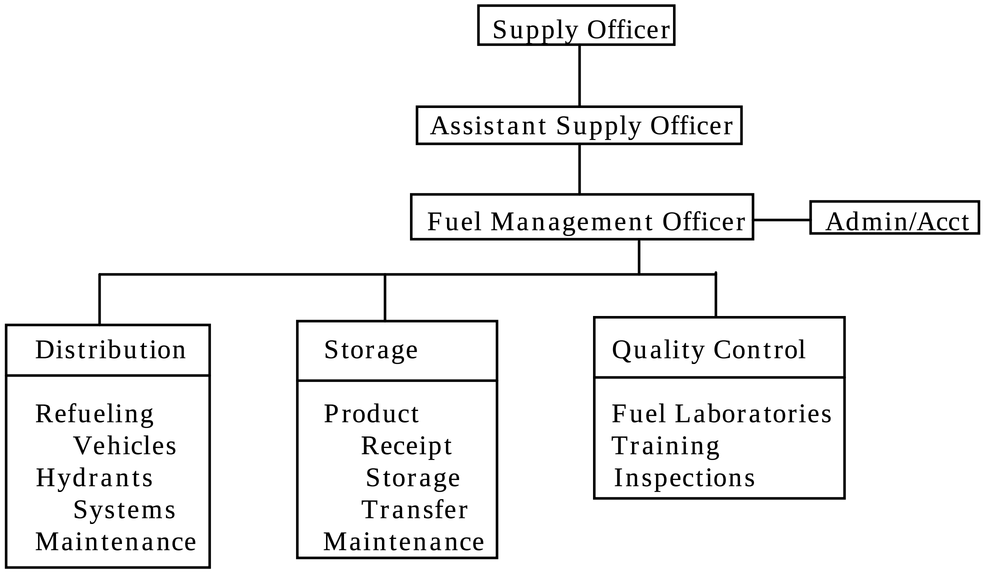


Figure 1-3.—Typical Aviation Fuels Division Ashore.

sure differential records for filter/separators and fuel monitors.

STORAGE

Storage is responsible for the receipt, storage, and transfer of all fuels handled by the division. Included with these responsibilities is maintenance of equipment used in transfer operations.

SUMMARY

In this chapter, you learned the purpose of a training manual and its accompanying nonresident training course. You also learned the relationship of a TRAMAN with specific occupational standards. You reviewed the paths for advancement in the AB rating and studied the PQS for Aviation Fuels Afloat.

CHAPTER 2

GENERAL MAINTENANCE EQUIPMENT

As an ABF, you are routinely assigned tasks requiring the use of hand or power tools. It is to your advantage to become familiar with the tools you will use to accomplish these tasks. The right tool for the right job is an old, but time proven, proverb.

SAFETY is paramount when you are using tools— power or hand operated. Special care should be used with all wood or metal cutting tools. Eye goggles must be in place before cutting tools are used.

Power tools are more dangerous than nonpowered tools. Use power tools only if you are familiar with them and have been checked out on their use and proper operation by a competent authority.

Tools and Their Uses, NAVEDTRA 10085-B2, contains more detailed information on the various tools the ABF will use.

COMMON HAND TOOLS

LEARNING OBJECTIVES: Identify the common hand tools used by the ABF. Explain the use and care of hand tools.

Figure 2-1 illustrates some of the hand tools discussed in this section. All hand tools have a specific

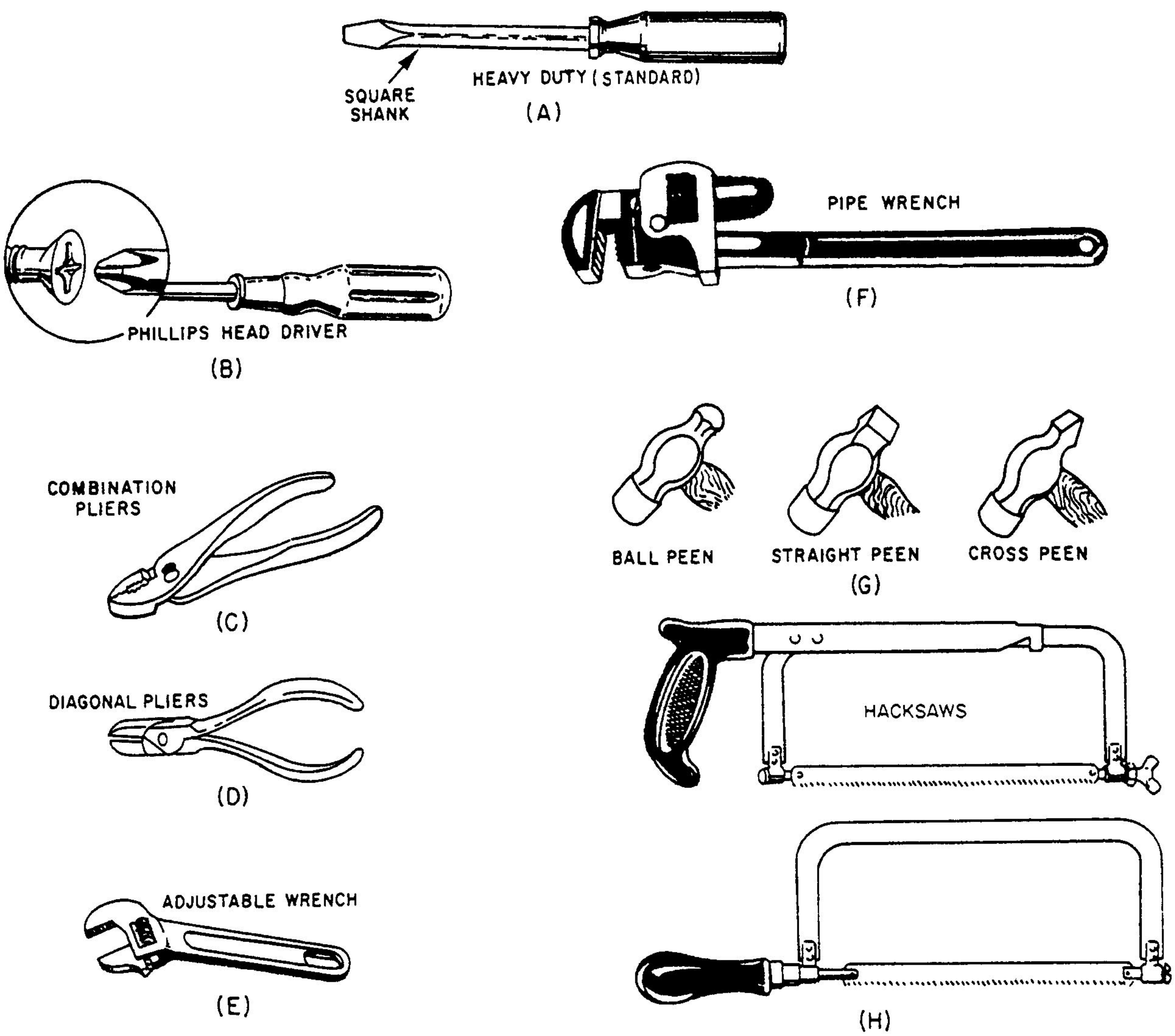


Figure 2-1.—Common hand tools.

purpose and should be used only on the objects they are designed for. When you use a hand tool for other purposes, you usually damage both the tool and the object it is used on. Use screwdrivers to drive and remove screws. Do not use them to scrape paint, as a pry bar or chisel, and certainly never use them to test an electrical circuit.

STANDARD SCREW DRIVER

Three main parts make up the construction of the standard screwdriver (fig. 2-1, view A), the handle, the shank, and the end. The end (called the blade) fits into the screw slot. When using a screwdriver, select the proper size blade for the job intended. A blade too large or too small causes the screwdriver blade and the screwhead to become damaged. At least 75 percent of the screw slot should be filled by the blade for proper fit.

PHILLIPS HEAD SCREWDRIVER

A Phillips head screwdriver (fig. 2-1, view B) differs in construction from a standard screwdriver only in that the tip is shaped to fit the special cavity in the Phillips screwhead. A standard screwdriver must never be used in a Phillips screwhead as damage will occur to it. The Phillips cavity should be filled completely by the selected driver for proper fit.

HAMMER

The hammer (fig. 2-1. view G) most used by the ABF is the ball peen. The ball peen hammer is used for working metals, such as chiseling rivets and shearing metal.

COMBINATION PLIERS

Combination pliers (fig. 2-1, view C) are manufactured with straight serrated jaws for gripping objects. The pivots, with which the jaws are attached, are adjustable to fit different size objects. Pliers should not be used to grasp the shanks of screwdrivers to gain greater twisting force.

DIAGONAL PLIERS

Diagonal pliers (fig. 2-1, view D) are used only for cutting small material such as wire or cotter pins. They are designed specifically for cutting. They should NOT be used for grasping objects such as nuts and bolts.

ADJUSTABLE WRENCHES

An adjustable wrench (fig. 2-1, view E) is not intended to replace an open-end wrench, but it is useful in working in restricted areas. In addition, it can be adjusted to fit odd-sized nuts or bolts. This wrench is often called a knuckle buster because mechanics frequently suffer the consequences of using it improperly.

PIPE WRENCHES

A pipe wrench (fig. 2-1, view F) is primarily used for rotating round stock and/or various pipes and piping. The most common pipe wrench is the Stillson. It has two jaws that have serrated teeth to provide a gripping ability. The larger jaw is a fixed jaw. The smaller jaw is adjustable and the weaker of the two jaws. Whenever a Stillson wrench is used, it should be applied in such a manner that the fixed jaw provides the twisting force. These wrenches also come in varying lengths, which makes the jaw sizes vary. A Stillson wrench should never be used on machined surfaces, as the teeth tend to mar or otherwise ruin the metal.

The strap wrench (fig. 2-2) should be used instead of a Stillson to eliminate damage to soft metals. The strap wrench employs a heavy nylon strap. One end is attached to the wrench handle. while the other end is free to pass around the object to be rotated, and then back through the locking device provided on the wrench handle.

SPANNER WRENCHES

Many special nuts are made with notches cut into their outer edge. For these nuts a hook spanner

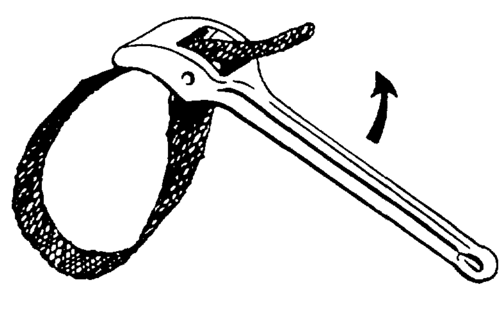


Figure 2-2.—Strap wrench.

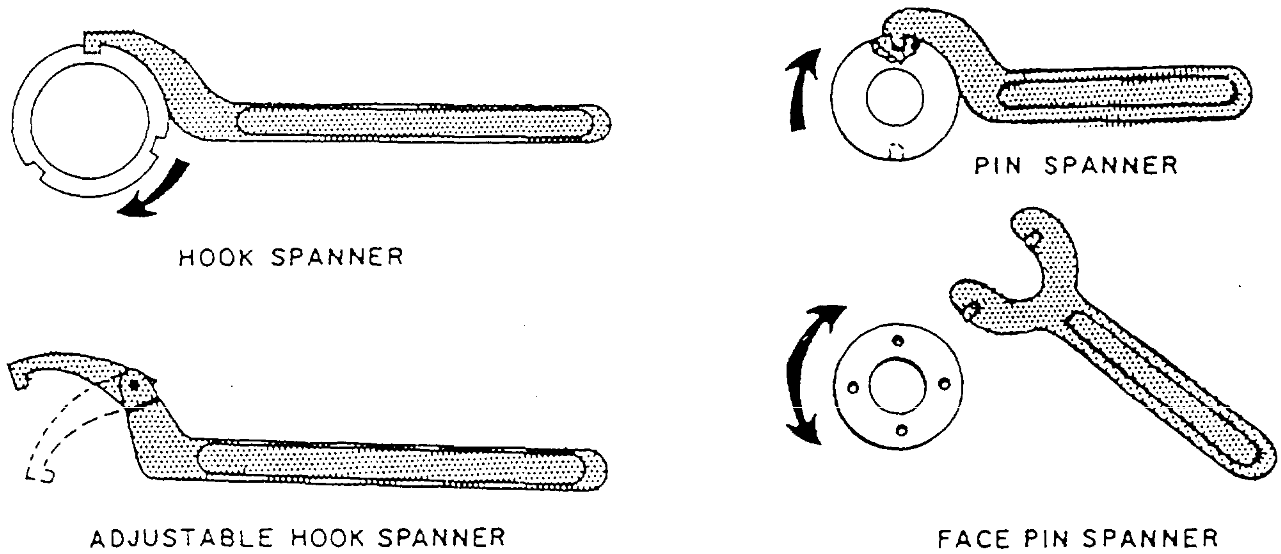


Figure 2-3.—General purpose spanner wrenches.

(fig. 2-3) is required. This wrench has a curved arm with a lug or hook on the end. This lug fits into one of the notches of the nut and the handle is turned to loosen or tighten the nut. This spanner may be made for just one particular size of notched nut, or it may have a hinged arm to adjust it to a range of sizes.

Another type of spanner is the pin spanner. Pin spanners have a pin in place of a hook. This pin fits into a hole in the outer part of the nut.

Face pin spanners are designed so the pins fit into holes in the face of the nut (fig. 2-3).

When you use a spanner wrench, you must ensure the pins, lugs, or hooks make firm contact with the nut while the turning force is applied. If this is not done, damage will result to either personnel, tools, or equipment.

SETSCREW WRENCHES (ALLEN AND BRISTOL)

In some places it is desirable to use recessed heads on setscrews and capscrews. The Allen screw is used extensively on office machines and in machine shops. The Bristol is used infrequently.

Recessed head screws usually have a hexshaped (six-sided) recess. To remove or tighten this type of screw requires a special wrench that will fit in the recess. This wrench is called an Allen wrench. Allen wrenches are made from hexagonal L-shaped bars of tool steel (fig. 2-4). They range in size up to 3/4 inch. When using the Allen wrench, make sure you use the correct size to prevent rounding or spreading the head of the screw. A snug fit within the recessed head of the screw is an indication that you have the correct size.

The Bristol wrench is made from round stock. It is also L-shaped, but one end is fluted to fit the flutes or little splines in the Bristol setscrew (fig. 2-4).

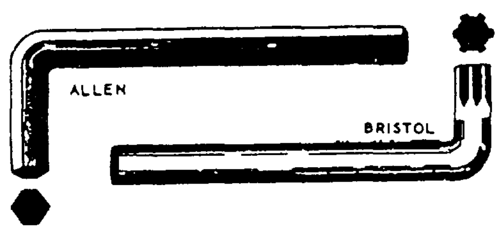


Figure 2-4.—Allen and Bristol wrenches.

SOCKET WRENCH

The socket wrench is one of the most versatile wrenches in the toolbox. It consists of a handle and a socket wrench that can be attached to the handle.

The Spintite wrench shown in figure 2-5, is a special type of socket wrench. It has a hollow shaft to accommodate a bolt protruding through a nut, has a hexagonal head, and is used like a screwdriver. It is supplied in small sizes only and is useful for assembly and electrical work. When used for the latter purpose, it must have an insulated handle.

A complete socket wrench set consists of several types of handles, bar extensions, adapters, and a variety of sockets (fig. 2-5).

Sockets

A socket (fig. 2-6) has a square opening cut in one end to fit a square drive lug on a detachable handle. In the other end of the socket is a 6-point or 12-point opening very much like the opening in the box end wrench. The 12-point socket needs to be swung only half as far as the 6-point socket before it has to be lifted and fitted on the nut for a new grip. It can therefore be used in closer quarters where there is less room to move the handle. (A ratchet handle eliminates the necessity of lifting the socket and refitting it on the nut every time a turn is made.)

Sockets are classified for size according to two factors. One is the size of the square opening, which fits on the square drive lug of the handle. This size is known as the drive size. The other is the size of the opening in the opposite end, which fits the nut or bolt. The standard toolbox can be outfitted with sockets having 1/4-, 3/8-, and 1/2-inch square drive lugs. Larger sets are usually available in the toolroom for temporary checkout. The openings that fit onto the bolt or nut are usually graduated in 1/16-inch sizes. Sockets are also made in deep lengths to fit over spark plugs and long bolt ends.

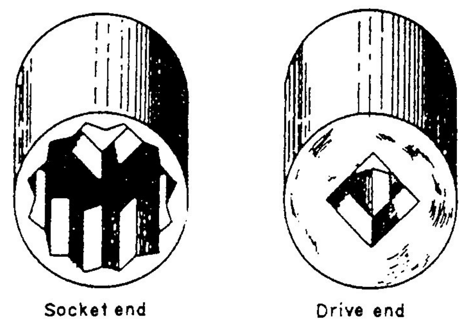


Figure 2-6.—12-point socket.

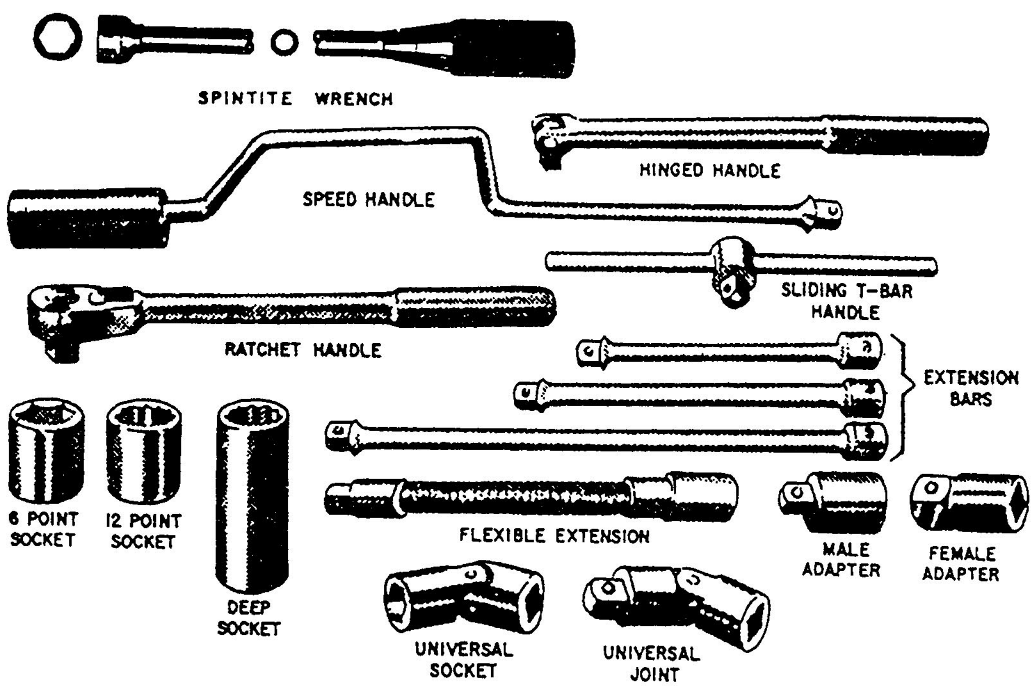


Figure 2-5.—Socket set components.

Socket Handles

There are four types of handles used with these sockets. (See fig. 2-5) Each type has special advantages, and the experienced worker chooses the one suited for the job at hand. The square driving lug on the socket wrench handles has a spring-loaded ball that fits into a recess in the socket receptacle. This mated ball-recess feature keeps the socket engaged with the drive lug during normal usage. A slight pull on the socket, however, disassembles the connection.

RATCHET.— The ratchet handle has a reversing lever that operates a pawl (or dog) inside the head of the tool. Pulling the handle in one direction causes the pawl to engage in the ratchet teeth and turn the socket. Moving the handle in the opposite direction causes the pawl to slide over the teeth, permitting the handle to back up without moving the socket. This allows rapid turning of the nut or bolt after each partial turn of the handle. With the reversing lever in one position, the handle is used for tightening. In the other position, it is used for loosening.

HINGED HANDLE.— The hinged handle is also very convenient. To loosen tight nuts, swing the handle at right angles to the socket. This gives the greatest possible leverage. After loosening the nut to the point where it turns easily, move the handle into the vertical position, and then turn the handle with the fingers.

SLIDING T-BAR HANDLE.— When using the sliding bar or T-handle, the head can be positioned anywhere along the sliding bar. Select the position that is needed for the job at hand.

SPEED HANDLE.— The speed handle is worked like the wood-worker's brace. After the nuts are first loosened with the sliding bar handle or the ratchet handle, the speed handle can be used to remove the nuts more quickly. In many instances the speed handle is not strong enough to be used for breaking loose or tightening the nut. The speed socket wrench should be used carefully to avoid damaging the nut threads.

Accessories

To complete the socket wrench set, there are several accessory items. Extension bars of different lengths are made to extend the distance from the socket to the handle. A universal joint allows the nut to be turned with the wrench handle at an angle. Universal sockets are also available. The use of universal joints, bar extensions, and universal sockets in combination with appropriate handles makes it possible to form a variety of tools that will reach otherwise inaccessible nuts and bolts.

Another accessory item is an adapter that allows you to use a handle having one size of drive and a socket having a different size drive. For example, a 3/8- by 1/4-inch adapter makes it possible to turn all 1/4-inch square drive sockets with any 3/8-inch square drive handle.

HACKSAW

The hacksaw is a handy portable metal cutting tool that can be used for cutting sheet metal, bolts, and pipe. A hacksaw cuts on the push stroke only; the blade should be installed in the frame with the teeth facing away from the handle. Figure 2-1, view H, shows two types of hacksaws with the blade in the proper position.

CHISELS

Chisels are tools that can be used for chipping or cutting metal. They will cut any metal that is softer than the materials of which they are made. Chisels are made from a good grade tool steel and have a hardened cutting edge and beveled head. Cold chisels are classified according to the shape of their points, and the width of the cutting edge denotes their size. The most common shapes of chisels are flat (cold chisel), cape, round nose, and diamond point (fig. 2-7).

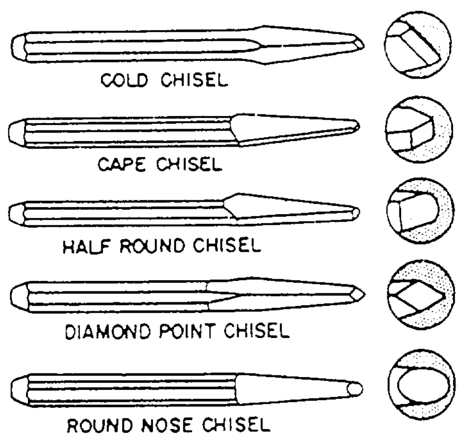


Figure 2-7.—Types of points on metal cutting chisels.

The type of chisel most commonly used is the flat cold chisel, which serves to cut rivets, split nuts, chip castings, and thin metal sheets. The cape chisel is used for special jobs like cutting keyways, narrow grooves, and square corners. Round-nose chisels make circular grooves and chip inside corners with a fillet. Finally, the diamond-point is used for cutting V-grooves and sharp comers.

As with other tools there is a correct technique for using a chisel. Select a chisel that is large enough for the job. Be sure to use a hammer that matches the chisel; that is, the larger the chisel, the heavier the hammer. A heavy chisel will absorb the blows of a light hammer and will do virtually no cutting.

As a general rule, hold the chisel in the left hand with the thumb and first finger about 1-inch from the top. It should be held steadily but not tightly. The finger muscles should be relaxed, so if the hammer strikes the hand it will permit the hand to slide down the tool and lessen the effect of the blow. Keep the eyes on the cutting edge of the chisel, not on the head, and swing the hammer in the same plane as the body of the chisel. If you have a lot of chiseling to do, slide a piece of rubber hose over the chisel. This will lessen the shock to your hand.

When using a chisel for chipping, always wear goggles to protect your eyes. If other personnel are working close by, ensure they are protected from flying chips by erecting a screen or shield to contain the chips. Remember that the time to take these precautions is before you start the job.

FILES

A toolkit for nearly every rating in the Navy is not complete unless it contains an assortment of files. There are several different types of files in common use, and each type may range in length from 3 to 18 inches.

Grades

Files are graded according to the degree of fineness and according to whether they have single or double-cut teeth. The difference is apparent when you compare the files in figure 2-8, view A.

Single-cut files have rows of teeth cut parallel to each other. These teeth are set at an angle of about 65 degrees with the center line. You will use single-cut files for sharpening tools, finish filing, and drawfiling. They also are the best tools for smoothing the edges of sheet metal.

Files with crisscrossed rows of teeth are double-cut files. The double cut forms teeth that are diamond-shaped and fast cutting. You will use double-cut files for quick removal of metal and for rough work.

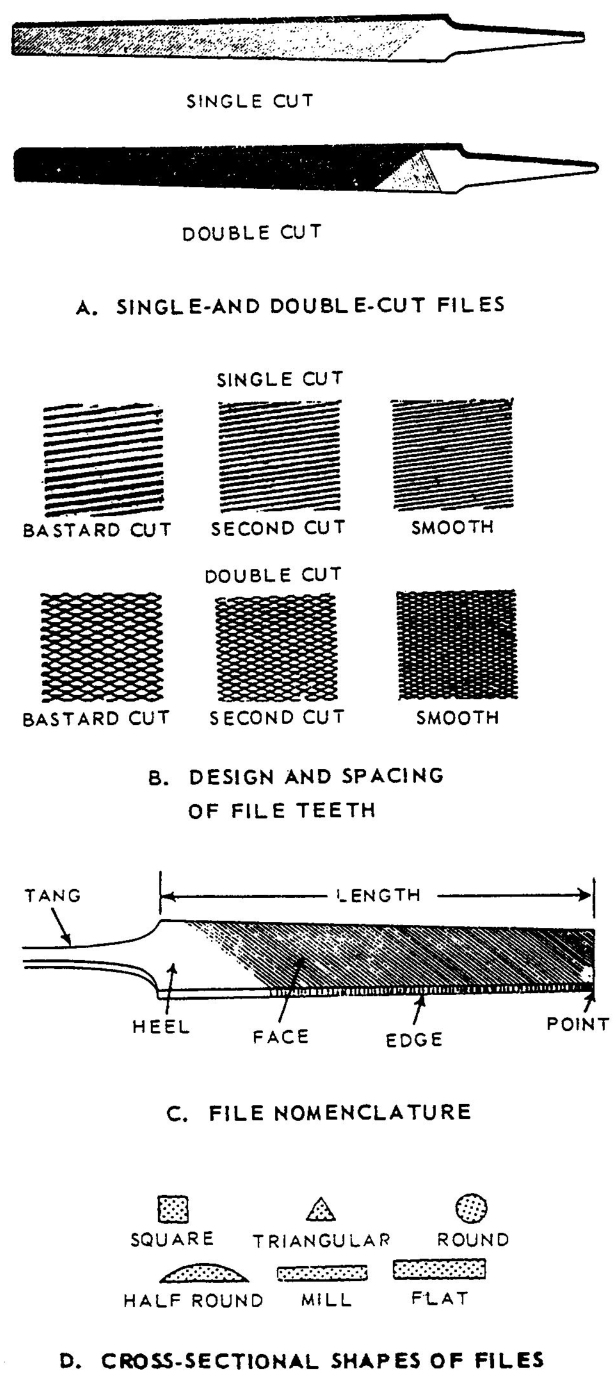


Figure 2-8.—File descriptions.

Files are also graded according to the spacing and size of their teeth, or their coarseness and fineness. Some of these grades are pictured in figure 2-8, view B. In addition to the three grades shown, you may use some DEAD SMOOTH files, which have very fine teeth, and some ROUGH files with very coarse teeth. The fineness or coarseness of file teeth is also influenced by the length of the file. The length of a file is the distance from the tip to the heel, and does not include the tang (fig. 2-8, view C). When you have a chance, compare the actual size of the teeth of a 6-inch, single-cut smooth file and a 12-inch, single-cut smooth file. You will notice the 6-inch file has more teeth per inch than the 12-inch file.

Shapes

Files come in different shapes. Therefore, in selecting a file for a job, the shape of the finished work must be considered. Some of the cross-sectional shapes are shown in figure 2-8, view D.

TRIANGULAR files are tapered (longitudinally) on all three sides. They are used to file acute internal angles and to clear out square comers. Special triangular files are used to file saw teeth.

MILL files are tapered in both width and thickness. One edge has no teeth and is known as a SAFE EDGE. Mill files are used for smoothing lathe work, drawfiling, and other fine, precision work. Mill files are always single-cut.

FLAT files are general-purpose files and may be either single- or double-cut. They are tapered in width and thickness. HARD files, not shown, are somewhat thicker than flat files. They taper slightly in thickness, but their edges are parallel.

The flat or hard files most often used are the double-cut for rough work and the single-cut, smooth file for finish work.

SQUARE files are tapered on all four sides and are used to enlarge rectangular-shaped holes and slots. ROUND files serve the same purpose for round openings. Small, round files are often called "rattail" files.

The HALF ROUND file is a general-purpose tool. The rounded side is used for curved surfaces and the flat face on flat surfaces. When you file an inside curve use a round or half round file whose curve most nearly matches the curve of the work.

Kits of small files, often called Swiss pattern or jewelers files, are used to fit parts of delicate mechanisms and for filing work on instruments. Handle these small files carefully because they break easily.

TAPS AND DIES

Taps and dies are used to cut threads in metal, plastics, or hard rubber. The taps are used for cutting internal threads, and the dies are used to cut external threads. There are many different types of taps. However, the most common are the taper, plug, bottoming, and pipe taps (fig. 2-9).

The taper (starting) hand tap has a chamfer length of 8 to 10 threads. These taps are used when starting a tapping operation and when tapping through boles.

Plug hand taps have a chamfer length of 3 to 5 threads and are designed for use after the taper tap.

Bottoming hand taps are used for threading the bottom of a blind hole. They have a very short chamfer length of only 1 to 1 1/2 threads for this purpose. This tap is always used after the plug tap has already

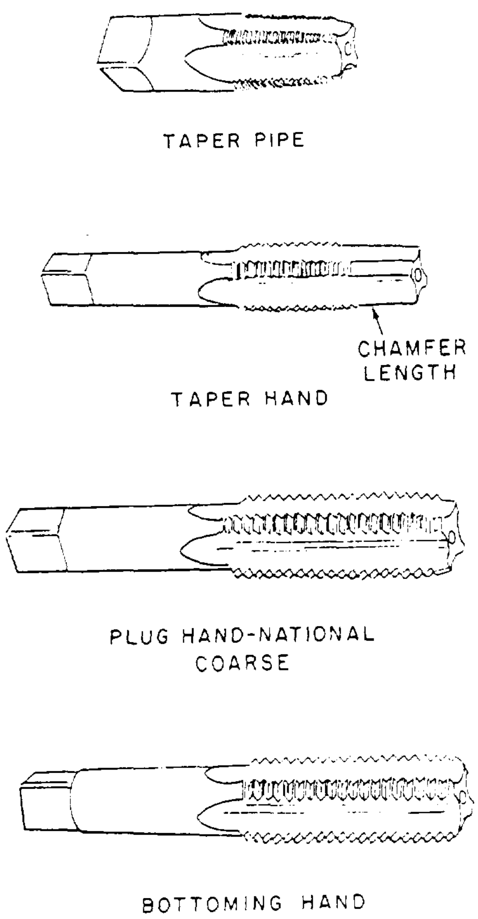


Figure 2-9.—Types of common taps.

been used. Both the taper and plug taps should precede the use of the bottoming hand tap.

Pipe taps are used for pipe fittings and other places where extremely tight fits are necessary. The tap diameter, from end to end of the threaded portion, increases at the rate of 3/4 inch per foot. All the threads on this tap do the cutting, as compared to the straight taps where only the nonchamfered portion does the cutting.

Dies are made in several different shapes and are of the solid or adjustable type. The square pipe die (fig. 2-10) will cut American Standard pipe thread only. It comes in a variety of sizes for cutting threads on pipe with diameters of 1/8 inch to 2 inches.

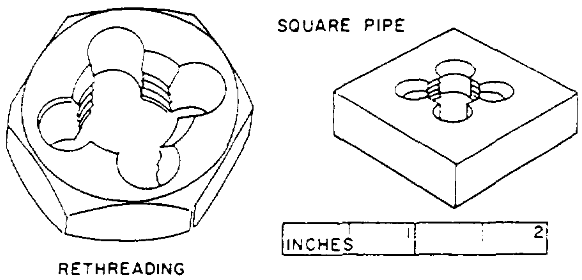


Figure 2-10.—Types of solid dies.

A rethreading die (fig. 2-10) is used principally for dressing over bruised or rusty threads on screws or bolts. It is available in a variety of sizes for rethreading American Standard coarse and fine threads. These dies are usually hexagon in shape and can be turned with a socket, box, open-end, or any wrench that will fit. Rethreading dies are available in sets of 6, 10, 14, and 28 assorted sizes in a case.

Round split adjustable dies (fig. 2-11) are called button dies and can be used in either hand diestocks or machine holders. The adjustment in the screw adjusting type is made by a fine-pitch screw that forces the sides of the die apart or allows them to spring together. The adjustment in the open adjusting types is made by three screws in the holder, one for expanding and two for compressing the dies. Round split adjustable dies are available in a variety of sizes to cut American Standard coarse and fine threads, special form threads, and the standard sizes of threads that are used in Britain and other European countries. For hand threading, these dies are held in diestocks (fig. 2-12). One type of diestock has three pointed screws that will hold round dies of any construction,

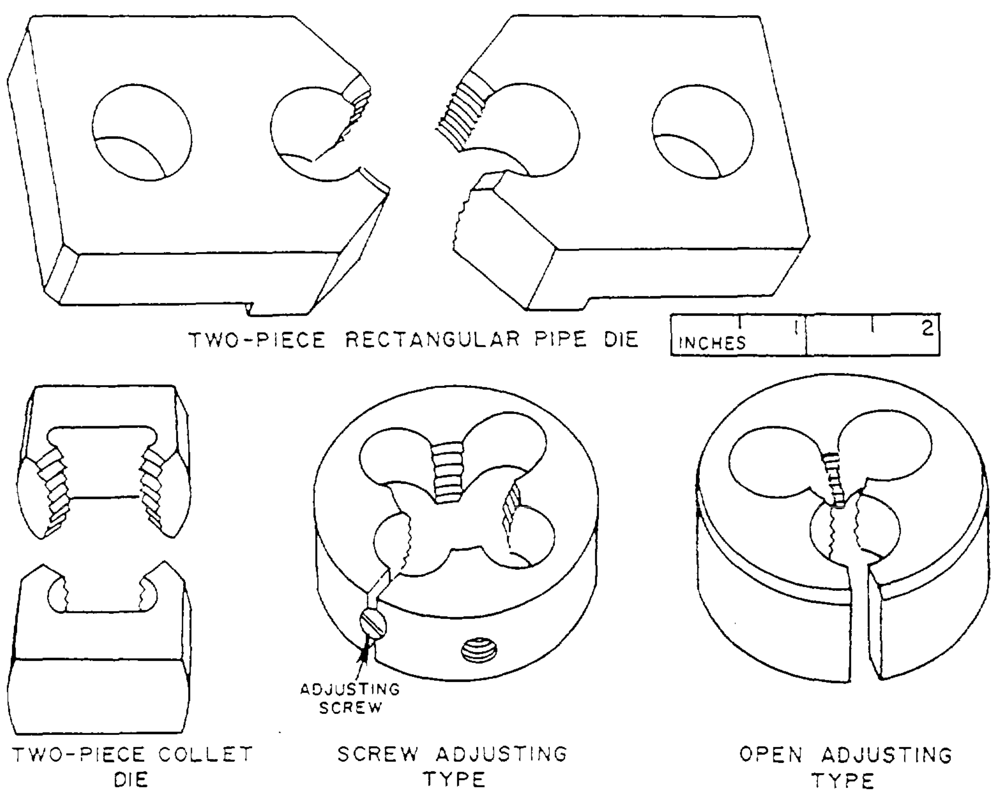


Figure 2-11.—Types of adjustable

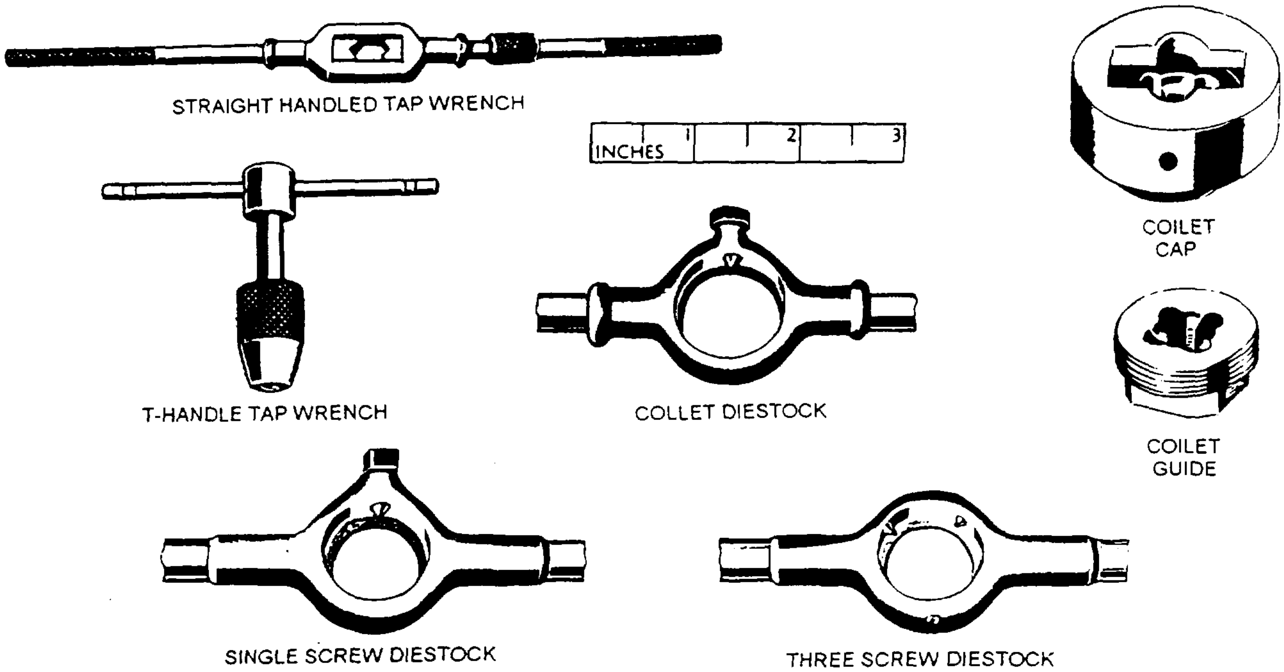


Figure 2-12.—Diestocks, diecollet, and tap wrenches.

although it is made specifically for open adjusting-type dies.

Two-piece collet dies (fig. 2-11) are used with a collet cap (fig. 2- 12) and a collet guide. The die halves are placed in the cap slot and are held in place by the guide that screws into the underside of the cap. The die is adjusted by setscrews at both ends of the internal slot. This type of adjustable die is issued in various sizes to cover the cutting range of American Standard coarse and fine and special form threads. Diestocks to hold the dies come in three different sizes.

Two-piece rectangular pipe dies (fig. 2-11) are available to cut American Standard pipe threads. They are held in ordinary or ratchet-type diestocks (fig. 2-13). The jaws of the dies are adjusted by set-screws. An adjustable guide serves to keep the pipe in alinement with respect to the dies. The smooth jaws of the guide are adjusted by a cam plate. A thumbscrew locks the jaws firmly in the desired position.

Threading sets are available in many different combinations of taps and dies, together with diestocks, tap wrenches, guides, and necessary screwdrivers and wrenches to loosen and tighten adjusting screws and

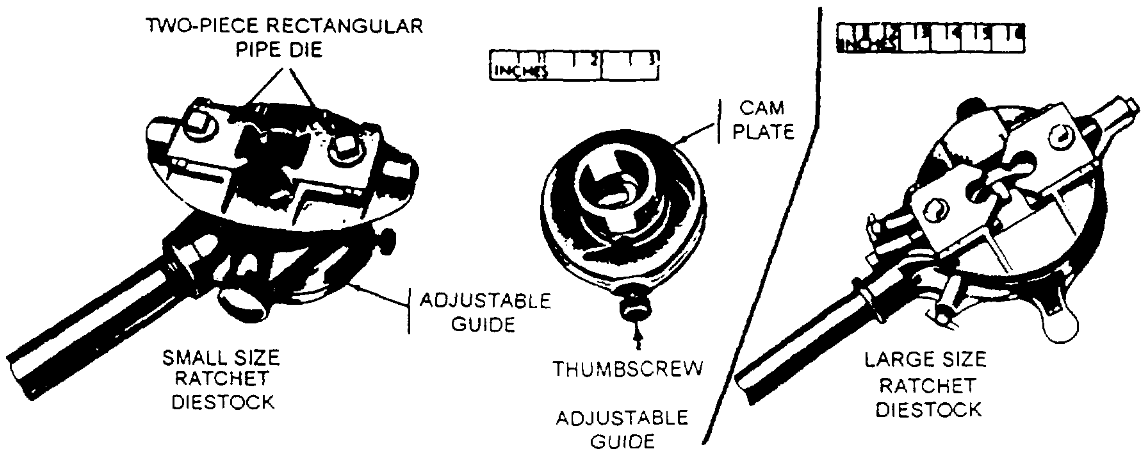


Figure 2-13.—Adjustable die guide and ratchet diestocks.

bolts. Figure 2-14 illustrates a typical threading set for pipe, bolts, and screws.

Never attempt to sharpen taps or dies. Sharpening of taps and dies involves several highly precise cutting processes that involve the thread characteristics and chamfer. These sharpening procedures must be done by experienced personnel to maintain the accuracy and the cutting effectiveness of taps and dies.

Keep taps and dies clean and well oiled when not in use. Store them so they do not contact each other or other tools. For long periods of storage, coat taps and dies with a rust-preventive compound, place in individual or standard threading set boxes, and store in a dry place.

SCREW AND TAP EXTRACTORS

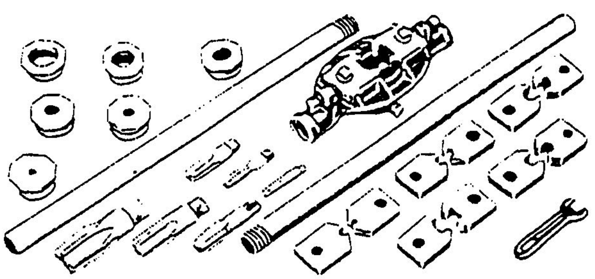
Screw extractors are used to remove broken screws without damaging the surrounding material or the threaded hole. Tap extractors are used to remove broken taps.

Some tap extractors (fig. 2-15, view A) are straight, having flutes from end to end. These extractors are available in sizes to remove broken screws having 1/4- to 1/2-inch outside diameters (O.D.). Spiral tapered extractors (fig. 2-15, view B) are sized to remove screws and bolts from 3/16-inch to 2 1/8-inches O. D..

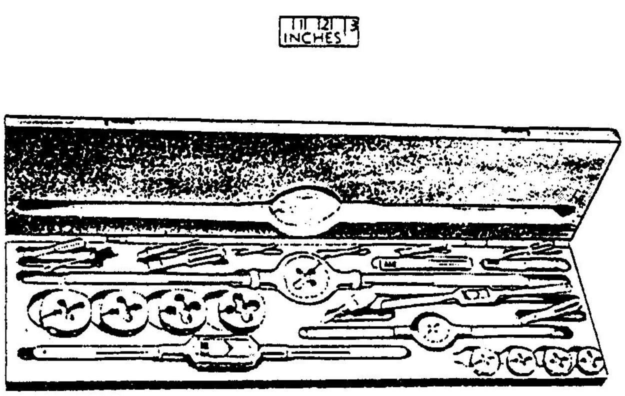
Most sets of extractors include twist drills and a drill guide. Tap extractors are similar to the screw extractors and are sized to remove taps ranging from 3/16- to 2 1/8-inches O. D..

To remove a broken screw or tap with a spiral extractor, first drill a hole of proper size in the screw or tap. The size hole required for each screw extractor is stamped on it. The extractor is then inserted in the hole and turned counterclockwise to remove the defective component.

If the tap has broken off at the surface of the work, or slightly below the surface of the work, the straight tap extractor shown in figure 2-15, view A, may re-move it. Apply a liberal amount of penetrating oil to the broken tap. Place the tap extractor over the broken tap and lower the upper collar to insert the four sliding

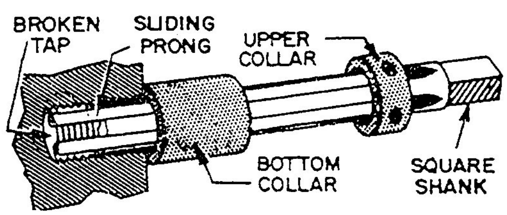


PIPE THREADING SET WITH RECTANGULAR ADJUSTABLE DIES, DIESTOCK, WRENCH, GUIDES AND TAPS

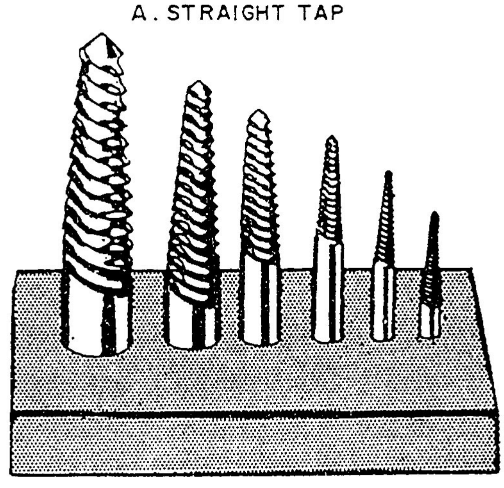


BOLT AND SCREW THREADING SET WITH ROUND ADJUSTABLE SPLIT DIES, DIESTOCKS, TAPS, TAP WRENCHES, AND SCREWDRIVERS

Figure 2-14.—Threading sets.



A. STRAIGHT TAP



B. SPIRAL SCREW

Figure 2-15.—Screw and tap extractors.

prongs down into the four flutes of the tap. Then slide the bottom collar down to the surface of the work so it will hold the prongs tightly against the body of the extractor. Tighten the tap wrench on the square shank of the extractor and carefully work the extractor back and forth to loosen the tap. It may be necessary to remove the extractor and strike a few sharp blows with a small hammer and pin punch to jar the tap loose. Then reinsert the tap remover and carefully try to back the tap out of the hole.

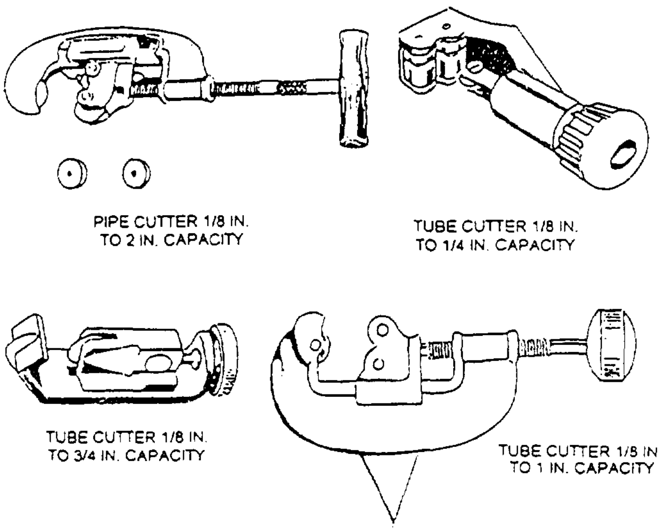


Figure 2-16.—Pipe and tubing cutters.

PIPE AND TUBING CUTTERS AND FLARING TOOLS

Pipe cutters (fig. 2-16) are used to cut pipe made of steel, brass, copper, wrought iron, and lead. Tube cutters (fig. 2-16) are used to cut tubing made of iron, steel, brass, copper, and aluminum. The essential difference between pipe and tubing is that tubing has considerably thinner walls. Flaring tools (fig. 2-17) are used to make single or double flares in the ends of tubing.

Two sizes of hand pipe cutters are generally used in the Navy. The No. 1 pipe cutter has a cutting capacity of 1/8 to 2 inches, and the No. 2 pipe cutter has a cutting capacity of 2 to 4 inches. The pipe cutter has a special alloy-steel cutting wheel and two pressure rollers that are adjusted and tightened by turning the handle.

Most tube cutters closely resemble pipe cutters, except they are of lighter construction. A hand screw feed tubing cutter of 1/8-inch to 1 1/4-inch capacity has two rollers with cutouts located off center so that cracked flares may be held in them and cut off without waste of tubing. It also has a retractable cutter blade that is adjusted by turning a knob. The other tube cutter shown is designed to cut tubing up to and including 3/4- and 1-inch O.D. Rotation of the triangular portion of the tube cutter within the tubing will eliminate any burrs.

Flaring tools are used to flare soft copper, brass, or aluminum. The single flaring tool consists of a split

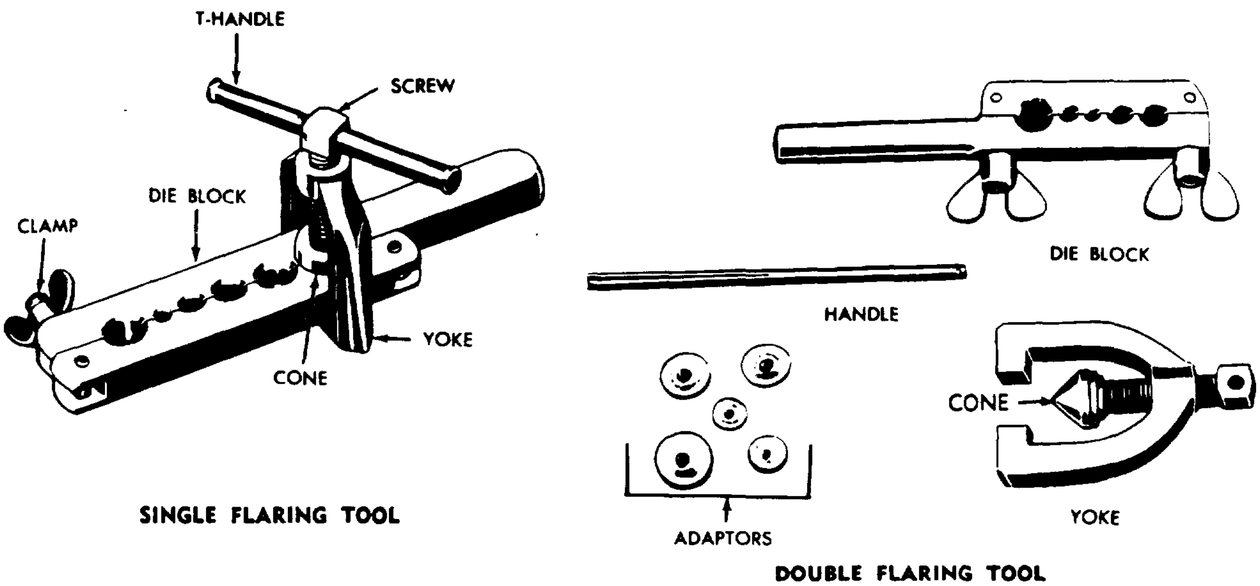


Figure 2-17.—Flaring tools.

die block that has holes for 3/16-, 1/4-, 5/16-, 3/8-, 7/16-, and 1/2-inch O.D. tubing, and a clamp to lock the tube in the die block. It also has a yoke that slips over the die block and has a compressor screw and a cone that forms a 45-degree flare or a bell shape on the end of the tube. The screw has a T-handle. A double flaring tool has the additional feature of adapters that turn in the edge of the tube before a regular 45-degree double flare is made. It consists of a die block with holes for 3/16-, 1/4-, 5/16-, 3/8-, and 1/2-inch tubing, a yoke with a screw and a flaring cone, plus five adapters for different size tubing, all carried in a metal case.

CARE OF HAND TOOLS

Tools are expensive, vital equipment. When the need for their use arises, common sense plus a little preventive maintenance prolongs their usefulness. The following precautions for the care of tools should be observed:

1. Clean tools after each use. Oily, dirty, and greasy tools are slippery and dangerous.

2. NEVER hammer with a wrench.

3. NEVER leave tools scattered about. When not in use, stow them neatly on racks or in toolboxes.

4. Apply a light film of oil after cleaning to prevent rust on tools.

5. Inventory tools after use to prevent loss.

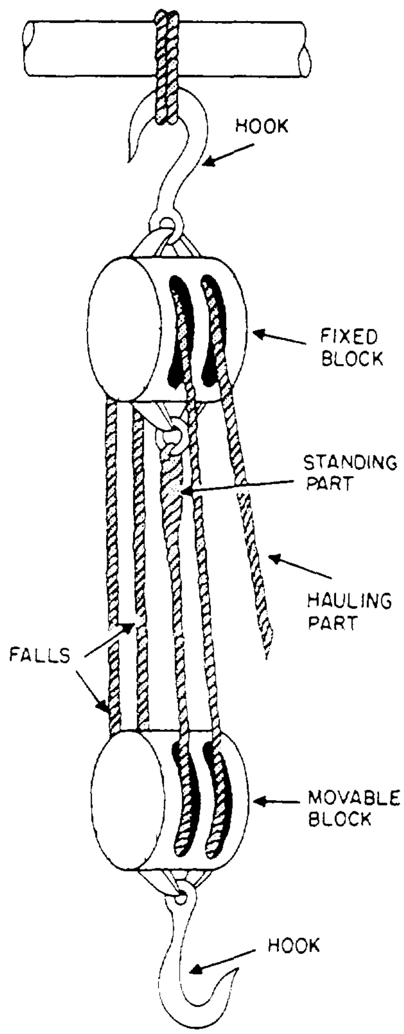


Figure 2-18.—Parts of a tackle.

TACKLE

A tackle is an assembly of blocks and ropes used to gain a mechanical advantage in lifting or pulling. Figure 2-18 shows the name and location of various main parts of a tackle.

In working with tackle, it helps you to understand the meaning of a few simple terms you hear used. The term *fall* means a rope, either manila or wire, reeved through a pair of blocks to form a tackle. The hauling part is the part of the fall leading from one of the blocks upon which the power is exerted. The standing part is the end of the fall of the blocks. The movable (or running) block of a tackle is the block attached to the object to be moved. The fixed (or standing) block is the block attached to a fixed object or support. When a tackle is being used, the movable block moves up and down and the fixed block remains stationary.

The *mechanical advantage* of a tackle is the term applied to the relationship between the load being lifted and the power required to lift that load. Thus, if a load of 10 pounds requires 10 pounds of power to lift it, the mechanical advantage is 1. However, if a load of 50 pounds requires only 10 pounds to lift it, then you have a mechanical advantage of 5 to 1, or 5 units of weight are lifted for each unit of power applied.

The easiest way to determine the mechanical advantage of a tackle is by counting the number of parts of the falls at the movable (or running) block. If there are two parts, the mechanical advantage is two times the power applied (less friction). A gun tackle, for instance, has a mechanical advantage of 2. Thus, to lift a 200-pound load with a gun tackle requires 100 pounds of power, disregarding friction.

By inverting any tackle, a mechanical advantage of 1 is always gained because the number of parts at the movable block is increased. By inverting a gun tackle (fig. 2-19) a mechanical advantage of 3 is attained. When a tackle is inverted, the direction of pull is difficult. This can be easily overcome by adding a snatch block, which changes the direction of pull, but does not increase the mechanical advantage.

Types Of Tackle

Various types of tackle are in common use. Three are shown in figure 2-20.

In studying each type illustrated, note the direction in which the arrows are pointing for that particular tackle. The purpose of the arrows is to indicate the sequence and direction in which the standing part of the fall is led in reeving.

A gun tackle is made up of two single sheave blocks. This tackle got its name in the old days by being used to haul muzzle-loading guns back into battery after the guns had been fired and reloaded. As stated, a gun tackle has a mechanical advantage of 2. A single luff tackle consists of a double and a single block. This type has a mechanical advantage of 3. A twofold purchase consists of two double blocks, as illustrated. It has a mechanical advantage of 4.

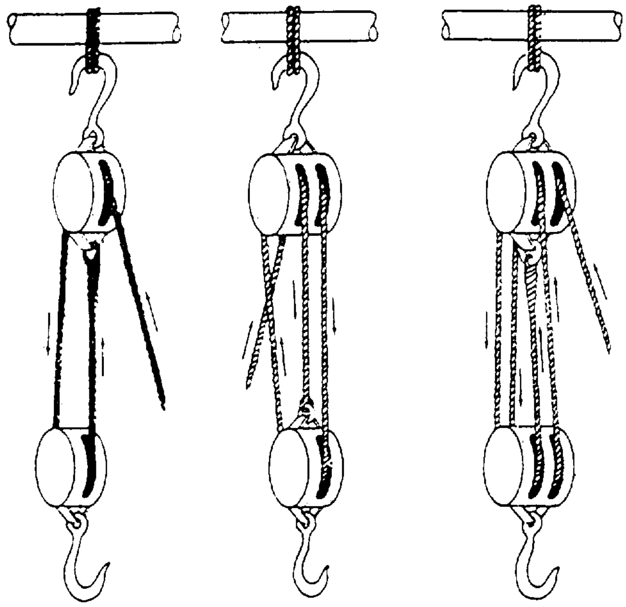


Figure 2-20.—Three common types of tackle.

Chain Hoists

Chain hoists are portable lifting devices suspended from a hook and operated by a hand chain. The one most commonly used by the ABF is the spur-geared hoist. The spur-geared hoist gains its mechanical advantage from the difference in diameter of the spur gears (reduction gear ratio) (fig. 2-21).

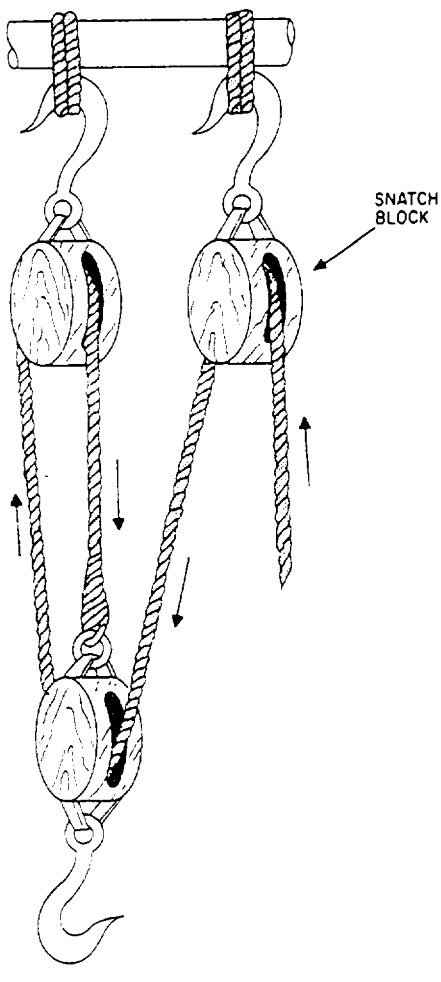


Figure 2-19.—Inverted gun tackle.

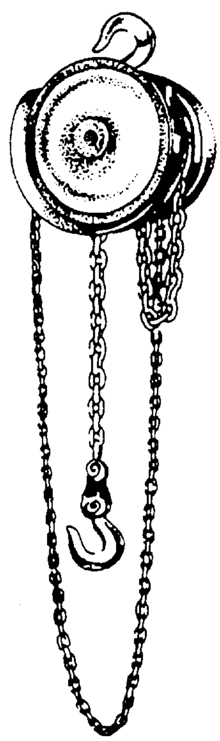


Figure 2-21.—Spur gear head chain hoist.

Two separate chains are used, one as a load chain and the other as the hand chain. The hand chain drives a pocketed chain wheel sheave that in turn drives the spur gears. The spur gears drive a single load sheave. One end of the load chain is attached to the swivel load hook. The chain then passes over the load sheave. The other end is attached to the hoist frame. A mechanical brake, consisting of a ratchet and pawl or friction disk unit plate, is used to sustain the load. To lower, pull the operating chain in the reverse direction, slipping the friction brake or releasing the ratchet-pawl device.

The worm-geared hoist and the spur gear chain hoist operate in the same way except the gearing is reduced with the use of a worm gear drive. The lead (pitch) of the worm gear makes the hoist nonoverhauling.

Lever-Operated Chain Hoist

One of the widely used pieces of lifting equipment is the ratchet hoist. In more common terms it is usually called a come-along (fig. 2-22).

The ratchet hoist (come-along) has an operating handle similar to a ratchet wrench, hence its name. It is normally light in weight and comes in a variety of sizes, depending on the job to be done. A hoist has a ratchet and pawl or a friction disk brake incorporated in its mechanism to hold the load when the handle is released. Ratchet hoists are reversible so the load may be raised or lowered. Ratchet chain hoists come equipped with the load chain either of the roller sprocket (bicycle) or link chain type.

Load chains should be lubricated and should show no indication of binding. Do not exceed the load rating of the hoist or use extensions on the ratchet lever. Inspect load chains for wear, reduction in link bar diameter, and increase in unit lengths. Use the manufacturer's data sheet or manual for reference.

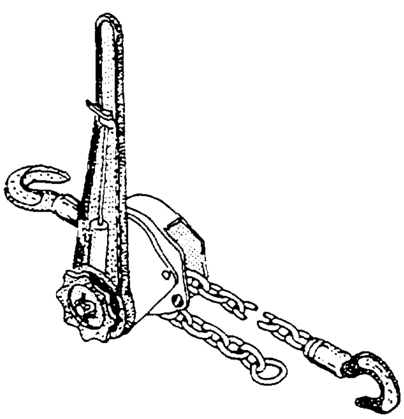


Figure 2-22.—Lever-operated chain hoist (come-along).

PIPE PATCHES

While not a tool in the normal sense of the word, pipe patches are an integral part of the ABF's toolroom. There are miles of pipes in a fuel system, and damage to this piping can result from battle, accident, or merely the wear and tear of daily use. The ABF should know how to locate and repair piping system troubles.

Repairs to piping are classified as permanent or temporary. Permanent repairs are made when the time and the material are available. Temporary are made when the correct material is not available and/or the system cannot be secured for the time needed.

Temporary repairs are usually made by securing some type of patch over the damaged section of pipe. The material used for the patch depends upon the type of piping that is being repaired. A good general rule is to make the temporary patch from the same type of material that is used for the flange gaskets in the system. Back up the patch with a piece of sheet metal, and secure the sheet metal to the pipe with bolted metal clamps or similar devices. A sealing compound may be applied between the patch and the pipe to help seal the patched area.

Jubilee pipe patches (fig. 2-23) are frequently used to stop leaks in piping. These patches may be obtained from standard stock or they may be fabricated on board ship. When making up a patch of this type, be sure to reinforce the flange so it will be strong enough to hold against the pressure of the system. The main disadvantage of the Jubilee patch is that assorted sizes must be stocked since each patch is manufactured to fit only one size of pipe.

Temporary repairs to some piping systems also may be made by using plastic patching materials. The materials required for plastic patching are furnished in a special kit.

Emergency Damage Control Metallic Pipe Repair Kit

Most water and fuel lines can be easily repaired and service restored to the system in as little time as 30 minutes by using the emergency damage control metallic pipe repair kit, often called a "plastic patch."

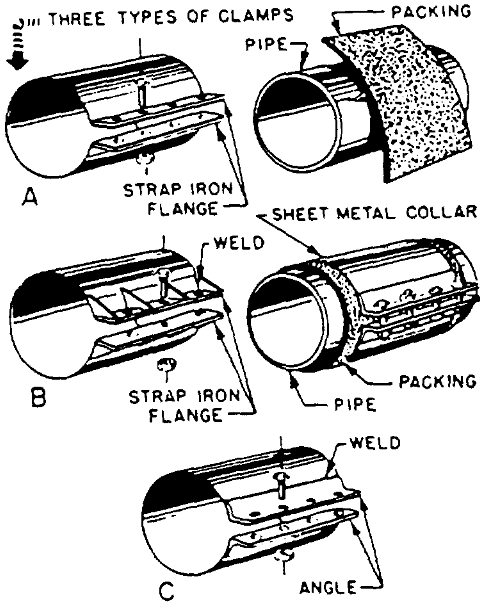


Figure 2-23.—Jubilee pipe patches.

In addition to the repair or patching of piping, certain materials are included in the kit that may be used to patch small cracks and ruptures in flat metal surfaces.

Materials in the kit may be obtained separately through appropriate supply channels whenever a need arises to replace them. You need not obtain another completely new kit. A complete kit contains the following materials:

4 cans of liquid resin, 400 grams each

4 cans of liquid hardener, 100 grams each

4 cans of paste resin, 300 grams each

4 cans of paste hardener, 75 grams each

1 piece of woven roving cloth 24” x 10”

1 piece of void cover, 8” x 36”

1 piece of polyvinyl chloride (PVC) film, 36” x 72”

1 chalk line, 1/8-lb

4 pairs of gloves

2 eyeshields

4 wooden spatulas

1 sheet of emery cloth, 9” x 11”

1 pair of scissors

4 tongue depressors

1 instruction manual

A description of the basic materials and factors related to plastics is necessary for you to more thoroughly understand the discussion of the kit and its use.

RESINS AND HARDENERS.— The liquid and paste resins are of the epoxy type. The liquid and paste hardeners are chemical compounds used to harden the resins. The resins and the hardeners are packaged in premeasured amounts. For proper mixture and better results, the complete contents of the hardener in the smaller can should be mixed with the complete contents of the resin in the larger can.

CAUTION

Do not mix hardener with resin until all preparations have been completed, and do not intermix liquid resin and paste hardener or paste resin and liquid hardener.

When the hardeners and the resins are mixed, a chemical reaction occurs that causes the mixture to harden (liquid mixture, approximately 12 minutes; paste mixture, approximately 17 minutes).

VOID COVERS.— The void cover is resin-treated glass cloth that can be cut and formed to cover the damaged area and is sufficiently rigid to give support to the patch.

WOVEN ROVING CLOTH.— The woven roving cloth is made of a short staple glass fiber woven into a thick, fluffy cloth. During the application of a plastic patch, this cloth is coated with the resin-hardener mixture and either wrapped around or placed over the damaged area. The glass cloth provides the main strength of the patch and also provides a means of applying the resin-hardener mixture.

FILM (PVC).— The plastic film is a thin, transparent polyvinyl chloride material that is used as a separating film for the flat patch to prevent the patch from sticking to the backup plate or other supports. It is called PVC. In the pipe patch it is used to cover the entire patch and keep the activated resin around the patch. Kraft wrapping paper may be used as a substitute if necessary.

Chemical Reaction of the Plastic Patch

When the resins and the hardeners are mixed together, a chemical reaction begins. This reaction is exothermic, meaning heat is given off. For about 12 to 17 minutes the temperature increases gradually until it reaches 120° to 135°F. Then a sudden, sharp increase in temperature occurs until it reaches its peak at or about 350°F. This sudden, sharp rise in temperature is known as kick-over. At this temperature, the resin-hardener mixture begins to solidify and change color from gray to light brown. The peak temperature (350°F) can be observed through the external change of the patch.

The resin-hardener mixture begins to cool slowly because the materials conduct heat poorly. After kick-over, the mixture continues to harden and increase in strength. This process is called curing. Approximately 30 minutes after kick-over (the sharp rise in temperature), the patch is strong and hard and cool enough to use. Pressure should not be restored to the system until the patch has cured. The patch is considered sufficiently cured when the bare hand can be placed on it without discomfort from heat.

Several factors contribute to the control of kick-over. The most important factor is the temperature. Both the initial temperature of the activated resin mixture and the temperature of the atmosphere affect the kick-over time. Of these two temperatures, the initial temperature of the activated resin has the greater effect. When the temperature of the resin and the hardener before mixing is increased, the kickover time decreases. Conversely, when the temperature of the resin and hardener before mixing decreases, the kick-over time increases.

A knowledge of the control of kick-over is necessary since it corresponds to the application of working time. This means, for example, that when the initial temperature of the mixture is 73°F, the patching material must be placed over the rupture within 12 minutes. Once the resin and the hardener are mixed, the chemical reaction cannot be stopped. Therefore, the patch should be completely applied before kick-over occurs.

Figure 2-24 shows the relationship of the kick-over time to the resin temperature. If you know the resin temperature at the time of mixing, you are able to determine the amount of time available to apply the patch before kick-over occurs. You can see in figure 2-24 that if the resin temperature is 80°F (point A), the kick-over will occur in less time than if the resin temperature were 60°F (point B). The difference in resin temperatures represents an application working time of 9 minutes instead of 18 minutes.

NOTE

If the initial resin temperature exceeds 80°F, the temperature should be reduced by artificial means to 73°F before mixing. This lowering of the temperature allows for additional application working time.

Advantages of the Plastic Patch

From the damage control viewpoint, the main advantages of the plastic patch are (1) versatility, (2) simplicity, (3) effectiveness, (4) speed of application, and (5) durability.

The plastic patch can be successfully applied to a variety of damaged surfaces, whether with smooth edges or jagged protruding edges. Since the plastic has excellent adhesive qualities, it can be readily applied to steel, cast iron, copper, copper-nickel, brass, bronze, and galvanized metals.

It is easy to prepare the plastic materials and to apply the plastic patch. By following the instructions outlined in the instruction manual that is included in the kit, anyone with little or no experience can readily prepare the materials and apply a plastic patch. A plastic patch is applied in much the same way as a battle dressing is used in first aid.

If the materials are properly prepared and the application procedures are followed, the plastic patch will be 100 percent effective. If leakage occurs through a plastic patch, it is likely that propr preparation and application procedures have not been followed.

The speed of application varies somewhat with the size and type of rupture, and with local working conditions. When proper preparation procedures are followed, a simple patch can be applied to a 4-inch pipe by an inexperienced crew who have had the minimum amount of training and indoctrination in 10 minutes or less. The type and the size of the rupture or the shape and the size of the structure to which the patch is applied do not materially affect the time involved in patching, but some types of damage may require more initial preparation.

The maximum period of effectiveness of a plastic patch is not known, but all indications are that a properly applied patch can last indefinitely or certainly until permanent repairs can be made. The patch is relatively inert, being seriously affected only by excessive heat and concentrated acids.

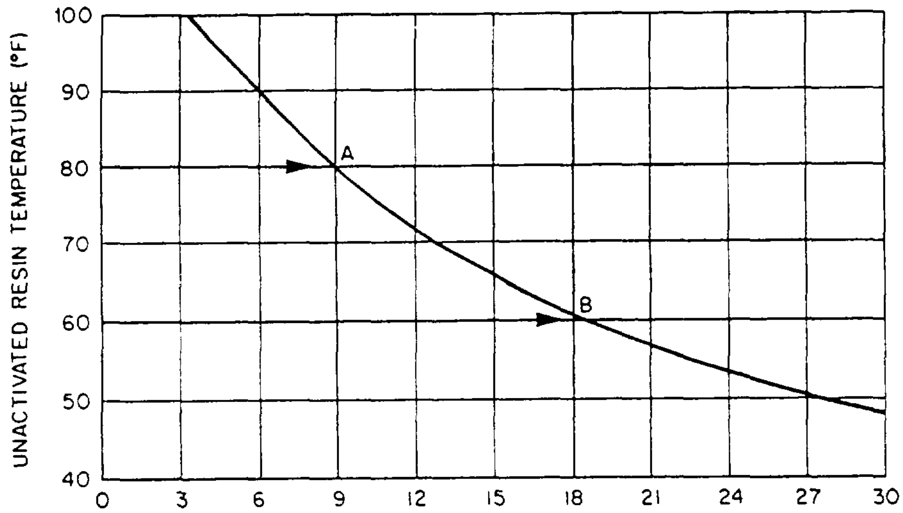


Figure 2-24.—Resin temperature vs kick-over time.

Application of Plastic Patches

In the following discussion on applying different types of plastic patches (simple, elbow, severed, and others) you can readily see that as the individual patch materials are applied, the patch becomes progressively wider. The sketch in figure 2-25 shows the relative positions of the patch materials to one another. The buildup in the patch length during application must be considered in initially determining the length of the patch to be applied. Where suitable, allow the patch to extend at least 4 to 5 inches on either side of the rupture.

In addition to the size of the rupture, the width of the patch also may depend upon the location of the rupture in the pipe system. For example, an elbow rupture may require a patch of greater width than the same size rupture would require in a straight section of pipe. Complete application instructions are included in each kit.

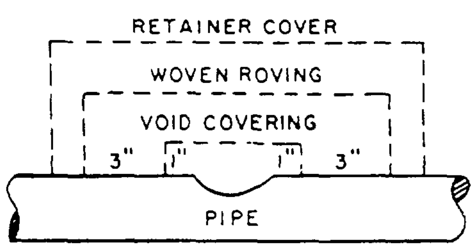


Figure 2-25.—Sequence of applied patch materials.

PREPARATION.— Before you actually apply the plastic patch, you must make the following preparations:

1. Secure or isolate the ruptured area in the piping system.

2. Remove all lagging.

3. Clean the area around the rupture and remove all grease, oil, dirt, paint, and other foreign matter. If grease or oil is present, use an approved solvent to clean around the rupture. If no approved solvent is available, scrape and wipe the surface until it is clean. When a clean surface is obtained, the surface may be further abraded for better adhesion. An abrasive cloth is furnished with the kit.

4. Ensure that all moisture and fuel are removed from the inside of the piping and the entire pipe surface is dry.

5. Where practical, the rupture should be simplified by bending or removing irregular projections. This may be done by cutting or burring.

CAUTION

Ensure no explosive conditions exist before you use spark-producing tools or burring equipment.

6. Determine the amount of materials required, such as the amount of woven roving cloth as well as the

amount of resins and hardeners. For example, a 2-inch rupture in a 2-inch diameter pipe requires 500 grams of activated resin and a length of woven roving cloth at least 25 inches long. Cut the woven roving cloth, in width, to extend at least 3 to 4 inches on either side of the rupture.

Simple Pipe Patch.— The following numbered instructions are step-by-step procedures for applying the simple pipe patch;

1. Put on the eyeshields and the gloves, then open the liquid resin can and the liquid hardener can.

2. Add hardener to the resin and mix thoroughly for approximately 2 minutes or until a uniform gray color is observed. (Note that the entire contents of the liquid hardener in the smaller can is the correct proportion for mixing with the entire contents of the larger can of liquid resin.)

3. Coat both sides of the void cover with the resin hardener mixture and tie the void cover over the rupture with chalk line (view A of fig. 2-26).

4. Lay the woven roving cloth on a clean, flat surface. Starting at one end of the cloth, pour on resin-hardener mixture and spread evenly over the entire surface of the cloth using the spatula provided in the kit. It is only necessary to impregnate one side of the woven roving cloth, but be careful to ensure the edges are well impregnated with the resin-hardener mixture.

5. Center the woven roving cloth over the void cover with the impregnated side toward the pipe and wrap around the pipe not less than three turns and preferably not more than four turns. See view B of figure 2-26.

6. Wrap the PVC film around the entire patch, making at least two complete turns. Tie the PVC film with the chalk line, starting from the center of the patch and working toward one end, making 1/2-inch spacings between spirals (view C of fig. 2-26). Tie this end securely but do not sever the line. Make one spiral back to the center of the patch, then, working to the opposite end from the center of the patch, make 1/2-inch spacings between spirals and again secure the line. After 30 to 40 minutes, the patch should be sufficiently cured to restore the pipe to service.

7. Remember that for best results the temperature of the liquid resin and the liquid hardener, before mixing, should be approximately 70°F. With a temperature of 70°F at the time of mixing, the patch cures in approximately 1 hour from the initial mixing time.

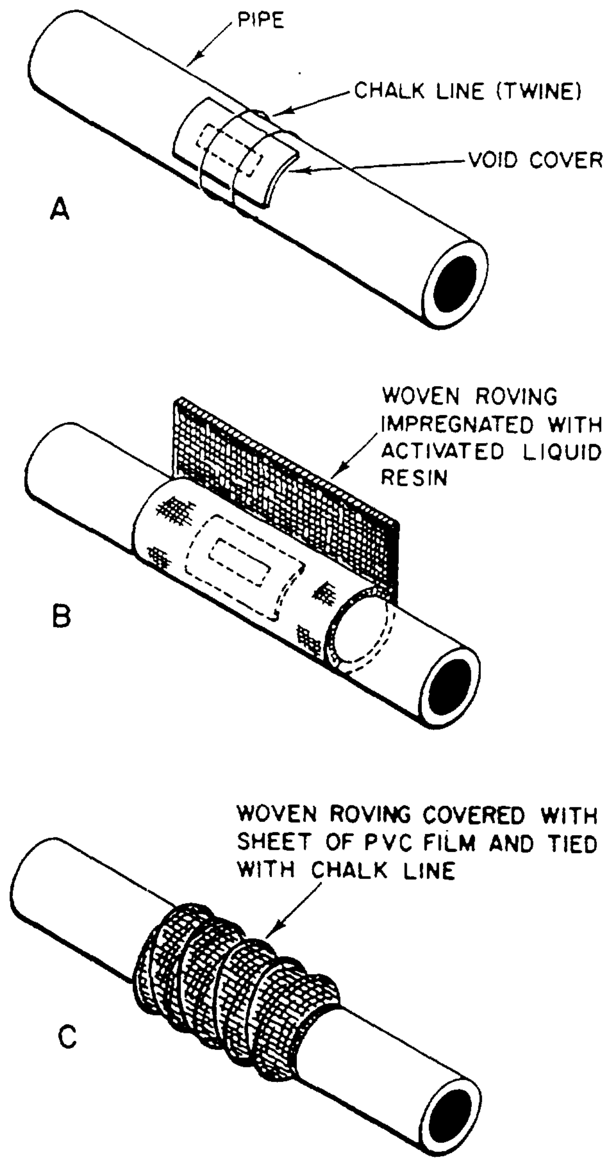


Figure 2-26.—Simple pipe patch.

8. In emergencies, if the temperature of the resins and the hardeners is below 50°F, kick-over may be accelerated by applying external heat with hot air heaters, infrared lamps, or light bulbs. The external heat must be applied gradually because excessive application of heat causes the plastic patch to be extremely porous. Before mixing, it is better to warm the resin and hardener in the can to a temperature of about 70°F.

9. Be careful not to restore pressure to the piping system too soon. In general, pressure may be restored when you can hold your hand on the entire patch area without discomfort resulting from heat. Normally this may require between 30 to 40 minutes after kick-over, or 50 to 60 minutes from the initial mixing time.

10. In emergencies, the liquid in the piping system also may be used as an artificial cooling medium 15 minutes after kick-over. This is done by circulating the liquid at very low pressure (not above 10 psi) through the system for approximately 5 minutes. This procedure generally reduces the time before full pressure can be restored to the system by about 15 minutes.

The sketch shown in figure 2-25 illustrates the relative positions of patch materials to one another. This buildup in the patch during application must be considered in initially determining the length of patch to be applied.

Elbow Patch.— The elbow patch shown in figure 2-27 is applied, using the same basic procedures as the simple patch. However, note the following exceptions:

1. The edges of the void cover are slit 2 to 3 inches at each end to conform to the contour of the pipe. See view B of figure 2-27.

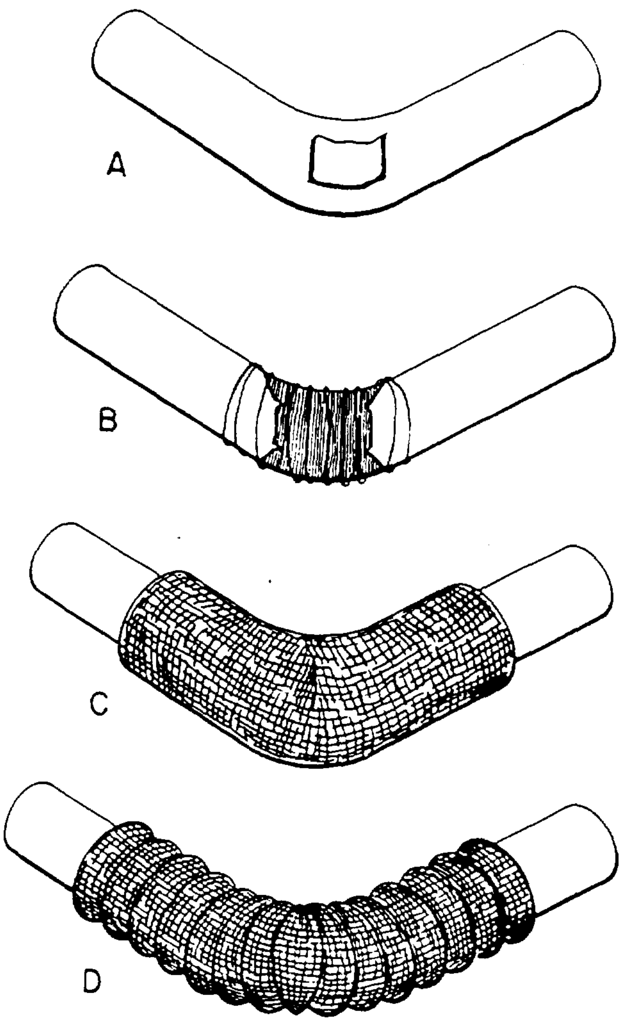


Figure 2-27.—Elbow pipe patch.

2. After the impregnated woven roving cloth has been wrapped around the pipe, use the gloved hand to shape the cloth to the contour of the pipe.

3. Then apply the PVC film and tie it with the chalk line as described for the simple pipe patch.

Severed Pipe Patch.— The severed pipe patch shown in figure 2-28 is also applied with the same basic procedures as the simple pipe patch, but this procedure too has some exceptions:

1. Where the gap exceeds 4-inches, thin sheet metal or other suitable materials may be used as a substitute for the void cover in bridging the gap. The substitute

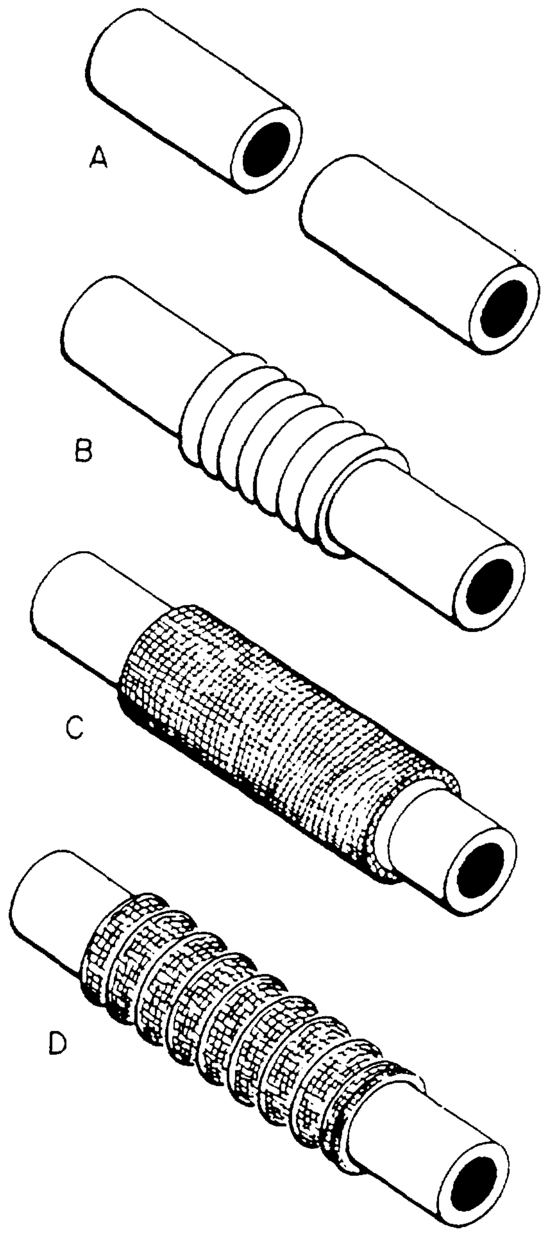


Figure 2-28.—Severed pipe patch.

material should be cut so it extends at least 2 inches on either side of the gap and should be long enough to provide one complete turn around the pipe with a possible overlap of about 2 inches. Secure the substitute material with the chalk line.

2. Cut the woven roving cloth so it extends at least 4 inches beyond the edges of the bridge material. Impregnate the cloth with the resin/hardener mixture. Wrap the cloth around the bridge materials and tie it securely as you did for the simple pipe patch.

3. Apply the PVC film and tie it securely with the chalk line as you did for the simple pipe patch.

Corn pound Patch.— When you are making repairs resulting from battle damage to piping systems, the compound-type rupture, as shown in figure 2-29, is the one you get most often. Since compound ruptures may take a variety of shapes, it becomes difficult to select a single example to fit all repairs. In most compound ruptures, it should be possible to simplify the rupture by removing butterfly edges or by cutting away the damaged section to form either a severed pipe or a simple pipe repair. When the butterfly edges or other projections cannot be removed by pounding in, cutting, or burning, a simple pipe patch may be applied with the following modifications:

1. Tie the chalk line firmly between the jagged edges (view B of fig. 2-29) crisscrossing as much as possible. This chalk line acts as a support for the woven roving cloth and keeps it from falling into the void. No void cover is used in this example as it would be impractical to cut a void cover to suit the jagged edges shown in view A of figure 2-29.

2. A small piece of impregnated woven roving cloth (view C of fig. 2-29) is folded and laid in the void where it helps to build up the mass and acts as an insulator.

3. Apply the woven roving cloth (view D of fig. 2-29) cut to the appropriate length and width over the small folded piece of woven roving cloth, and tie it firmly as outlined previously for the simple pipe patch.

Flange Patch.— The flange patch (fig. 2-30) is also applied similarly to the simple pipe patch, but it has some modifications in the application procedure.

1. As illustrated in view B of figure 2-30, the void cover is cut into an H shape, impregnated with the resin-hardener mixture, inserted into the void, and tied securely in place.

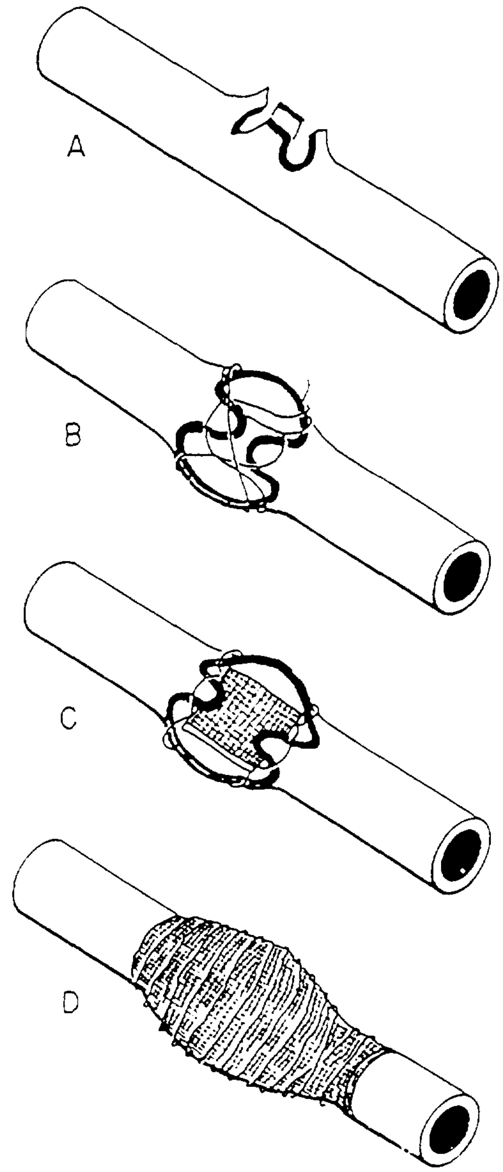


Figure 2-29.—Compound rupture patch, edges not removed.

2. Four pieces of woven roving cloth are cut long enough to make one complete turn around the pipe and overlap 1 inch. These four pieces of woven roving cloth are cut in an H shape, but the center pieces are not cut away. Instead, they are folded up over the edges of the flange.

3. Impregnate the separate pieces of woven roving cloth with the resin-hardener mixture and place over the rupture, as shown in view C of figure 2-30.

4. Apply the PVC film and tie down firmly, starting at one end and working up to the flange. Make several windings through the gap in the flange in the

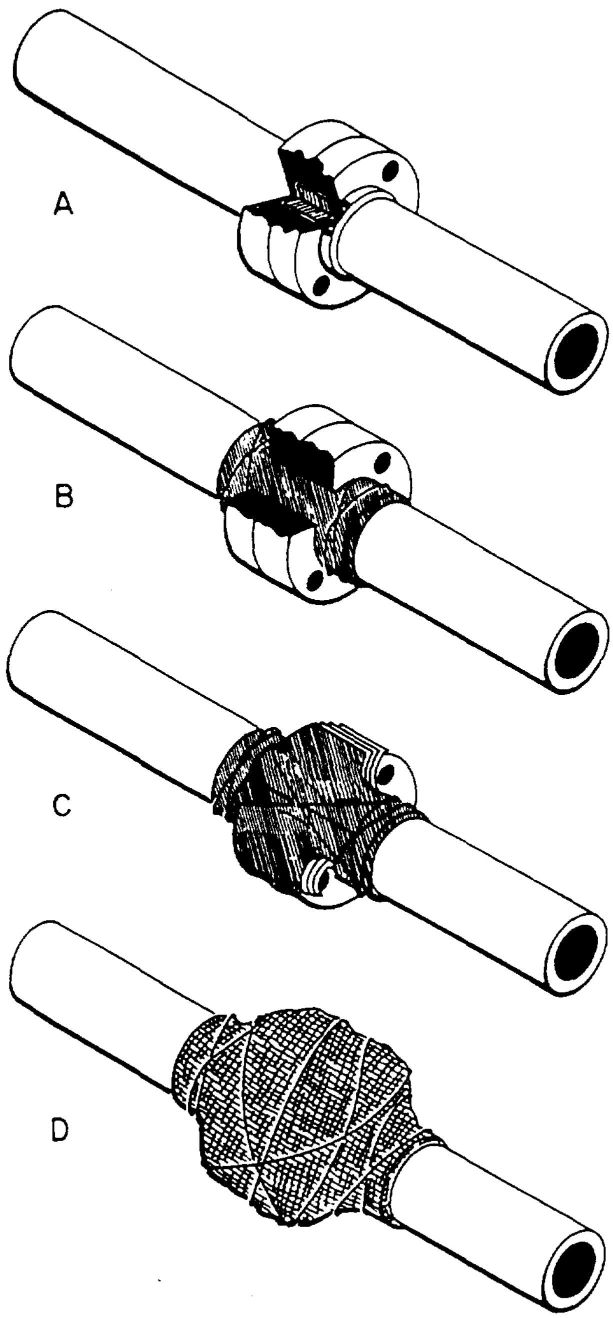


Figure 2-30.—Flange rupture patch.

shape of an X to have the woven roving cloth conform to the center of the rupture and the flange edges. Continue to the opposite end of the patch and tie securely in place.

SAFETY RULES.— The following safety precautions should be observed by all personnel when they are working with plastic materials:

1. Provide forced intake and exhaust ventilation; this is particularly important when heat and resultant fumes are given off.

2. Wear long-sleeved coveralls, long-sleeved neoprene gloves, knee-high rubber boots, and goggles.

3. Immediately relieve and treat anyone evidencing sensitization.

4. Wash hands frequently. (Personal cleanliness is your most important and effective protection.)

5. Do not expose yourself to or breathe the noxious fumes given off during cure.

6. Avoid spilling plastic materials. Keep kraft paper in areas where material is likely to spill or drip.

7. Keep the resin and liquid hardener off skin areas, wherever possible. Use protective ointment. If contaminated, remove material as soon as possible, using soap and hot water.

8. Keep the resin and liquid hardener out of the eyes. If contaminated, immediately flush with water for at least 15 minutes and obtain medical treatment.

9. Wash gloves and goggles immediately after each use with a good detergent.

Aboard ship, these precautions should be taken as far as possible but not to such an extent as to delay vital repair measures. Reasonable care in the handling of materials and thorough washing after their use should suffice. Since it appears that resins and liquid hardeners do not have primary irritant qualities, they maybe used aboard ship without any trouble, except a possible rare case of sensitivity.

An ideal plastic patch is one that can be applied and cured in the shortest time possible and maintains the desired tightness. The primary factor controlling kick-over time is the temperature of the resin and hardener before mixing. To effect the cure in the shortest time possible, you must contain the heat generated in the patch. This is done by creating a mass about the break in the pipe or bulkhead rupture by using an impregnated woven roving cloth. You can see that the correct amount of mass is necessary to have an effective patch. It is also important that the patch cool readily, for you cannot restore pressure to the system until the patch cools to about 150°F. The net result is that you buildup a mass about the rupture that gives you the patch with the most desirable characteristics in the shortest time possible.

PORTABLE POWER TOOLS

LEARNING OBJECTIVES: Identify portable power tools used by the ABF. Explain the use and care of power tools. State the safety precautions required when using power tools.

ABFs are frequently required to use portable power tools in the maintenance of assigned areas that are exposed to the weather. Power tools, when used properly and efficiently, are an enormous time and manpower saver, especially when a large painted or rusted surface requires scaling and representation. Before using electric portable tools, be sure the proper voltage is supplied. This information can be found on the nameplate permanently attached to the tool. Electric tools of all types used in the Navy are required to have a proper ground capability. If doubt exists whether or not a good ground has been established, request the services of an Electrician's Mate to check it out before applying power to the tool. NEVER VARY the manufacturer's recommended voltage. SAFETY IS PARAMOUNT.

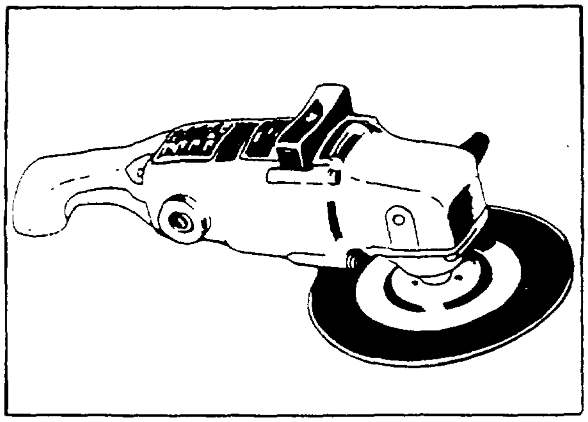


Figure 2-31.—Portable electric sander.

When pneumatic tools are used, the air supply pressure specified on the nameplate should always be maintained. Insufficient air pressure causes the tool to function improperly. Excessive air pressure results in damage to the tool and the person operating the tool may not be able to control it properly.

REMEMBER that tools can cut through rust, paint, metal, arms, and legs. Give your full attention while operating any power tool and never distract anyone who is using power equipment.

PORTABLE ELECTRIC DRILL

The electric drill is a versatile item of equipment. It is probably used more than any other portable electric tool. It can be used for drilling holes in wood or metals, mixing paint, and buffing small items with the proper attachments, as well as a variety of other uses.

The average size electric drill has a 1/4-inch capacity, with a three-fingered chuck tightened with a chuck key. The chuck key is usually taped to the electric cord about 18 inches from the drill itself to allow it to be used in the chuck without being removed from the cord. Heavier drills are larger in appearance and weight but have larger motors and

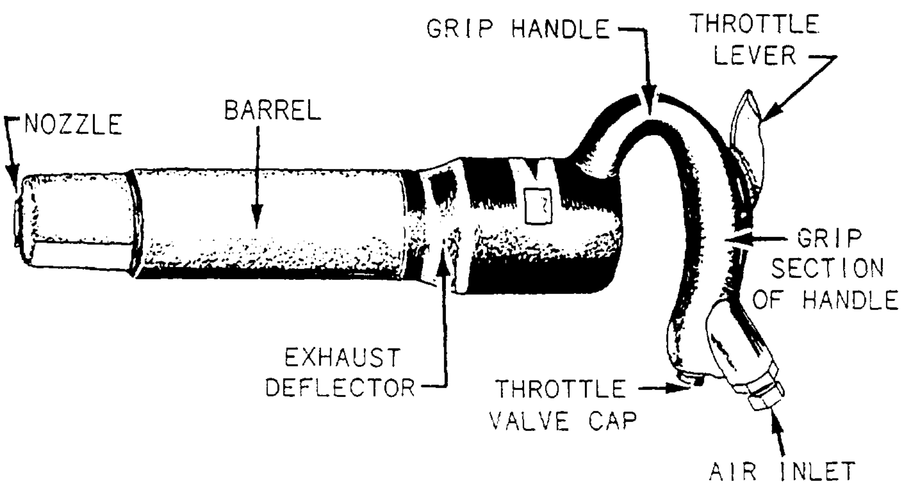


Figure 2-32.—Pneumatic chipping hammer.

chucks. In general, the larger the drill (and motor), the slower the rpm, which provides the needed extra torque to twist a greater size drill bit.

CAUTION

Unplug the drill before attempting to tighten or remove drill bits.

PORTABLE ELECTRIC OR NEUMATIC OPERATED SANDER

The power sander (fig. 2-31) is one of the most desirable tools for scaling rust, removing paint, and smoothing decks and bulkheads before painting. The design of the portable power sander is much like that of the electric drill motor with the addition of the sanding disk attached at right angles. The average size disk sander used in the Navy is either 7 or 9 inches.

PNEUMATIC CHIPPING HAMMER

The pneumatic chipping hammer (fig. 2-32) is another tool useful to the ABF when scaling large areas in preparation for repainting. Air pressure supply should be maintained to the manufacturer's recommended working pressures found on the nameplate attached to the tool. Never point the pneumatic chipping hammer at another person or yourself while air pressure is supplied to the tool. Personal injury could occur if the chisel was expelled at high speed from the scaling hammer.

ROTARY IMPACT SCALER

The rotary impact scaler (fig. 2-33) is a scaling and chipping tool, sometimes called a jitterbug. It is electric or pneumatic powered and has a bundle of cutters mounted on either side. In use, it is pushed along the surface to be scaled with the rotating chippers doing the work. Replacement bundles of cutters are available.

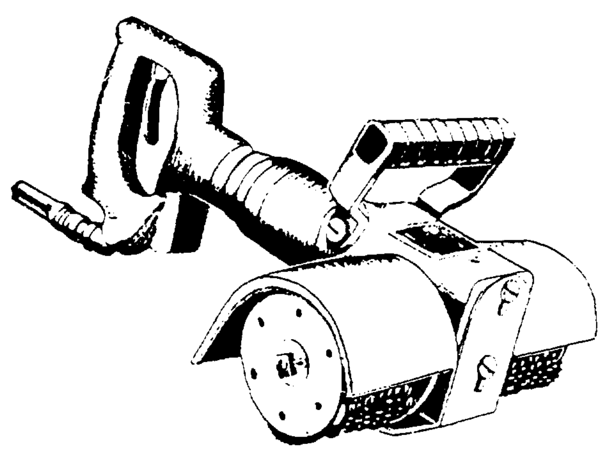


Figure 2-33.—Rotary impact scaler.

NEEDLE IMPACT SCALER

The needle impact scaler (fig. 2-34) has needlelike attachments that fit into one end. It is often called a needle-gun. This tool is used in conjunction with the rotary scaler and can clean out (scale) corners not reached by the other tool.

PRECISION MEASURING EQUIPMENT

LEARNING OBJECTIVES: Identify precision measuring equipment used by the ABF. Explain the use and care of precision measuring equipment.

As an ABF, you will be using measuring tools that read in the thousandths (0.001). On PMS and in major maintenance work, you will be required to use torque wrenches, micrometers, telescoping gages, vernier calipers, and dial indicators. Aligning pumps, checking shafts for wear, and checking bearings' inside and outside diameters are just a few places where these tools are used. We will now go through the selection and use of the proper tool for the job at hand.

TORQUE WRENCHES

There are times when, for engineering reasons, a definite force must be applied to a nut or bolt head. In such cases a torque wrench must be used. For example, equal force must be applied to all the head bolts of an engine. Otherwise, one bolt may bear the brunt of the force of internal combustion and ultimately cause engine failure.

The three most commonly used torque wrenches are the deflecting beam, dial indicating, and

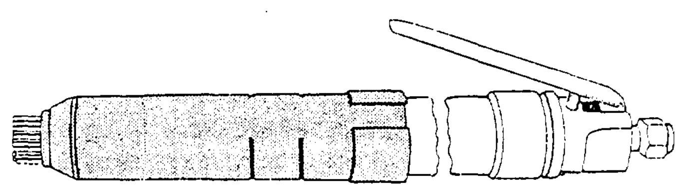


Figure 2-34.—Needle impact scaler (needle-gun).

micrometer setting types (fig. 2-35). When using the deflecting beam and the dial indicating torque wrenches, the torque is read visually on a dial or scale mounted on the handle of the wrench.

To use the micrometer setting type, unlock the grip and adjust the handle to the desired setting on the micrometer-type scale, then relock the grip. Install the required socket or adapter to the square drive of the handle. Place the wrench assembly on the nut or bolt and pull in a clockwise direction with a smooth, steady motion. (A fast or jerky motion will result in an improperly torqued unit.) When the torque applied reaches the torque value, indicated on the handle setting, a signal mechanism will automatically issue an audible click, and the handle will release or "break," and move freely for a short distance. The release and free travel are easily felt, so there is no doubt about when the torquing process is complete.

Manufacturers' and technical manuals generally specify the amount of torque to be applied. To assure getting the correct amount of torque on the fasteners, it is important that you use the wrench properly according to manufacturers' instructions.

Use that torque wrench that will read about mid-range for the amount of torque to be applied. BE SURE THAT THE TORQUE WRENCH HAS BEEN CALIBRATED BEFORE YOU USE IT. Remember, too, that the accuracy of torque measuring depends a lot on how the threads are cut and the cleanliness of the threads. Make sure you inspect and clean the threads. If the manufacturer specifies a thread lubricant, it must be used to obtain the most accurate torque reading. When using the deflecting beam or dial indicating wrenches, hold the torque at the desired value until the reading is steady.

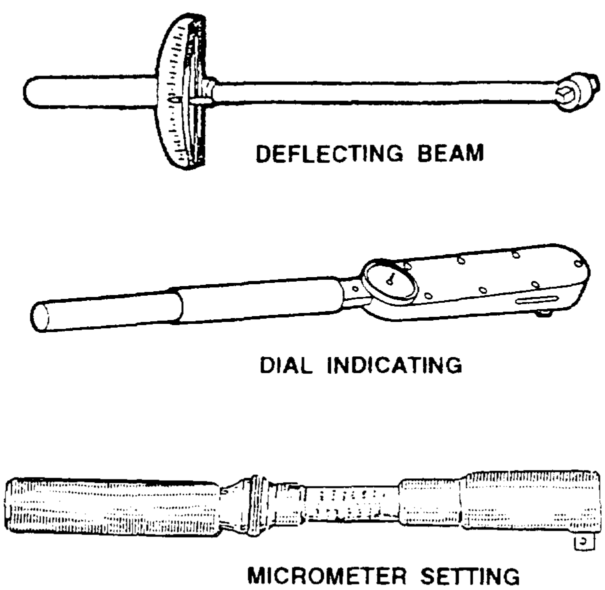


Figure 2-35.—Torque wrenches.

Torque wrenches are delicate and expensive tools. The following precautions should be observed when using them:

1. When using the micrometer setting type, do not move the setting handle below the lowest torque setting. However, place it at its lowest setting before returning it to storage.

2. Do not use the torque wrench to apply greater amounts of torque than its rated capacity.

3. Do not use the torque wrench to break loose bolts that have been previously tightened.

4. Do not drop the wrench. If dropped, the accuracy will be affected.

5. Do not apply a torque wrench to a nut that has been tightened. Back off the nut one turn with a nontorque wrench and retighten to the correct torque with the indicating torque wrench.

6. Calibration intervals have been established for all torque tools used in the Navy. When a tool is calibrated by a qualified calibration activity at a shipyard, tender, or repair ship, a label showing the next calibration due date is attached to the handle. This date should be checked before a torque tool is used to ensure that it is not overdue for calibration.

MICROMETERS

The type of micrometers commonly used are made so the longest movement possible between the spindle and the anvil is 1 inch. This movement is called the range. For example, a 2-inch micrometer has a range from 1 inch to 2 inches, and only measures work between 1 and 2 inches thick. Therefore, you must first determine the approximate size, to the nearest inch, of the piece to be measured and then select the proper size micrometer. The size of a micrometer indicates the size of the largest work it can measure.

Outside Micrometer

The nomenclature of an outside micrometer is illustrated in figure 2-36.

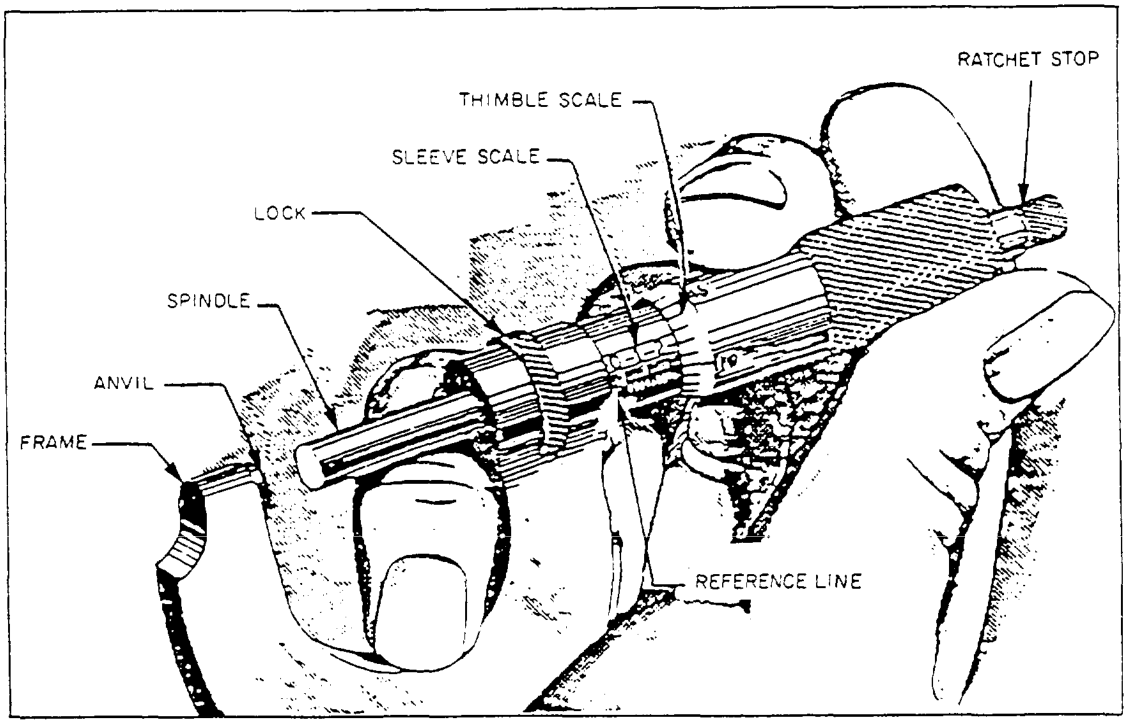


Figure 2-36.—Nomenclature of an outside micrometer.

The sleeve and thimble scales of a micrometer (fig. 2-37) have been enlarged and laid out for demonstrational purposes. To understand these scales you need to know that the threaded section on the spindle, which revolves, has 40 threads per inch. Therefore, every time the thimble completes a revolution, the spindle advances or recedes 1/40 inch or 0.025 inch.

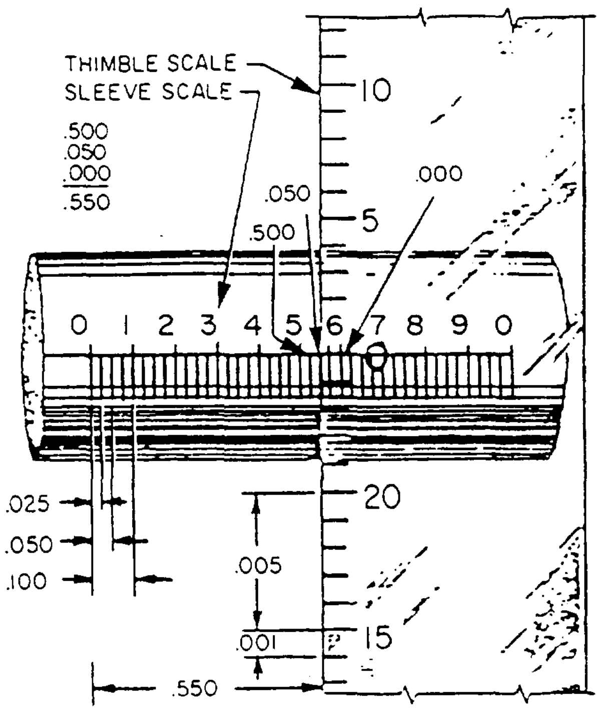


Figure 2-37.—Sleeve and thimble scales of a micrometer.

Note the horizontal line on the sleeve is divided into 40 equal parts per inch. Every fourth graduation is numbered 1, 2, 3, 4, and so on, representing 0.100 inch, 0.200 inch, and so on. When you turn the thimble so its edge is over the first sleeve line past the 0 on the thimble scale, the spindle has opened 0.025 inch. If you turn the spindle to the second mark, it has moved 0.025 inch plus 0.025 inch or 0.050 inch.

When the beveled edge of the thimble stops between graduated lines on the sleeve scale, you must use the thimble scale to complete your reading. The thimble scale is divided into 25 equal parts; each part or mark represents 1/25 of a turn. And 1/25 of 0.025 inch equals 0.001 inch. Note in figure 2-37, every fifth line on the thimble scale is marked 5, 10, 15, and so on. The thimble scale permits you to take very accurate readings to the thousandths of an inch.

The thimble is turned far enough to expose the 7 on the sleeve scale, but not far enough to expose the first mark after the 7. Therefore, the measurement must be between 0.700 inch and 0.725 inch. Exactly how far between 0.700 inch and 0.725 inch must be read on the thimble scale.

The enlarged scale in figure 2-38 can help you understand how to take a complete micrometer reading to the nearest thousandth of an inch.

As you can see, the thimble has been turned through 12 spaces of its scale, and the 12th graduation is lined up with the reference line on the sleeve. When the value on the sleeve scale is added to the value on the thimble scale that is lined up with the reference line on the sleeve scale, the space between the anvil and spindle must be 0.712 inch (seven hundred and twelve-thousandths of an inch).

Occasionally you attain a reading in which the horizontal reference line of the sleeve scale falls between two graduations on the thimble scale, as shown in figure 2-39. Note the horizontal reference line is closer to the 15 mark than the 14 mark. To read this measurement to THREE decimal places, simply round off to the 15 mark as shown in example A of figure 2-39. To read this measurement to FOUR decimal places, estimate the number of tenths of the distance between thimble scale graduations the horizontal reference line has fallen. Each tenth of this distance equals one ten-thousandth (0.0001) of an inch. Add the ten-thousandths to the reading as shown in example B of figure 2-39.

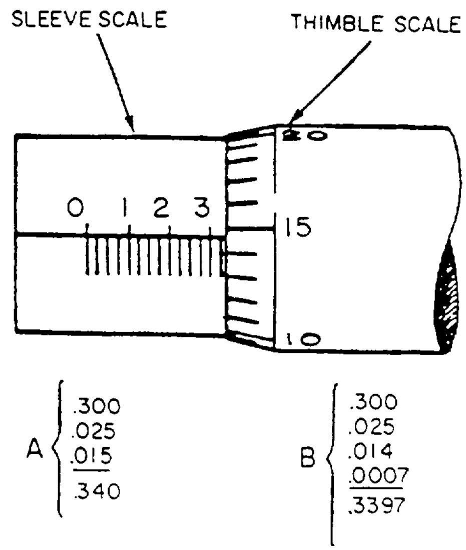


Figure 2-39.—Estimating a micrometer reading.

Reading the Vernier Scale on a Micrometer

Many times you are required to work to exceptionally precise dimensions. Under these conditions it is better to use a micrometer that is accurate to ten-thousandths of an inch. This degree of accuracy is obtained by the addition of a vernier scale.

The vernier scale of a micrometer (fig. 2-40) furnishes the fine readings between the lines on the thimble rather than requiring you to interpolate (or estimate) the reading. The 10 spaces on the vernier are equivalent to 9 spaces on the thimble. Therefore, each unit on the vernier scale is equal to 0.0009 inch and the difference between the sizes of the units on each scale is 0.0001 inch.

When a line on the thimble scale does not coincide with the horizontal reference line on the sleeve, you can determine the additional spaces beyond the readable thimble mark by finding which vernier mark matches up with a line on the thimble scale. Add this

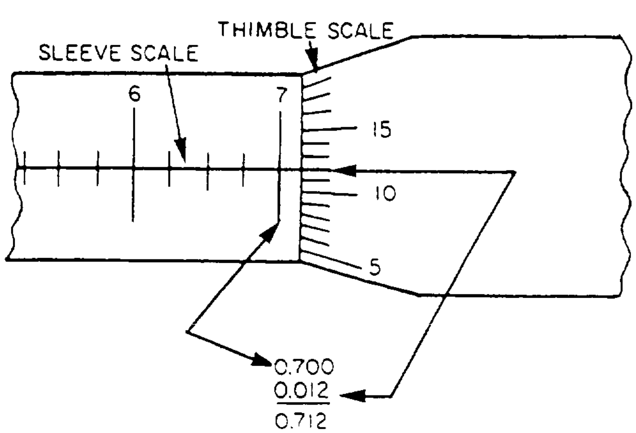


Figure 2-38.—Enlarged micrometer scale.

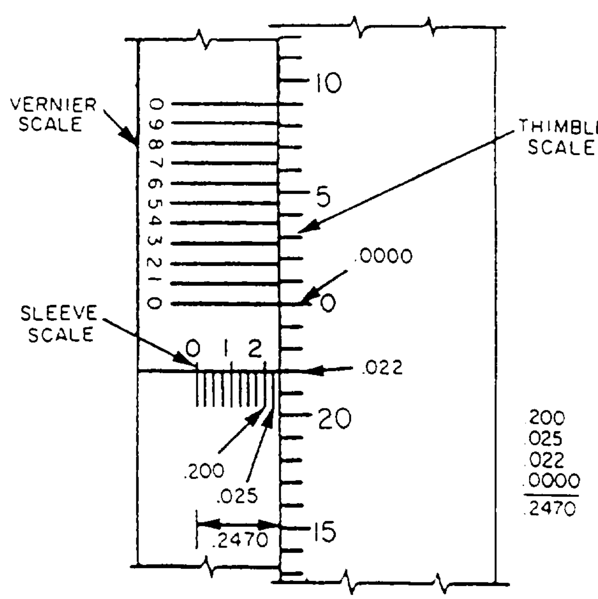


Figure 2-40.—Vernier scale of a micrometer.

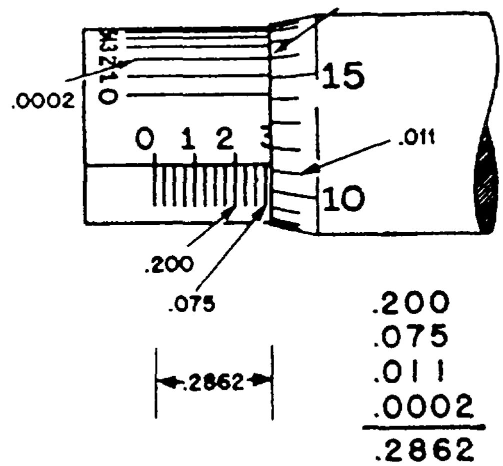


Figure 2-41.—Reading a vernier scale micrometer.

number, as that many ten-thousandths of an inch, to the original reading. In figure 2-41, see how the second line on the vernier scale matches up with a line on the thimble scale.

This means that the 0.011 mark on the thimble scale has been advanced an additional 0.0002 beyond the horizontal sleeve line. When you add this to the other readings, the reading is 0.200 + 0.075 + 0.011 + 0.0002 or 0.2862, as shown.

Inside Micrometer

The inside micrometer, as the name implies, is used for measuring inside dimensions, such as pump casing wearing rings, cylinders, bearings, and bushings. Inside micrometers usually come in a set that includes a micrometer head, various length spindles (or extension rods) that are interchangeable, and a spacing collar that is 0.500 inch in length. The spindles (or extension rods) usually graduate in 1-inch increments of range; for example, 1 to 2 inches, 2 to 3 inches (fig. 2-42).

The 0.500 spacing piece is used between the spindle and the micrometer head so the range of the micrometer can be extended. A knurled extension handle is usually furnished for obtaining measurements in hard-to-reach locations.

To read the inside micrometer, read the micrometer head exactly as you would an outside micrometer, then add the micrometer reading to the rod length (including spacing collar, when installed) to obtain the total measurement.

When the 1- to 2-inch spindle is used, and the sleeve and thimble scales are set to 0.00 inch, the distance between the face of the anvil and the face of the spindle is exactly 1.00 inch.

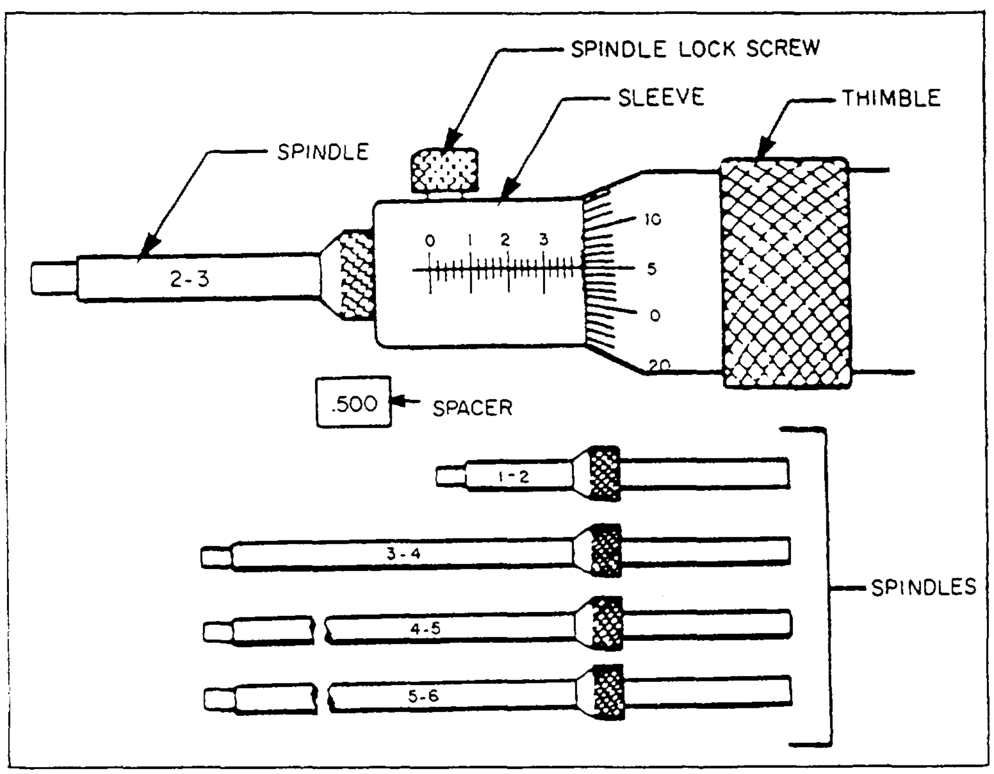


Figure 2-42.—Inside micrometer set.

VERNIER CALIPER

The vernier caliper (fig. 2-43) consists of an L-shaped member with a scale engraved on the long shank. A sliding member is free to move on the bar and carries a jaw that matches the arm of the L. The vernier scale is engraved on a small plate that is attached to the sliding member.

The vernier caliper can provide very accurate measurements over a large range. It can be used for both internal and external measurement. Some models have a depth reading feature in addition to the internal and external measurements.

In using the vernier caliper, you must be able to read a vernier scale. Figure 2-44 shows a bar 1 inch long divided by graduations into 40 parts, so each graduation indicates one-fortieth of an inch (0.025 inch). Every fourth graduation is numbered; each number indicates tenths of an inch (A x 0.025 inch). The vernier, which slides along the bar, is graduated into 25 divisions; these together are as long as 24 divisions on the bar. Each division of the vernier is 0.001 inch smaller than each division of the bar. Verniers that are calibrated as explained previously are known as English-measure verniers. The metric-measure vernier is read the same, except that the units of measurement are in millimeters.

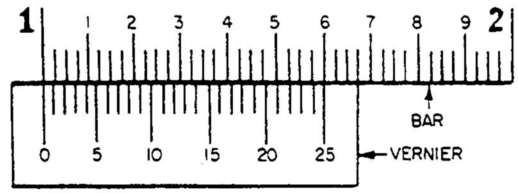


Figure 2-44.—English-measure vernier scale.

Taking Outside Measurements with the Vernier Caliper

To measure the distance between outside surfaces or the outside diameter of a round object (such as sound stock or a shaft), steady the object with one hand and hold the caliper in one hand as shown in figure 2-45. In the figure, the clamping screws are at A and B; the horizontal adjustment screw nut is at C. With A and B loose, slide the movable jaw toward the piece being measured until it is almost in contact. Then tighten clamping screw A to make the fine adjusting nut C operative. Using the fine adjusting nut, adjust the movable jaw to the proper feel, then secure the setting by tightening clamping screw B. The reading can then be taken as previously described.

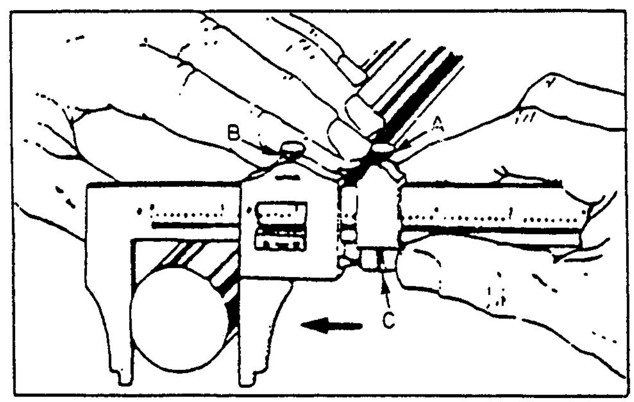


Figure 2-45.—Taking an outside measurement with a vernier caliper.

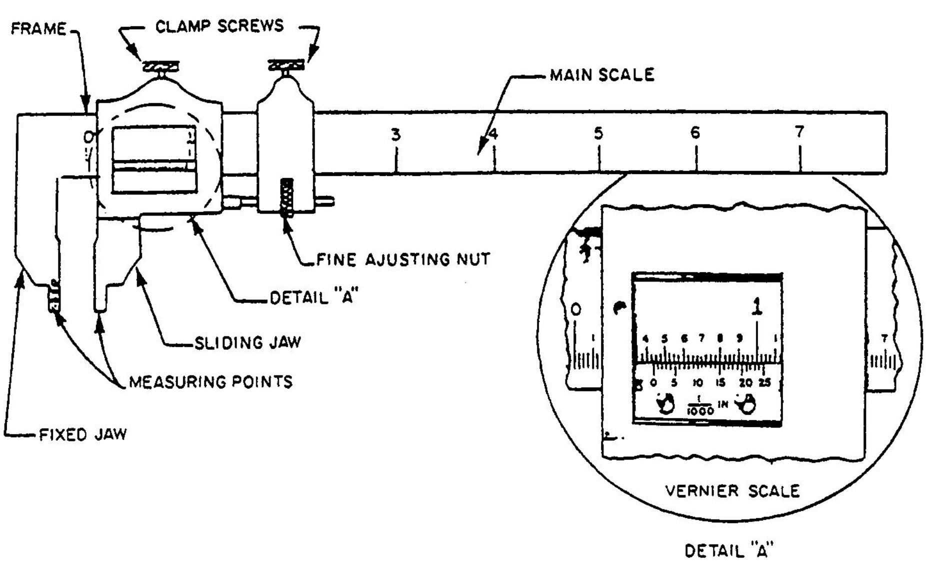


Figure 2-43.—Vernier caliper.

Taking Inside Measurements with the Vernier Caliper

To measure the distance between inside surfaces, or the inside diameter of a hole, with a vernier caliper, use the scale marked INSIDE. Figure 2-46 shows the measuring points in place.

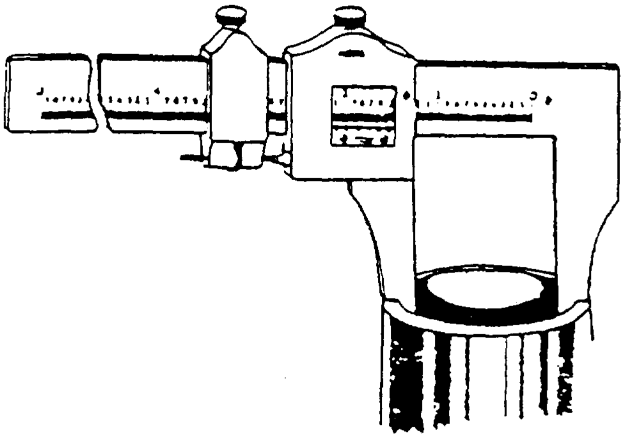


Figure 2-46.—Taking an inside measurement with a vernier caliper.

Remember that if you are using a vernier caliper with both metric and English scales, the scales appear on opposite sides of the caliper and apply only to outside measurements. Then, to get correct inside measurements, you add to the actual reading the measuring point allowance for the size of caliper you are using. The measuring point allowance is usually etched on the measuring point of the fixed jaw (refer to fig. 2-43), or it is contained in the manufacturer's instructions. So if the actual reading from the vernier scale is 1.026 inch and the measuring point allowance is 0.250 inch, the inside measurement would be 1.276 inch.

DEPTH GAGE

A depth gage is an instrument for measuring the depth of holes, slots, counterbores, recesses, and the distance from a surface to some recessed part. The RULE DEPTH GAGE and the MICROMETER DEPTH GAGE (fig. 2-47) are the most commonly used in the Navy.

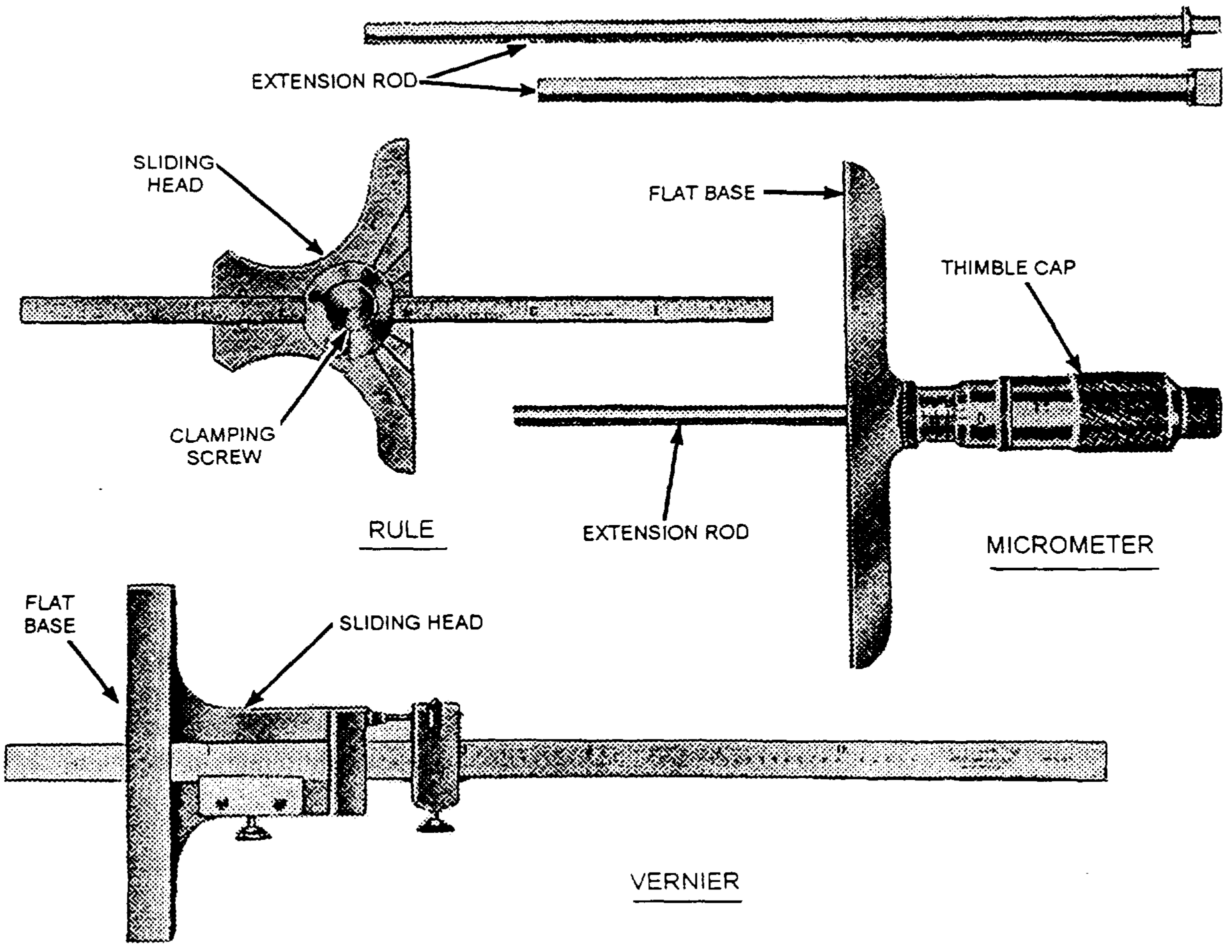


Figure 2-47.—Types of depth gages.

The rule depth gage is a graduated rule with a sliding head designed to bridge a hole or slot and to hold the rule perpendicular to the surface on which the measurement is taken. This type has a measuring range of 0 to 5 inches. The sliding head has a clamping screw so it may be clamped in any position. The sliding head has a flat base that is perpendicular to the axis of the rule and ranges in size from 2 to 2 5/8 inches in width and from 1/8 to 1/4 inch in thickness.

The micrometer depth gage consists of a flat base attached to the barrel (sleeve) of a micrometer head. These gages have a range from 0 to 9 inches, depending on the length of extension rod used. The hollow micrometer screw (the threads on which the thimble rotates) itself has a range of either 1/2 or 1 inch. Some have a ratchet stop. The flat base ranges in size from 2 to 6 inches. Several extension rods are normally supplied with this type of gage. To measure the depth of a hole or slot with reasonable accuracy, use a depth gage as shown in figure 2-48, view A. Hold the body of the depth gage against the surface from which the depth is to be measured and extend the scale into the hole or slot. Tighten the set-screw to maintain the setting. Withdraw the tool from the work and read the depth on the scale.

To measure the depth of a hole or slot with more accuracy than is possible with an ordinary depth gage, place a vernier depth gage over the slot as shown in figure 2-48, view B. Notice the clamping screws are at X and Y; the horizontal adjusting screw nut is at Z. With X and Y loose, slide the scale down into the slot being measured until it is almost in contact. Then tighten X to make Z operative. With Z, adjust the scale to the proper feel and secure the setting with Y. By proper feel we mean the adjustment at which you first notice contact between the end of the scale and the bottom of the slot. Then read the setting as described under "Reading a Vernier Scale."

To set the vernier depth gage to a particular setting, loosen both setscrews at X and at Y and slide the scale through the gage to the approximate setting. Tighten the sets crew at X, turn the knurled nut at Z until the desired setting is made, and tighten the setscrew at Y to hold the setting.

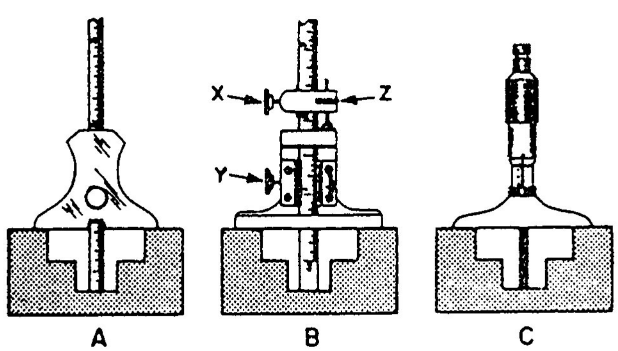


Figure 2-48.—Using depth gages.

To measure the depth of a hole or slot, as shown in figure 2-48, view C, with more accuracy than is possible with either an ordinary depth gage or a vernier depth gage, place a micrometer depth gage over the slot and adjust the thimble until the contact of the spindle causes the ratchet stop to slip. Remove the micrometer from the work and read the micrometer. Remember, if extension rods are used, the total depth reading will be the sum of the length of the rods plus the reading on the micrometer.

DIAL INDICATOR

The dial indicator is used in several different ways to measure the amount of deviation (or runout) in revolving or rotating parts. Accurate shaft-to-shaft alignment is impossible without using a dial indicator.

Dial indicators are supplied with various fittings, links, and adapters. Additionally, special application hardware is available. Figure 2-49 illustrates the basic hardware of a dial indicator set and two different types of dial heads. The dial scale is usually graduated in thousandths of an inch and has an adjustable bezel around it. The scale of a dial indicator usually reads plus numbers to the right of zero and minus numbers to the left of zero.

The typical setup for checking the trueness of a shaft, using a dial indicator and vee blocks (or roller blocks), is to place the shaft in the vee blocks, mount the magnetic base or clamp attachment (whichever is the most appropriate) with the swivel post and dial head attached to a solid surface. Adjust the mounting linkage to a convenient angle that permits ease in reading the dial (but does not interfere with the task being performed). Bring the sensor button into contact with the shaft, loosen the swivel post clamp screw, raise and lower the sensor button to determine what the full travel of the indicator is. After the extent of travel has been determined, set the pointer at mid travel, secure the swivel post clamp screw, and then zero the dial with the adjustable bezel. Rotate the shaft slowly and observe the pointer for deviation. The combined deflection (plus and minus sides of the scale) is the total indicator reading (TIR).

CARE OF PRECISION INSTRUMENTS

Special treatment is required for precision instruments if they are to serve their intended purpose. The following precautions will help ensure their accuracy.

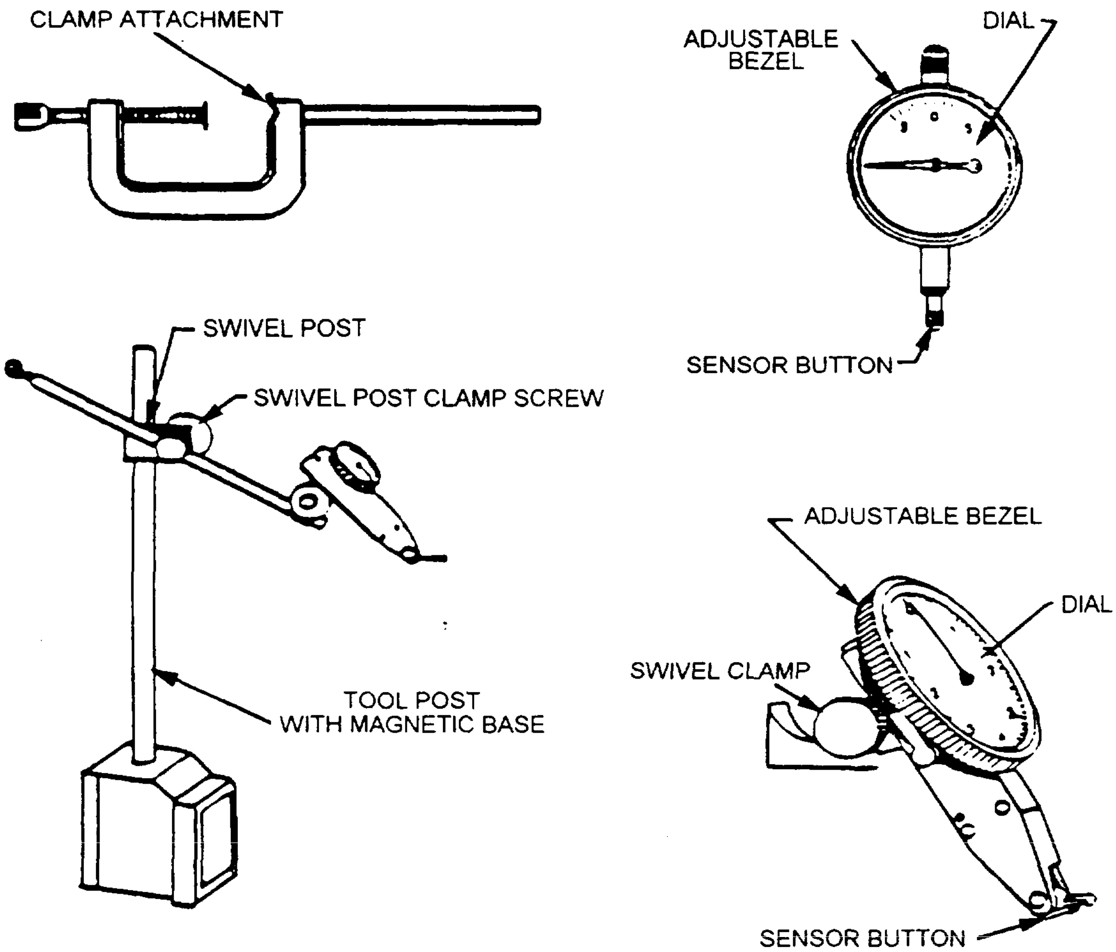


Figure 2-49.—Dial indicator and attachments.

—Keep clean and lightly oiled. (Do not oil dial indicators.)

—Always wipe an instrument clean of fingerprints before returning it to the box.

—Always verify an instrument's accuracy before using it by checking its calibration sticker.

—Have a precision instrument calibrated according to PMS, when one has been dropped or when you are in doubt about the accuracy of one.

—Always allow the temperature of a precision instrument to equalize with ambient temperature to ensure accuracy of measurements.

—Return to the box a precision instrument not in use.

—Never store a precision instrument with other tools such as wrenches, hammers, and so on.

—Never carry a precision instrument in your pocket unless it has an appropriate pocket carrying case.

—Never close a precision instrument such as an outside micrometer, vernier caliper, or dial indicator tight for storage. Temperature changes can cause frames, spindles, and so on, to become distorted.

—Never open or close a micrometer by twirling the frame.

—Never attempt to remove mill shavings or dirt from a precision instrument with an air hose. This procedure only embeds small particles into the working parts.

—Never attempt to calibrate a precision instrument yourself. Always send it to an authorized calibrating facility.

—Never attempt to clean measuring surfaces with an abrasive.

—Never force a precision instrument to attain a measurement.

—Never attempt to take readings on operating machinery.

We have to understand that even with the best tools, it is the person behind the tool who makes things work.

ABFs can take measurements accurately and new parts to be installed can be on hand. If the one who finally assembles the pump does not know how to torque a casing or pipe flange, he or she can destroy all the hard work and money that have been put into the job. For maintenance and repair on all equipment, **use the appropriate technical manuals.**

CORROSION CONTROL

LEARNING OBJECTIVES: Describe the types of corrosion the ABF will confront. Identify their signs and explain the corrective action.

The most effective repair protection is prevention. A thorough maintenance program continuously carried out prevents most equipment failure. With higher strength and closer tolerances being demanded of metals, equipment would rapidly become inoperable without regular anticorrosion maintenance.

Corrosion endangers the equipment by reducing the strength and changing the mechanical characteristics of the metals used in its construction. Materials are designed to carry certain loads and withstand given stresses as well as to provide an extra margin of strength for safety. Corrosion can weaken the structure, thereby reducing or eliminating this safety factor.

Corrosion may take place over the entire surface of a metal from chemical reaction with the surrounding environment. It may be electrochemical in nature between two metallic materials or two points on the surface of the same alloy, differing in chemical activity. The presence of moisture is essential in both types of attacks. The most familiar example of corrosion is rust found on iron or steel.

All metals are affected to some extent by the atmosphere. Water and water vapor containing salt combine with oxygen in the atmosphere and produce the main source of corrosion. There are many forms of corrosion; the form of corrosion depends upon the metal involved, atmospheric conditions, and the corrosion-producing agents present. For this discussion, we may consider corrosion as three general types-surface, galvanic, and intergranular corrosion.

SURFACE CORROSION

The effect of the atmosphere produces a corrosion that appears on the surface of a metal as a general roughening, etching, or pitting. Iron rust is the most common example of surface corrosion.

Although aluminum, magnesium, and other nonferrous metals do not rust, these metals are subject to surface corrosion. Surface corrosion on unpainted aluminum alloy is evident as white or gray powdery deposits on the metal surface. The condition is first indicated by the powdery residue deposited on the area of contact; later pitting and searing appear on the aluminum surface, and finally complete deterioration of the aluminum. Corrosion on painted aluminum-alloy surfaces cannot be recognized by either the roughened surface or by the powdery deposit. Instead, the paint or plating appears to lift off the surface, indicated by a blistered appearance and/or discoloration that results from the pressure of the underlying accumulation of the corrosion products.

Surface corrosion on magnesium alloys can be recognized by powdered or roughened surfaces. Magnesium corrosion products are white and quite large compared to the size of the base metal being corroded. The deposits have a tendency to raise slightly, and the corrosion spreads rapidly. When white, puffy areas are discovered on magnesium, prompt attention is required to prevent the corrosion from penetrating entirely through the structure. This can occur in a very short time.

It has been generally established that surface corrosion is caused by moisture in the air. Since this type of corrosion is visible, it can be detected in its early stages by close visual inspection. Surface corrosion can be prevented or retarded by protecting the metal surface with a plating or paint and by keeping the plating or paint in good condition.

GALVANIC CORROSION

Galvanic (or electrolytic) corrosion occurs when two different metals are connected and exposed to an electrolyte such as water, especially salt water. When aluminum pieces are attached with steel bolts or screws, galvanic corrosion may occur between the aluminum and steel in the presence of moisture. An electrical potential is setup, current flows between the two metals, and an effect similar to that which occurs in batteries is produced. Galvanic corrosion can usually be recognized by the presence of a buildup of corrosion products at the joint between two metals. Preventive measures include painting and plating.

INTERGRANULAR CORROSION

The third type of corrosion, intergranular, is not visible on the surface and is very dangerous. It spreads through the interior of the metal along the grain boundaries, reducing the strength and destroying the ability of the metal to be formed or shaped. Among the metals affected by this type of corrosion are stainless steel, certain magnesium alloys, and the copper-bearing aluminum alloys.

Intergranular corrosion occurs in certain grades of stainless steel when the steel is heated as in welding. Brittleness results, and later the metal cracks near the weld. For this reason, a post-weld heat treatment is needed before you reinstall stainless steel parts that have been welded.

As an ABF, you are going to be concerned mainly with the first two types of corrosion, surface and galvanic. With this in mind, remember that rust on steel and the white powder on aluminum or magnesium are produced by corrosion. These products, along with dirt and salt, pick up moisture from the air and hold it in contact with the metal, which speeds up the corrosive action.

CORROSION REPAIR

There are many factors that affect the type, speed, cause, and seriousness of metal corrosion. Some of these corrosion factors can be controlled; others cannot. Preventive maintenance factors, such as inspection, cleaning, painting, and preservation, are within the control of the operating activity.

When you first find corrosion on equipment or a structure, the first step you take should be the safe and complete removal of the corrosion deposits or replacement of the affected part. Whether you remove the corrosion or replace the part depends upon the degree of corrosion, the extent of damage, the capability to repair or replace, and the availability of replacement parts. Any parts that have been damaged by corrosion should be replaced if continued use is likely to result in structural failure. Areas to be treated to eliminate corrosion deposits must be clean, unpainted, and free from oil and grease. Chips, burrs, flakes of residue, and surface oxides must be removed. However, be careful to avoid removing too much of the uncorroded surface metal. Corrosion deposit removal must be complete. Failure to clean away surface debris permits the corrosion process to continue even after the affected areas have been refinished.

When corrosion is present, any protective paint films must first be removed to ensure that the entire corroded area is visible. After you remove corrosion, the extent of damage must be assessed. It is at this point that you determine whether to repair or replace the affected part or to perform a corrosion correction treatment. The correction treatment involves neutralizing any residual corrosion materials that may remain in pits and crevices, and restoring permanent protective coatings and paint finishes.

CORROSION PREVENTION

Corrosion can be controlled by maintaining a dry environment using suitable moisture barriers or drying agents. CLEAN, DRY METALS DO NOT CORRODE. Therefore, when moisture and dirt are permanently removed from metal surfaces, the tendency of such surfaces to corrode is usually eliminated. Thus, it follows that the major problem in the prevention of corrosion consists of adequately removing moisture and dirt from the surface of the metal to be protected and covering these surfaces to prevent recontamination.

Consistent preventive maintenance is the most practical method of controlling metal corrosion. Maintenance such as cleaning, painting, and preservation shows great savings in labor and materials by eliminating costly repairs and replacements required when corrosion has been permitted to go unarrested.

To effectively remove oil, grease, dirt, and other undesirable foreign deposits, you should use certain cleaning agents, such as soaps, solvents, emulsion compounds, and chemicals. When you work with these agents, you should follow the correct method and sequence of procedure in applying them. You also must follow the accepted safety regulations and health precautions in the use and handling of the various cleaning agents. The important factors bearing on the choice of cleaning materials are the type and surfaces to be cleaned, such as painted or unpainted surfaces, and whether they are exterior or interior parts.

Uses of Paint

To prevent corrosion of metal (or deterioration of wood surfaces), you should repaint damaged or worn surfaces as soon as practical. Repaint no more often than is necessary for preservation. In the Navy, paint is used primarily for the preservation of surfaces. It seals the pores of wood and steel, arrests decay, and helps prevent the formation of rust. Paint also serves a variety of other purposes. It is valuable as an aid to cleanliness and sanitation, both because of its antiseptic properties and because it provides a smooth, washable surface. Paint also is used to reflector to absorb light or to redistribute light. For example, light-colored paint is used in the interior of the ship to distribute natural and artificial light to the best advantage. These same properties of reflection and absorption, incidentally, make camouflage painting possible. For these and other reasons, the Navy uses a great deal of paint.

Recommended Painting Procedures

As you know, there are many kinds of paint. For example, you cannot use the same type of paint on the deck, topside, and bulkheads in the captain's cabin. There is a different paint made for almost every purpose. Detailed instructions on the proper paint to use for each job may be found in the applicable NAVSEA instructions.

The most important single factor in securing good paint performance is proper surface preparation. Dirt, oil, grease, and rust or mill scale must be removed completely, and the surface must be thoroughly dry.

Equipment used to prepare surfaces includes hand tools, power tools, sandblasters and shot blasters, soap (or detergents) and water, and various paint and varnish removers.

Each year the Navy spends thousands of dollars developing and testing finishes for specific surfaces. Consequently, you have the best material available. If you prepare the surface properly, use the recommended finish, and apply the finish correctly, you can have a first-rate job that lasts a long time. Do not use any material not provided by or methods not recommended by the Navy.

Lubrication and Inspection

Preservation of equipment and spare parts is a continuous job aboard a ship. The moist salt air causes rust to form in a very short time. The operation and maintenance manual for each particular item will indicate the type of preservation to be used and which parts should be painted.

Moving parts must be kept free of corrosion by application of the proper lubricant. Parts that cannot be painted and that are not used very often should be coated with a preservative compound that is readily removable with solvents or can be wiped off. Dirt and rust should be removed carefully before applying preservatives or lubricants.

Such items as webbing and rubber goods require no preservative; however, they should be stowed in a clean, dry place when not in use. These items are subject to deterioration because of age and should be inspected frequently. When the over-age date (stamped on the webbing) is reached, the material should be discarded and replaced.

BLUEPRINTS AND DRAWINGS

LEARNING OBJECTIVE: Describe the information contained in blueprints, charts, and drawings.

All ABFs must be able to read blueprints and drawings. As you advance in rating, you are expected to be able to make sketches and drawings.

A sketch is made freehand and shows rough outlines and only those details that are necessary to visualize a system or an object. A drawing is similar to a sketch, but it is made with mechanical drawing instruments and is drawn to scale.

A blueprint is a duplicate of a drawing or sketch. Usually, only accurate drawings are blueprinted. These blueprints are furnished by the manufacturers of the machinery and equipment installed and used aboard ship, and also by the personnel concerned with the building and maintenance of the ship.

Mechanical drawing is a special language and is defined as follows: "A language which uses lines, symbols, dimensions, and notations to accurately describe the form, size, kind of material, finish, and construction of an object."

Blueprints are the link between the engineers who design equipment and the people who build, maintain. and repair it. In a comparatively little space, they give a great deal of information in a universal language easily understood.

Of the many types of blueprints you may use aboard ship, the simplest one is the plan view. This blueprint shows the position, location, and use of the various parts of the ship. You may use plan views to find your duty and battle stations, the sick bay, the barbershop, and other parts of the ship.

In addition to plan views, you will find aboard ship other blueprints called assembly prints. These prints show various kinds of machinery and mechanical equipment. Assembly prints show the various parts of the mechanism, how the parts fit together, and their relation to each other.

Individual mechanisms, such as motors and pumps, are shown on unit or subassembly prints. These show location. shape. size, and relationships of the parts of the subassembly or unit. Assembly and subassembly prints are used to learn operation and maintenance of machines, systems, and equipment.

Additional detailed information about mechanical drawing and the reading of prints and drawings is contained in *Blueprint Reading and Sketching,* NAVEDTRA 10077-F1.

PLANNED MAINTENANCE SYSTEM

LEARNING OBJECTIVES: Describe the 3-M systems' purpose. Explain how the ABF will use the 3-M systems.

Heads up thinking and asking questions can make your work as an ABF run smoothly. On a day-to-day basis, you come in contact with PMS. The PMS (Planned Maintenance System) weekly schedule displays the planned maintenance scheduled to be done in your work center for a specific week. The weekly PMS schedule is posted in each work center. It is used by the work center supervisor to assign and monitor the accomplishment of the required PMS tasks by work center personnel.

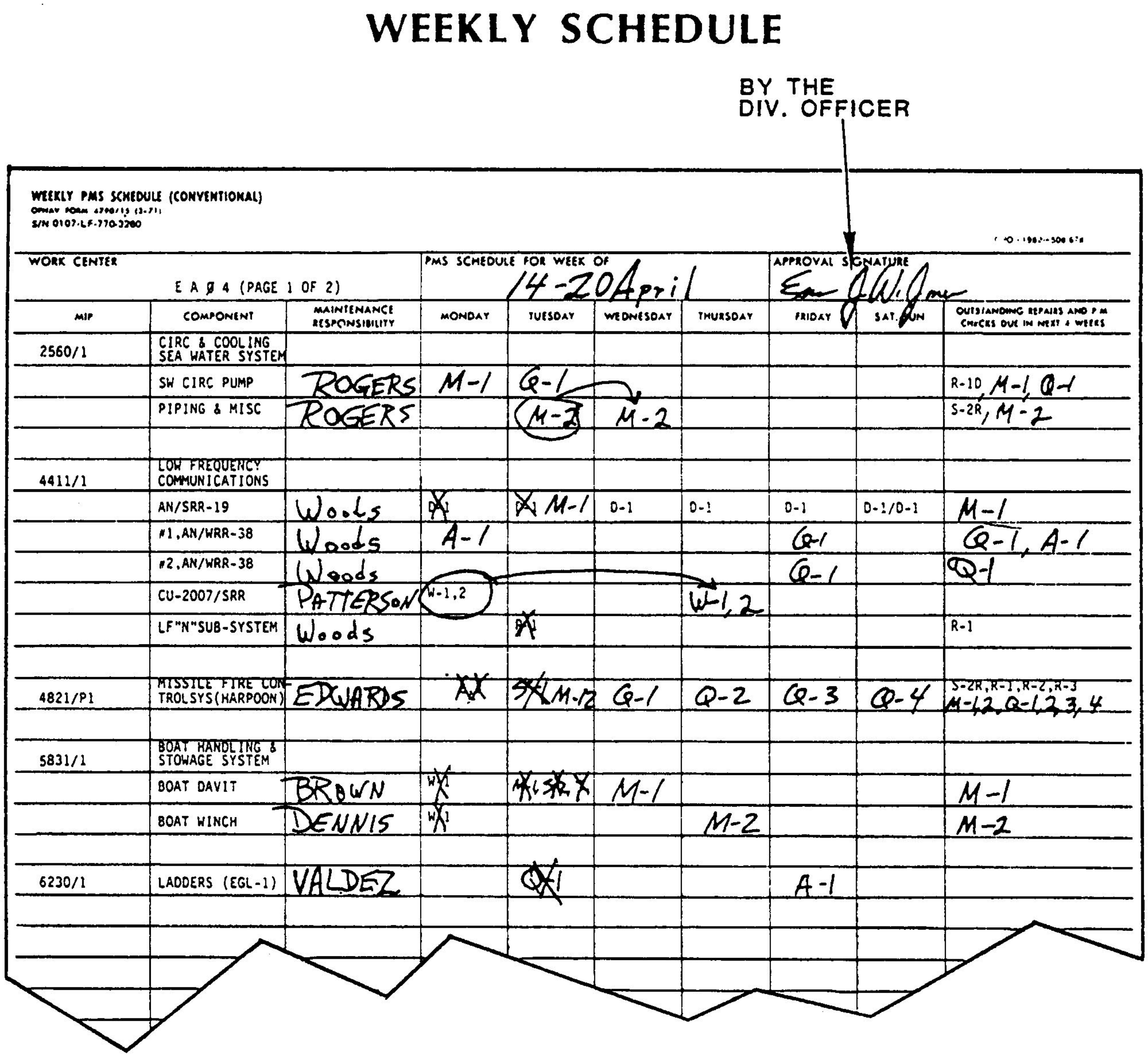
The following is a list of the contents of weekly PMS schedules (fig. 2-50).

1. Work center code.

2. Date of current week.

3. Division officer's approval signature.

4. MIP code minus the date code.



WEEKLY PMS SCHEDULE (CONVENTIONAL)
OPNAV FORM 4790/15 (3-71)
S/N 0107-LF-770-3200

WORK CENTER: E A Ø 4 (PAGE 1 OF 2)
PMS SCHEDULE FOR WEEK OF: 14-20 April
APPROVAL SIGNATURE

MIP	COMPONENT	MAINTENANCE RESPONSIBILITY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SAT./SUN	OUTSTANDING REPAIRS AND P M CHECKS DUE IN NEXT 4 WEEKS
2560/1	CIRC & COOLING SEA WATER SYSTEM								
	SW CIRC PUMP	ROGERS	M-1	Q-1					R-1D, M-1, Q-1
	PIPING & MISC	ROGERS		M-2	M-2				S-2R, M-2
4411/1	LOW FREQUENCY COMMUNICATIONS								
	AN/SRR-19	Woods	A-1	A-1 M-1	D-1	D-1	D-1	D-1/D-1	M-1
	#1,AN/WRR-38	Woods	A-1				Q-1		Q-1, A-1
	#2,AN/WRR-38	Woods					Q-1		Q-1
	CU-2007/SRR	PATTERSON	W-1,2			W-1,2			
	LF"N"SUB-SYSTEM	Woods		A-1					R-1
4821/P1	MISSILE FIRE CONTROL SYS(HARPOON)	EDWARDS	AX	SX M-12	Q-1	Q-2	Q-3	Q-4	S-2R,R-1,R-2,R-3 M-12,Q-1,2,3,4
5831/1	BOAT HANDLING & STOWAGE SYSTEM								
	BOAT DAVIT	BROWN	W-1	[illegible]	M-1				M-1
	BOAT WINCH	DENNIS	W-1			M-2			M-2
6230/1	LADDERS (EGL-1)	VALDEZ		Q-1			A-1		

Figure 2-50.—Weekly PMS schedule.

5. A list of applicable components.

6. Maintenance responsibilities assigned, by name, to each line item of equipment.

7. The periodicity codes of maintenance requirements to be performed, listed by columns for each day.

8. Outstanding major repairs, applicable PMS requirements, and all situation requirements.

As with any system, things change; as they do, there must be a way to communicate. In PMS the way is called the PMS FBR (Feedback Report, OPNAV 4790/7B Form). The PMS FBR is used by fleet personnel to notify the NAVSEACEN and/or the TYCOM, as applicable, of matters related to PMS. The FBR is a five-part form composed of an original and four copies. Instructions for preparation and submission of the form are printed on the back of the last copy. These forms are obtained through the Navy Supply System. They are to be prepared, submitted, and processed in two major categories.

The two major categories of FBRs are category A and category B. These are defined as follows:

Category A of FBR is nontechnical in nature and is intended to meet PMS needs that do not require technical review. Consequently, to reduce response time, the ship's 3-M coordinator submits directly to the NAVSEACEN these FBRs, which pertain to the need for replacement of missing MIPs and MRCs.

Category B FBRs are technical in nature. They are submitted by the ship's 3-M coordinator to the applicable TYCOM and pertain to the following:

1. Technical discrepancies inhibiting PMS performance. These discrepancies can exist in "documentation, equipment design, maintainability, reliability, or safety procedures as well as operational deficiencies in PMS support (parts, tools, and test equipment). Discrepancies in technical manuals are reported by way of the TMDER (Technical Manual Deficiency/Evaluation Report), NAVSEA 4160/1.

2. Notification of shift of maintenance responsibility from one work center to another.

3. TYCOM assistance in the clarification of 3-M instructions.

CAUTION

When the reason for submission of a PMS FBR involves safety of personnel or potential or actual damage to equipment and relates to the technical requirements of PMS, the FBR is considered URGENT. Urgent FBRs are forwarded by a naval message, containing a PMS feedback serial number, to the NAVSEACEN with information copies to the cognizant SYCOM/NAVMEDCOM/NAVSAFECEN. The message must describe the unsafe procedures or conditions and must identify the MIP/MRC involved. A follow-up PMS FBR may be submitted to amplify information contained in the message. It must contain reference to the message and the FBR serial number indicated in the message subject.

For complete information on PMS, consult the *SHIPS' 3-M MANUAL*, OPNAVINST 4790.4.

QUALITY ASSURANCE (QA) PROGRAM

LEARNING OBJECTIVES: Describe the purpose of the Quality Assurance Program. Explain the areas in which it will apply to maintenance performed by the ABF.

A Quality Assurance Program is essential to ensure consistent, quality repairs and maintenance of shipboard equipment. The QA Program is intended to improve force readiness through the implementation of a formalized plan that sets forth minimum requirements to be accomplished for nonnuclear maintenance and repair actions performed by forces afloat. The *Quality Assurance Manual (Forces Afloat)*, COMNAVAIRPAC/LANTINST 9090.1, provides the plan and contains the necessary guidance to establish an effective and viable QA Program.

The QA Program is important to the ABF because JP-5 piping, valves, tanks, pumps, filters, and most other equipment related to the JP-5 system are included in its coverage. Do not confuse the QA Program, which is designed to ensure quality maintenance on equipment, with Quality Surveillance, which is used to ensure high quality fuel is delivered to aircraft.

The QA Program is intended to achieve quality work through internal audits and in-process inspections. In-process is defined as that period of time during which the fabrication, maintenance, and/or repair task is being accomplished. For forces afloat, the in-process inspection control document is the controlled work package (CWP).

A CWP is developed to ensure a quality product will result from in-process fabrication, maintenance, and repair tasks. There are two primary objectives a CWP must accomplish; first, it must provide the quality control techniques and all the technical information needed to accomplish the work properly. Secondly, it must provide objective quality evidence (OQE), so when the work is completed, a documented record exists to show the work was done correctly and to specified standards.

The typical CWP consists of references, various enclosures that include applicable QA forms, material requirements, prerequisites, safety precautions, general notes, and a step-by-step work sequence, including tests and inspections, with signature requirements. Each CWP will cover the entire scope of the work process and will be able to stand close examination based solely on its contents.

SAFETY PRECAUTIONS

LEARNING OBJECTIVE: State the ABF's responsibility in observing safety precautions.

Many personnel confront dangers in their workday lives, and a number of safety precautions apply to all personnel at one time or another. A shipboard environment "introduces factors affecting safety that are not found ashore. Underway refueling, multiship exercises, storms, and other situations require personnel at sea to be constantly vigilant. An accident at sea can involve all hands in a matter of seconds. Everyone must be continually alert to hazardous conditions. *Navy Safety Precautions for Forces Afloat,* OPNAVINST 5100.19, provides a general reference for mandatory and advisory safety precautions.

You need not learn each safety precaution by heart, but you should know what each means and why it should be observed. Although most of the precautions given here are from a shipboard viewpoint, many of them apply equally well ashore. The hazards presented by improperly grounded electrical tools, for example, are the same everywhere. Remember: Accidents seldom just happen, they are caused. Another point to remember is never let familiarity breed contempt. Hundreds of people have been injured by accidents, and many have died because of their injuries. Most of those accidents could have been prevented had the personnel involved heeded the proper safety precautions.

It is the responsibility of supervisory personnel to ensure that subordinates are instructed in and carry out the applicable safety precautions for their work and work areas. You are responsible for knowing, understanding, and observing all safety precautions that apply to your work and work area. In addition, YOU are responsible for the following:

—You shall report for work rested and emotionally prepared for the tasks at hand.

—You shall use normal reasoning in all your functions, equal with the work at hand.

—You shall report any unsafe condition, or any equipment or material that you consider unsafe, and any unusual or developing hazards.

—You shall warn others whom you believe to be endangered by known hazards or by failure to observe safety precautions, and of any unusual or developing hazards.

—You shall report to your supervisor any accident, injury, or evidence of impaired health occurring in the course of work.

—You shall wear or use the protective clothing and/or equipment of the type required, approved, and supplied for the safe performance of your duties.

—You shall report for work suitably clothed for your assigned tasks.

Suitable clothing is that normally worn by members of the trade or profession. Certain hair styles are hazardous around machinery and open flame and may interfere with vision or use of breathing devices. Hair shall be suitably restrained in caps or nets. Safety shoes or foot protection devices, including nonsparking and nonslip shoes, shall be worn when hazards so indicate. Jewelry, loose scarves, and ties shall not be worn when they might subject the wearer to additional hazards. Anyone requiring eye correction, hearing aids, or prosthetic devices to assure prompt perception and avoidance of hazards must use such devices while at work.

SUMMARY

In this chapter, you have learned about basic hand and power tools, precision tools, the Planned Maintenance System, the Quality Assurance Program, and general safety.

All you have learned in this chapter is to help you maintain and repair your equipment safely and obtain quality results. However, there is no way to teach integrity to an individual. You will often be required to perform maintenance or repairs alone. Do quality work. Your life, and the lives of others may depend on it!

CHAPTER 3

QUALITY SURVEILLANCE

This chapter will cover characteristics of fuels and quality surveillance. The fuels that the ABF will most commonly work with at naval activities are automotive gasoline (MOGAS) and jet engine (JP) fuels. You need to know the basic characteristics of these fuels to understand the need for safety and caution in handling them. This chapter includes the basic characteristics of gasolines and jet engine fuels that fuel-handling personnel should know.

CHARACTERISTICS AND PROPERTIES OF FUELS

LEARNING OBJECTIVE: Describe the characteristics and properties of the fuels commonly handled by the ABF.

Motor gasolines and jet engine fuels are petroleum products manufactured from crude oil by oil refineries. Through distillation, the crude oil is separated into **fractions,** which are groups of compounds having boiling points within a given range. Nearly all of the distillate fractions may be used as fuels. These fractions (which include gasoline, kerosene, jet fuels, and diesel fuel) are known as distillate fuels.

Distillate fuels are flammable liquids. This means they burn when ignited. Under proper conditions they even explode with forces similar to those of TNT or dynamite. Death can result if the vapors of any of these fuels are inhaled in sufficient quantities. Serious skin irritation also can result from contact with the fuels in the liquid state.

In the liquid form petroleum fuels are lighter than water, and in the vapor form they are heavier than air. So any water present in these fuels usually settles to the bottom of the container. On the other hand, vapors of these fuels, when released in the air, also tend to remain close to the ground. This increases the danger to personnel and property. From safety and health standpoints, motor gasolines and jet engine fuels must be handled with caution.

SOURCE OF ENERGY

Petroleum fuel is a liquid containing heat energy that turns into mechanical energy in an engine. An engine fuel must be made to suit the engine in which it is to be used. In the case of the aircraft engine, the fuel must also be suitable for the aircraft under a wide variety of operating conditions. There is no such thing as a universal fuel since a fuel suited for a gasoline engine does not work in a diesel engine and vice versa.

MOGAS DESCRIPTION

MOGAS (NATO Code Number F-46) is a gasoline composed of a mixture of highly volatile liquid hydrocarbons designed for use in internal combustion engines. It is composed of the lower boiling elements of petroleum and is **explosive and volatile, and must be handled with extreme caution.**

The octane number of MOGAS is

Motor – 83

Research – 91

The octane number is a numerical measure of the antiknock properties of motor fuel, based on the percentage of volume of isooctane in a standard reference fuel. For example, a motor fuel that produces the same degree of knocking as a standard reference fuel containing 80 percent isooctane has an octane number of 80. Octane number also may be referred to as octane rating. Because MOGAS has a low octane rating, it may cause knocking in engines.

JP-5 DESCRIPTION

JP-5 (NATO Code Number F-44) is best described as a kerosene-type jet fuel. It was developed to provide a higher flash-point fuel that could be stored on board more safely than either gasoline or earlier jet fuels. Like gasoline, it is a mixture of liquid hydrocarbons produced from petroleum. However, JP-5 is composed of higher boiling components than gasoline and is not as explosive and volatile as gasoline. JP-5 is the only grade of jet fuel authorized for fueling aircraft on Navy ships.

Although JP-5 does have a high flash point (140°F minimum) when manufactured, if it is mixed with other fuels that have a lower flash point, the liquid becomes unsafe. Even with its high flash point, JP-5 is highly flammable on rags and clothing, which act as a wick.

JP-5 is also an acceptable substitute for fuel, naval distillate, F-76 (commonly known as DFM), for use in diesels, gas turbines, and boilers.

JP-4 DESCRIPTION

JP-4 (NATO Code Number F-40) is a wide-cut gasoline-type jet fuel having a low flash point, typically below)0°F (-17.8°C). It is used by the Air Force, Army, and some Navy shore stations. It is **volatile, flammable, and dangerous.** JP-4 mixed with JP-5 will lower the JP-5 flash point to an unacceptable level for shipboard use.

JP-8 DESCRIPTION

JP-8 (NATO Code Number F-34) is a kerosene-type jet fuel having a flash point of 100°F (37.8°C). It is used by the Air Force in Europe and the British Isles, rather than JP-4. JP-8 mixed with JP-5 also will lower the flash point of the JP-5 to an unacceptable level for shipboard use.

VOLATILITY

The volatility of a petroleum fuel is usually measured in terms of vapor pressure and distillation. The vapor pressure indicates the tendency toward vaporization at specific temperatures, while distillation provides a measure of the extent to which vaporization proceeds at a series of temperatures.

Vapor pressure is measured in a Reid vapor pressure test bomb. In the test, one volume of fuel and four volumes of air are contained in a sealed bomb fitted with a pressure gage. The container and fuel are heated to 100°F, shaken, and the pressure read on the gage. The pressure shown on the gage is known as the Reid vapor pressure (RVP) and is expressed in pounds per square inch (psi).

The measurement for volatility by distillation is done in a standard distillation apparatus. The fuel in this test is heated to given temperatures with an amount of fuel boiled off as each temperature is measured. The military specification for the fuel gives these temperatures and the percentages of the fuel allowed to boil off to meet the desired standard.

Any fuel must vaporize and the vapor be mixed in a given percentage of air for it to burn or explode. For gasoline vapors in air, the limits are approximately a minimum of 1 percent and a maximum of 6 percent by volume. other types of fuel vapors may have different limits.

Volatility is an important factor in the proper operation of internal-combustion piston engines. In a piston engine, the fuel must vaporize and be mixed with a correct volume of air to bum and deliver power. If part of the fuel does not vaporize, it is wasted. Furthermore, it can damage the engine by washing the lubricant from the engine cylinder walls, which causes rapid wear to the piston rings and cylinder walls.

Military jet fuels in use at the present by the Navy include JP-4, which has a vapor pressure of 2 to 3 psi. and JP-5, which has no specification for vapor pressure. The vapor pressure for JP-5 is almost 0 psi at normal room temperatures and at standard atmospheric pressure.

Gasoline has a very strong tendency to vaporize and, as a result, always has considerable vapors mixed with the air over the surface of the liquid. In fact, in a closed tank at sea level with temperatures approximately 10°F or higher, so much fuel vapor is given off by gasoline that the fuel-air mixture is too rich to burn. When fuel is in contact with air, the fuel continues to evaporate until the air is saturated.

The amount of fuel vapor in the air above a fuel can never be greater than the saturation value. Of course, it takes time to saturate the air with fuel vapor, so the actual percentage of fuel vapor may be considerably below the saturation point, especially if the fuel container is open to air circulation.

JP-5 fuel does not give off enough vapor to be explosive until it is heated considerably above 100°F. However, if the JP-5 fuel is contaminated with even a small amount of gasoline or, more likely, JP-4, the amount of vapor given off increases to the point where it is in the flammable range at a much lower temperature. At room temperatures, 0.1 percent gasoline or JP-4 in JP-5 results in a fuel that is unsafe to store aboard ship since it fails the flash point requirement for unprotected storage.

Because of the range of its vapor pressure, grade JP-4 forms explosive vapors from minus 10°F to plus 80°F, its normal storage and handling temperatures. **This means that the space above the liquid almost always contains an explosive mixture.**

SPECIFIC GRAVITY

The specific gravity is the ratio of the weight of a given volume of a fuel to the weight of an equal volume of distilled water. Normally, the gravity of petroleum products is converted to degrees API, according to the API (American Petroleum Institute) scale. All gravity determinations are correlated with a specific temperature of 60°F by use of ASTM Standard D1250-80.

The specific gravity of petroleum products must be determined to correct the volume at different temperatures when gauging the liquid content of storage tanks, tankers, and barges. The specific gravity of JP-5 is also used to select the proper discharge ring on the centrifugal purifier.

A change of the specific gravity of a fuel may indicate a change of composition caused by the mixing of different fuels, or even mixing different grades of the same fuel.

VISCOSITY

Viscosity is the measure of a liquid's resistance to flow. The significance of viscosity depends on the intended use of the product. For application and performance, proper viscosity is highly important since specified minimum and maximum flow rates of flow are required for all fuels and lubricating oils. In fuel, viscosity determination serves as an index of how it will flow to the burners, the extent to which it will be atomized, and the temperatures at which the fuel must be maintained to be properly atomized.

SOLVENCY OF FUELS

All petroleum fuels have the characteristic of being able to dissolve some materials. They can dissolve common lubricants, such as oils and greases in pumps, valves, packing, and other equipment. This characteristic requires the use of special lubricants for gasoline services.

Gasolines also cause serious deterioration of all rubber materials except those synthetic types designed especially for gasoline service. It is very important, therefore, that only hose specially made and designated for gasoline be used in this service. This also applies to packing, gaskets, and other materials that must be used in gasoline systems.

Like gasoline, jet engine fuels have certain solvent properties that dissolve greases and cause deterioration of some rubber materials. Therefore, only specially designated greases and synthetic materials should be used for jet engine fuel service. Another important solvent property of jet engine fuels is their ability to dissolve asphalt used for aircraft runways and pavements. Jet engine fuels seriously damage asphalt pavements, and even small spills of this fuel on asphalt pavement should be avoided.

FREEZING POINTS OF FUELS

The freezing point of a fuel is the temperature at which solid particles begin to form in the fuel. These particles are waxy crystals normally held in solution in the fuel. These particles can readily block the filters in an aircraft fuel system. The fuel almost always becomes cloudy before the solid particles form. This cloud is due to the presence of dissolved water in the fuel coming out of the solution and freezing.

The freezing point of JP-5 is – 51°F. The fuels used by other NATO countries and by commercial users vary widely.

FLASH POINTS OF FUELS

The flash point of a fuel is the lowest temperature at which the fuel vaporizes enough to form a combustible vapor. These temperatures vary according to the fuel in question.

The flash point of a fuel is an index of the fuel's potential safety when being handled or when in storage. JP-5 must have a flash point of at least 140°F to have the high safety factor required for storage aboard an aircraft carrier in unprotected tanks. F-40 (JP-4) and F-34 (JP-8) fuels flash at any normal temperature and are in danger of ignition any time they contact a hot surface. Therefore, these fuels must be handled with caution from a safety standpoint.

HEALTH HAZARDS OF AVIATION FUELS

Most people are aware of the explosive and fire potential of aviation fuels. Furthermore, there is a danger to the health of the individual who must work where hydrocarbon vapors are present. Prolonged inhalation of hydrocarbon vapors can cause dizziness, intoxication, nausea, and death. Consequently, approved safety procedures that minimize the dangers to the health of fuel-handling personnel must be followed meticulously.

Gasoline

The concentration of gasoline vapors that can be tolerated by man is far below that required to produce combustible or explosive mixtures with air. Even one-tenth of the amount necessary to support combustion or to form an explosive mixture is harmful if inhaled for more than a short time, causing dizziness, nausea, and headache. Large amounts act as an anesthetic causing unconsciousness or death.

Personnel should not be permitted to work in spaces where hydrocarbon vapor concentrations exceed 500 parts per million by volume, unless they are protected by an air-supplied respirator. It is recommended that personnel be permitted to work only in well-ventilated spaces where the hydrocarbon vapors are at or below the permissible limit.

The occurrence of any of the symptoms mentioned, among personnel who are handling gasoline or who are within an area in which gasoline is handled or spilled, should be taken as a warning of the presence of dangerous amounts of gasoline vapor in the air. All exposed personnel must be sent out of the area until the vapors have been cleared. Recovery from early symptoms is usually prompt after removal to fresh air. Anyone who is overcome should be given first aid at once. Medical attention should be obtained promptly. First aid includes removing gasoline from the skin (if the skin or clothing has been contaminated in a fall or other accident), preventing chilling, and applying artificial respiration if breathing has ceased.

Tetraethyl lead, which was added to increase the antiknock value of gasoline, is no longer used, **but it could remain impregnated in tanks or piping systems.** The lead compound may enter the body through inhalation, by absorption through the skin, and by the mouth. Also, the gasoline vapor itself, when inhaled, may result in sickness. Therefore, take the following precautions:

—Avoid contact with liquid gasoline.

—Do not inhale gasoline vapors.

—Do not enter tanks that have contained gasoline until all traces of gasoline vapors have been eliminated.

NOTE

Sediment and sludge impregnated with gasoline may be present at the bottom of the tank. These constitute a serious fire and poison hazard until the tank is thoroughly cleaned. Before you enter the gasoline storage tanks, you must obtain permission from the commanding officer, and the gas-free engineer must test and certify the tanks are safe for entry.

There is danger in entering a tank that has been used for the storage of gasoline because of the chance of exposure to the toxic concentration of gasoline vapors in the air and in the sludge, wet or dry, in the bottom of such tanks. No person should be permitted to enter such a tank without special equipment and complete instructions for its use.

Gasoline is exceedingly irritating when swallowed. If gasoline should be swallowed, accepted first aid procedures must be followed and medical attention obtained as soon as possible.

Gasoline causes severe burns if it is allowed to remain in contact with the skin, particularly when the contact is maintained under soaked clothing or gloves. Clothing or shoes having gasoline on them should be removed at once. Repeated contact with gasoline removes the protective oils from the skin and produces drying, roughness, chapping, and cracking. Skin infection may follow this damage to the skin. A severe skin irritation may develop, beginning usually on the hands and perhaps extending to other parts of the body.

As soon as possible after contact, gasoline should be removed from the skin, preferably by washing with soap and water. Rags or waste, wet with gasoline, must not be put in a pocket, but must be disposed of at once. Soaked clothing should be kept away from flames or sparks, and should be washed out thoroughly with soap and water as soon as possible. If gasoline comes in contact with the eyes, accepted first aid procedures must be given at once.

Jet Fuels

Jet fuels may contain more toxic aromatics than gasolines. They should, therefore. be handled with the same health precautions as apply to gasolines. They should not be used for cleaning. The hygienic or health aspects for gasoline, therefore, apply equally well to jet fuels. These include precautions covering particularly the inhalation of vapors, skin irritations, and container hazards.

An important step in preventing the buildup of fuel vapors is to operate the ventilation system provided for all spaces where fuels are handled. The aviation fuels security watch must monitor the ventilation in these spaces when they are not manned. Vapor buildup due to inoperative ventilation is dangerous to both you and your ship. Notify your supervisor immediately if you discover the ventilation system in one of your fuels spaces is not working.

The *Standard First Aid Training Course,* NAVEDTRA 12081, should be studied by all personnel working with fuels for information on the treatment of those overcome or injured when handling fuels.

SUMMARY OF CHARACTERISTICS OF FUELS

In summary, it is important that you remember the following characteristics of fuels:

—From the standpoint of fire, explosion, and health, gasolines, JP-4, and JP-8 are extremely hazardous and must be handled with equal caution. JP-5 jet fuel is safer, with respect to possible explosions and poisoning. However, the potential hazards of fire from fuel-soaked rags and waste and of skin blistering from soaked clothing must not be ignored.

—Jet engine fuels and gasolines are designed for entirely different types of engines. Therefore, the proper fuel must be used for each type of engine.

QUALITY SURVEILLANCE

LEARNING OBJECTIVES: Describe the problems caused by fuel contamination. State the types and limits of fuel contaminants. Describe the equipment used and explain the correct operating procedures in testing for fuel contamination.

The major objective of fuel-handling personnel is to deliver fuel to aircraft, clean and free of water. The complex fuel systems of modem aircraft do not function properly if the fuel is contaminated with dirt, rust, water, or other foreign matter. Even very small quantities of dirt or solid matter can plug or restrict fuel metering orifices and accelerate the clogging of fuel filters. Very small quantities of water are also harmful since ice may form in aircraft tanks at high altitudes. Ice affects orifices, controls, and filters like dirt. The complete stoppage of fuel flow by ice or dirt causes engine failure, and partial stoppage causes poor engine performance.

PROBLEMS CAUSED BY FUEL CONTAMINATION

Contaminated fuel has caused aircraft accidents with a tragic loss of life, loss of valuable aircraft, and the grounding of entire squadrons. This means that clean fuel is a LIFE-OR-DEATH matter with aviation personnel. The lesson has been learned the hard way by too many, and with fatal results. The time to become fuel conscious is NOW.

ENGINE FAILURES

Besides being deadly, contaminants can be sneaky. A certain type of emulsion resulting from the presence of water and rust particles can stick to the sides of an aircraft's fuel cells and not be noticed. You can even drain out a sample of fuel and find no evidence of this deposit. It can continue to build up and part of it may wash off and pass through a strainer into a fuel control. There can be only one result, reduced power and, finally, engine failure.

Foreign particles so small they cannot be seen with the naked eye can cause damage in a jet engine. The fuel control of a jet engine is a masterpiece of engineering and craftsmanship. It automatically regulates fuel flow to compensate for changes in altitude and speed. It makes practical the piloting by human beings of incredibly powerful jet aircraft. But doing these things requires that the fuel control have precisely fitted meters and valves. The moving parts within some of these meters and valves have clearances of less than 0.005 of an inch. Particles of foreign matter only slightly larger than this clearance can jam the valve or prevent it from seating properly. Particles slightly smaller can stick and build up, or wedge between the parts. Thus, we must remove particles so small they can be seen only with a microscope.

UNNECESSARY REPAIR WORK

Fuel carrying water or dirt can cause a great deal of extra maintenance work. For example, in atypical Navy engine overhaul shop it became necessary at one time to completely disassemble every jet engine fuel control that came into the shop because of the chance of internal damage. Ordinarily, the controls that had been in use less than half of their overhaul time could have simply been bench-checked to verify their performance and then returned for use on the engine. However, experience showed that more than 50 percent of the fuel controls overhauled had failed because of internal corrosion. The cause was water in the fuel. Such extra repair work is not confined to jet engines. Water in the fuel also can cause erroneous readings on the aircraft's fuel quantity gages, which can be exceedingly dangerous in flight.

DELAYED FLIGHTS

In addition to causing engine failures, fuel contamination can mean serious delays in flight operations. Normal procedure requires that all aircraft fueled from a source where contamination is discovered be checked.

In some cases, aircraft must be defueled and then refueled before flight operations can proceed.

When a fuel is found to be contaminated, the contaminant must be tracked back to its source and the cause corrected. Until the cause of the contamination is found and corrected, the contaminated system cannot be used. The fuel system may be a mobile refueler, air station hydrant refueling system, or the entire fuels system of an aircraft carrier. Contaminated fuel may affect the operation of one aircraft or the operation of an entire air wing. For these reasons, be careful in every phase of fuel handling to prevent contaminants from entering the fuel.

CAUSES OF FUEL CONTAMINATION

How can you find out the causes of fuel contamination? How can you find out how much contamination is too much? Before you can determine amounts of contamination, you have to be able to understand the units of measurement used to identify contamination. The two major units for measuring the size of contaminants are microns for solids and parts per million (ppm) for water.

There are approximately 25,400 microns in 1 inch. Figure 3-1 gives you 2 microscopic view of a human hair, which is about 100 microns in diameter, and compares it with a 5-micron contaminant.

Parts per million is the reference used for water contamination. If you take a 32-oz sample bottle and fill it 3 1/4 inches from the bottom, the amount you will have is about 500 milliliters (ml). Break that 500 ml down into one million little pieces. You now have 1 ppm.

As you now realize, the equipment used in the quality surveillance laboratory has to be very accurate to make measurements that small. Operation of the lab equipment will be covered later in this chapter.

HUMAN FACTOR

Equipment now in use can remove most of the contamination that may be present in a fuel. It cannot separate two mixed or blended fuels. It cannot effectively reduce the contamination below the required limits if the contaminant level is too high. YOU must be careful to prevent the introduction of contamination in all phases of fuel handling. Additionally, all steps of contamination removal MUST be properly performed.

Inspection and sampling procedures are the only means to ensure that the equipment is performing properly. Unless the equipment is properly operated and the sampling procedures are carefully followed, the problem will always remain. Thus, the most important factor in preventing and removing contamination in fuels is the awareness of the people who handle the fuel.

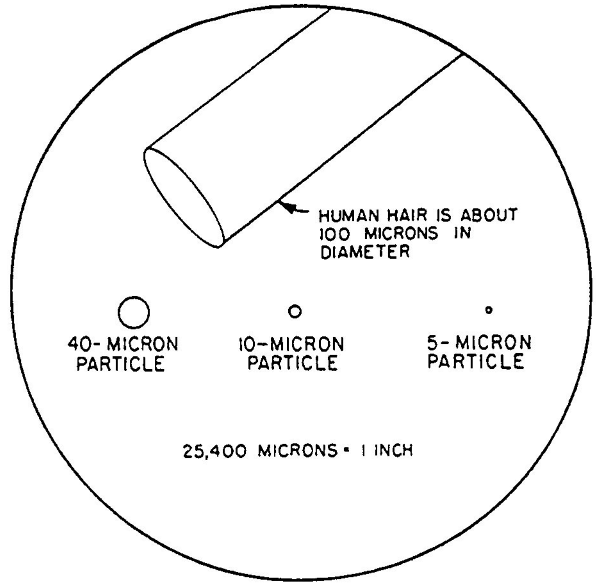


Figure 3-1.—Enlargement of small particles and comparison to a human hair.

The equipment is only a machine. You, the ABF, the educated operator, make a quality surveillance program work.

LIMITS OF CONTAMINATION

To be acceptable for delivery to aircraft, jet fuels must be clean and bright. They must not contain more than 5 ppm free water or 2 mg/liter particulate contamination. The terms *clean* and *bright* have no relation to the natural color of the fuel. Jet fuels are not dyed and they vary from clear, water-white to straw-yellow colored. *Clean* means the absence of any cloud, emulsion, visible sediment, or free water. *Bright*, means the fuel has a shiny, sparkling appearance.

A cloud, haze, specks of particulate matter, or entrained water indicate that the fuel is unsuitable and point to a probable breakdown in fuel handling equipment or procedures. If contamination limits are exceeded, delivery of fuel to aircraft shall be stopped and corrective measures completed before resuming fueling operations.

CAUSES OF CONTAMINATION

Steps should be taken to find the source of trouble and corrective measures taken immediately. See figure 3-2 for the various types of contamination that may be detected visually. The first sample of fuel in this illustration is an acceptable fuel.

Water

Water in fuels may be either fresh or salt and may be present either as dissolved or free water. Dissolved

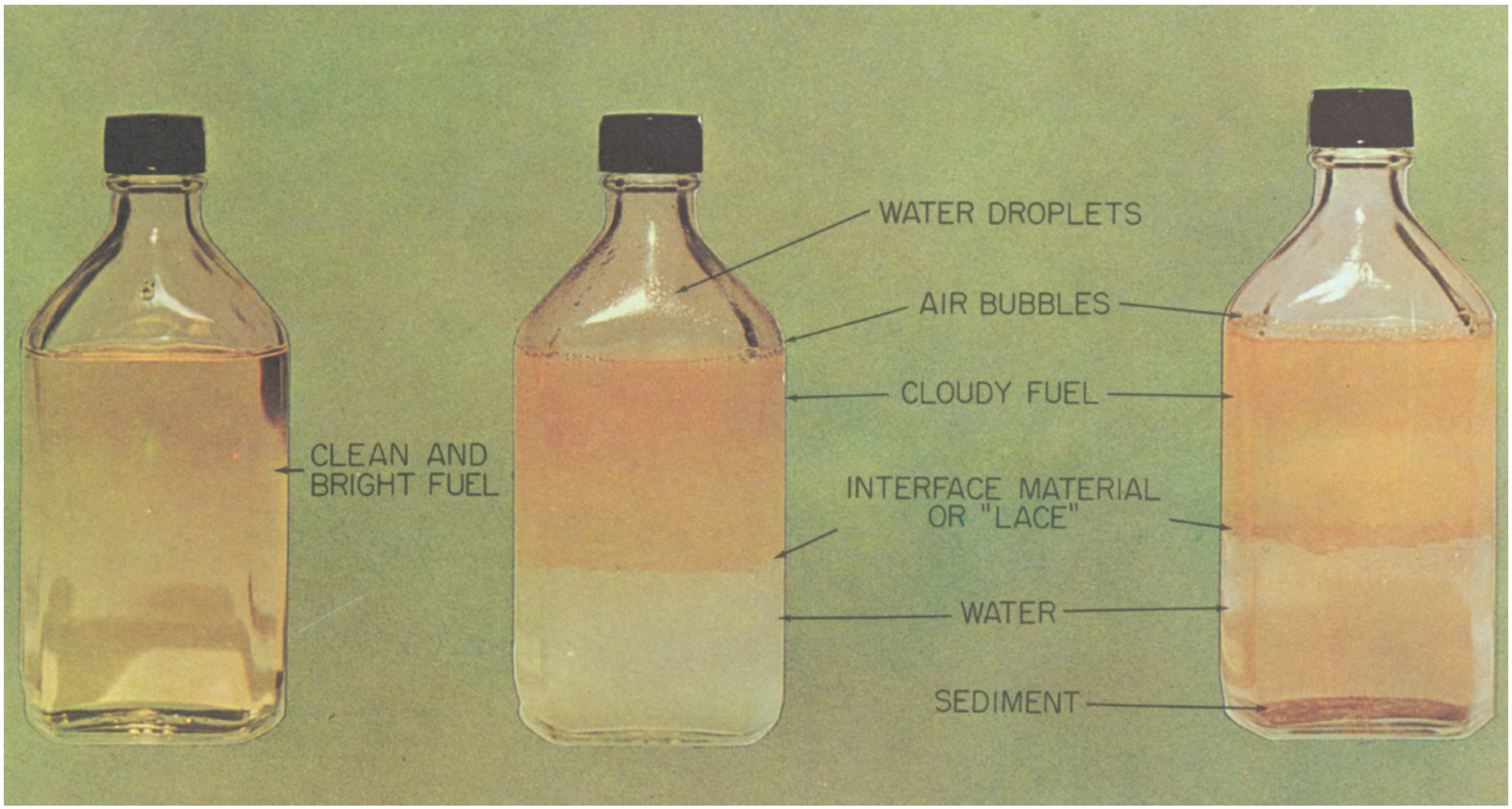


Figure 3-2.—Samples of JP-5 showing common types of visually detected contamination. (The air bubbles are not contaminants and are shown for information only.)

water is water absorbed in the fuel and is NOT visible. Free water may be in the form of a cloud, emulsion, droplets, or in gross amounts in the bottom of a tank or container. (Entrained water is free water that has not settled to the bottom.) Any form of free water can cause icing in the aircraft fuel system, malfunctioning of fuel quantity probes, and corrosion of fuel system components. Salt water will promote corrosion more rapidly than fresh water.

Ordinarily, a cloud indicates water-contaminated fuel. Occasionally, a cloud indicates excessive amounts of fine sediment or finely dispersed stabilized emulsion. Fuel containing a cloud from either cause is not acceptable. When clean and bright fuel cools, a cloud may form, indicating that dissolved water has precipitated out. This precipitation cloud represents a very slight amount of fresh water. This cloud appears when warm fuel is pumped to a cool area where the sample is taken. Remember, even though this is a very slight amount of water, if the fuel is not clear and bright, it does not go into an aircraft.

Sediment

Sediment appears as dust, powder, fibrous material, grains, flakes, or stain. Specks or granules of sediment indicate particles in the visible size (approximately 40 microns or larger). See figure 3-1. The presence of any appreciable number of such particles indicates a malfunction of the filter/separators, a source of contamination downstream of the filter/ separators, or an improperly cleaned sample container. Even with the most efficient filter/separators and careful fuel handling, an occasional particle may be seen. These strays are usually due to particle migration through the filter media and may present no particular problem to the engine or fuel control. The sediment ordinarily encountered is an extremely fine powder, rouge, or silt. The two principal components of this fine sediment are normally sand and rust.

Sediment includes both organic and inorganic matter. The presence of large quantities of fibrous materials (close to naked eye visibility) is usually indicative of filter element breakdown, either because of a ruptured element or mechanical disintegration of a component in the system. Usually, high metal content of relatively large particles suggests a mechanical failure somewhere in the system, which is not necessarily limited to a metallic filter failure.

In a clean sample of fuel, sediment should not be visible except upon the most meticulous inspection. Persistent presence of sediment is suspect and requires that appropriate surveillance tests and corrective measures be applied to the fuel-handling system.

Sediment or solid contamination can be separated into two categories:

1. Coarse sediment

2. Fine sediment

Coarse sediment is sediment that can be seen and that easily settles out of fuel or can be removed by adequate filtration. Ordinarily, particles 10 microns and larger are regarded as coarse sediment. See table 3-1 for more information. Coarse particles clog orifices and wedge in sliding valve clearances and shoulders, causing malfunctions and excessive wear of fuel controls and metering equipment. They also can clog nozzle screens and other fine screens throughout the aircraft fuel system.

Fine sediment consists of particles smaller than 10 microns in size. Proper settling, filtration, and centrifuging can remove 98 percent of the fine sediment in fuel. Particles in this range accumulate throughout fuel controls. They appear as a dark shellac like surface on sliding valves. They also may be centrifuged out in rotating chambers as sludgelike matter that causes sluggish operation of fuel-metering equipment. Fine particles are not visible to the naked eye as distinct or separate particles. However, they scatter light and may appear as point flashes of light or a slight haze in fuel.

Maximum settling time should be allowed in fuel tanks after they are filled to allow reasonable settlement of water and sediment. This can be done by proper rotation of the fuels.

Microbiological Growth

Microbiological growth consists of living organisms that grow at a fuel/water interface. These organisms include protozoa, fungus, and bacteria. Fungus is the major constituent and the cause of most problems associated with microbiological contamination of jet fuels. Fungus is a vegetable life; it holds rust and water in suspension and is an effective stabilizing agent for fuel-water emulsion. It clings to glass and metal surfaces and can cause erroneous readings in fuel quantity systems, sluggish fuel control operation, and sticking flow dividers. Microbiological growth is generally found wherever pockets of water exist in fuel tanks. It usually has a brown, black, or gray color and a stringy, fibrouslike appearance.

For microorganisms to develop in jet fuels, free water must be present. Traces of metallic elements are also necessary, but water is the key ingredient. Without

Table 3-1.—Visual Contamination Table

TYPE CONTAMINANTS	APPEARANCE	CHARACTERISTICS	EFFECTS ON AIRCRAFT	ACCEPTABILITY LIMITS FOR DELIVERY TO AIRCRAFT
A. WATER				
(1) Dissolved Water	Not visible.	Fresh water only. Precipitates out as cloud when fuel is cooled.	None unless precipitated out by cooling of fuel. Can then cause ice to form on low pressure fuel filters if fuel temperature is below freezing.	Any amount up to saturation.
(2) Free Water	Light cloud. Heavy cloud. Droplets adhering to sides of bottle. Gross amounts settled in bottom.	Free water may be saline water or fresh water. Cloud usually indicates water-in-fuel emulsion.	Icing of fuel system-usually low pressure fuel filters. Erratic fuel gage readings. Gross amounts of water can cause flame-outs. Salt water will cause corrosion of fuel system components.	Zero-Fuel must contain no visually detectable free water.
B. PARTICULATE MATTER				
(1) Rust	Red or black powder, rouge, or grains. May appear as dye-like material in fuel.	Red rust (Fe_2O_3)-nonmagnetic. Black rust (Fe_3O_4)-magnetic. Rust generally comprises major constituent of particulate matter.	Will cause sticking, and sluggish or general malfunction of fuel controls, flow dividers, pumps, nozzles, etc.	*Refer to NOTE 1
(2) Sand or Dust	Crystalline, granular or glass-like.	Usually present and occasionally constitutes major constituent.	Will cause sticking, and sluggish or malfunction of fuel controls, flow dividers, pumps, nozzles, etc.	*Refer to NOTE 1
(3) Aluminum or Magnesium Compounds	White or gray powder or paste.	Sometimes very sticky or gelatinous when wet with water. Usually present and occasionally represents major constituent.	Will cause sticking, and sluggish or general malfunction of fuel controls, flow dividers, pumps, nozzles, etc.	*Refer to NOTE 1
C. MICROBIOLOGICAL GROWTH	Brown, gray, or black. Stringy or fibrous.	Usually found with other contaminants in the fuel. Very light weight; floats or "swims" in fuel longer than water droplets or solid particles. Develops only when free water is present.	Fouls fuel quantity probes, sticks flow dividers, makes fuel controls sluggish.	Zero.
D. EMULSIONS				
(1) Water-in-fuel Emulsions	Light cloud. Heavy cloud.	Finely divided drops of water in fuel. Same as free water cloud. Will settle to bottom in minutes, hours, or weeks depending upon nature of emulsion.	Same as free water.	Zero-Fuel must contain no visually detectable free water.
(2) Fuel and Water or "Stabilized" Emulsions	Reddish, brownish, grayish, or blackish. Sticky material variously described as gelatinous, gummy, like catsup, or like mayonnaise.	Finely divided drops of fuel in water. Contains rust or microbiological growth which stabilizes or "firms" the emulsion. Will adhere to many materials normally in contact with fuels. Usually present as "globules" or stringy, fibrouslike material in clear or cloudy fuel. Will stand from days to months without separating. This material contains half to three-fourths water, a small amount of fine rust or microbiological growth and is one third to one half fuel.	Same as free water and sediment, only more drastic. Will quickly cause filter plugging and erratic readings in fuel quantity probes.	Zero.
E. MISCELLANEOUS				
(1) Interface Material	Lacy bubbles or scum at interface between fuel and water. Sometimes resembles jellyfish.	Extremely complicated chemically. Occurs only when emulsion and free water is present.	Same as microbiological growth.	Zero-There should be no free water.
(2) Air Bubbles	Cloud in fuel.	Disperses upward within a few seconds.		Any amount.

*NOTE 1:

Particles large enough to be visible should rarely be present. At the most, the total sediment should be a spot of silt. If any appreciable contamination is found, the test must be repeated. When testing with the AEL Mk III the max is 2mg/1.

water there is no growth. Remove any free water and growth ceases.

Microorganisms in jet fuel can cause severe corrosion damage to metal aircraft fuel tanks. Organic acids, or other byproducts produced by the growth of fungi or bacteria, react chemically with certain matter contained within the fuel to penetrate tank coatings. Once the coating is penetrated, the metal tank is attacked.

Microbiological growth causes fouling of aircraft fuel system filters and erratic operation of fuel-quantity probes. Microbiological contamination is more prevalent in tropical and semitropical climates because of the more favorable temperature and higher humidity. The presence of microbiological growth in fuel being delivered to an aircraft is a reliable indication of failure of the fuel system cleanup equipment and personnel.

The fuel from an aircraft suspected of having microbiological contamination must not be defueled into a clean system. Once a fuel system is contaminated with microbiological growth, the organisms continue to multiply unless the system is thoroughly cleaned.

Emulsions

An emulsion is a liquid suspended in other liquids. There are two types of emulsions; water-in-fuel and fuel-in-water (inverse) emulsions.

The water-in-fuel emulsion is the most common of emulsions found by fuel handlers. It appears as a light-to-heavy cloud in the fuel. (See the second and third bottles of fuel shown in fig. 3-2.) This type of emulsion may break down and settle to the bottom of the sample container at any time ranging from a few minutes to a week, depending on the nature of the emulsion.

Surfactants

Surfactant is a contraction of the words *surface active agent.* A surface active agent is a substance that causes a marked reduction in the interracial tension of liquids. A surfactant in fuel causes the fuel and water to mix more easily and become much harder to separate. Surfactants disperse both water and dirt in fuel and in some cases form very stable emulsions or slimes.

The surfactants that appear in jet fuels are usually the sulfonates or naphthenates of sodium. These can be present as naturally occurring materials in the crude oil or as residual refinery treating materials. Refinery processing must be such that it removes all traces of these materials, or poor quality fuel results.

Many other materials are also surface active. The list includes common household detergents, cleaning compounds used to clean fuel storage tanks and earner vehicles, greases used to lubricate valves, and corrosion inhibitors used in petroleum products to reduce rust in pipelines and tanks.

Surfactants in jet fuel can be a major problem. These materials accumulate and concentrate in the coalescer elements of filter/separators, destroying the ability of the elements to coalesce and remove water from fuel. Concentrations of less than 1 ppm of a surfactant in jet fuel have been known to cause malfunctioning of coalescer elements. Elements so affected pass free water and suspended particulate matter.

Surfactants are also associated with microbiological slime growths. It is not necessary that surfactants be present for microorganisms to flourish, but they promote luxuriant growth by aiding the mixing and emulsifying of fuel and water. Microorganisms need free water to multiply and grow. Surfactants help them to get it.

The problem with surfactants is that they quite often are not detected in jet fuels until after they have “poisoned” filter/separators, which in turn have allowed water and/or slime to be delivered to aircraft. There are laboratory tests for surfactants in fuel, but as yet there are no accurate field tests. However, a surfactant problem can usually be detected by one or more of the following observations:

1. Dark, red-brown, or black water in filter/ separator sump drains, refueler sump drains, or pipeline low-point drains

2. Excess quantities of dirt and/or free water in the fuel at dispensing points or downstream of filter/separators

3. Storage tanks not yielding a clear, bright fuel after prescribed settling times

4. Dark or black water and/or slime in drawoffs from storage tank bottoms

5. Triggering of fuel monitors in delivery systems, if installed

No two cases of surfactant contamination in fuel systems are exactly alike. However, some general measures can be used to correct and control this type of contamination. Some of these procedures are as follows:

1. Change monitor fuses.

2. Change falter/separator elements and clean out filter/separator cases.

3. Clean out pipelines.

4. Remove contaminated tanks from service and clean them thoroughly.

5. Recirculate fuel and return it to the system upstream of as many falter/separators as possible.

6. Investigate the source of contamination and eliminate it. Notify cognizant Military Inspection Service and Navy Fuel Supply Office if fuel is contaminated on receipt.

Commingling

The inadvertent mixing of two or more different fuels is known as commingling. Most hydrocarbon products (greases, oils, alcohols, and so on.) are readily capable of mixing with other hydrocarbon products and cannot be separated by mechanical means such as settling, filtering, or centrifuging. A fuel that has been contaminated by commingling with another petroleum product is extremely dangerous whether in storage or in use, because there may be no apparent visual or odor change.

This type of contamination is usually caused by carelessness or a misunderstanding of the operations of a fuel system. Most fuels systems are segregated from each other and from other types of fuel systems; but in some cases the piping of one fuel system may be interconnected with another system through valves, blanks, or flanges. The inadvertent opening of a wrong valve can result in commingling the two different products.

In other instances, fuel maybe pumped into a tank that has contained another product without the tank being properly cleaned. The small amount of the other product may be enough to contaminate the fuel.

JP-5 contaminated with other jet fuels or gasoline must not be stored aboard aircraft carriers unless a laboratory test indicates that the flash point is within the allowable limits of the specifications.

Because of the problem in detecting commingled fuels, you must be careful where two different fuels are handled in close association.

INSPECTION OF FUEL

The fuel systems and mobile refuelers now in use by the Navy are designed to deliver an acceptable uncontaminated fuel safely into the tanks of an aircraft when they are properly operated. To ensure that this fueling equipment is working properly and is being operated properly, samples of the fuel must be taken at several points and after each step in the operation.

SAMPLES

A sample is a small part of a quantity of a fuel representative of the quality or condition of the total quantity of that fuel, suitable for visual or chemical examination.

All ABFs must know the procedures for drawing of samples and examining them for visual contamination. A sample must be taken in such a manner and from such a location that the sample will be a true representative of the fuel sampled.

Many types of samples and sampling methods are used in the inspection of fuels. The four most common ones are discussed here.

Composite Sample

A single tank composite sample is a blend of samples taken from the upper, middle, and lower levels of a tank's contents. A multiple tank composite sample is a blend of individual all-levels samples from each of the tanks that contain the same type of product being sampled. These samples are in proportion to the volume of the product in each tank.

All-Levels Sample

This sample is one obtained by submerging a closed sampler (thief') to a point as near as possible to the drawoff level, then opening the sampler and raising it at such a rate that it is nearly but not quite full as it emerges from the liquid.

Line Sample

A line sample is one taken from a pipeline or hose at or near the discharge point before commencing delivery and during the first few minutes of pumping. This sample is taken to give an initial visual identification of the fuel.

Representative Sample

This type of sample is used for packaged stocks of fuel. One container from a large stock of packaged fuel when all are of the same age and grade may be selected as a representative of the entire stock. When the containers of fuel are small and suitable for shipment, a container of fuel is taken as the sample without its being opened. For drums of fuel, the sample is drawn from one drum.

SAMPLING PROCEDURES

Correct sampling and labeling of petroleum products is as important to fuels inspection as correct testing. Improper containers of poorly drawn samples or incorrectly identified samples can cause laboratory results to be meaningless or, worse, misleading.

Some cardinal rules in sampling follow:

1. The sampler's hands or gloves must be clean.

2. A sample container must be meticulously clean. It should be thoroughly cleaned and inspected before use. Before a sample is taken, the clean container should be rinsed and flushed three times with the fuel being sampled.

3. All samples must be representative of the product being sampled. Any sample of fuel being delivered to an aircraft should be taken from the fueling nozzle and during actual fueling operations. A sample taken to test a fixed filter/separator should be taken at the filter discharge.

4. Each sample should be capped promptly with an approved cap. Do not use sealing wax, rubber gaskets, or caps with wax seals.

5. Each sample should be drawn from a connection in a vertical pipe run where practical. If it must be drawn from a horizontal run, the connection should be halfway between the top and the bottom of the pipe.

6. A sample should be taken with the system operating at a normal and steady flow rate, if possible.

7. To prevent leakage due to increased pressure caused by thermal expansion of the product, do not fill any container above 90 percent capacity.

8. A container such as a drum should be sampled with a thief sampler and not by tilting. Be careful to remove all foreign matter from the area before the plug is removed from the drum.

9. For nozzle samples, the sample should be taken from the overwing nozzle during or immediately after the fueling of an aircraft. A pressure nozzle has a Gammon sample connection that allows a sample to be taken while the aircraft is being fueled.

Sizes of Samples

The minimum size sample container for taking samples of fuel is 1 quart. This size sample is of sufficient size for sediment, water, and flash point tests only. For other types of tests, the sample submitted should be at least 1 gallon.

A sample container for sediment and water tests must always be glass with a nonmetallic top.

Identification of Samples

Proper identification and accurate records of samples are necessary so the test results maybe correlated with the samples submitted.

The following should be used as a guide for sample identification:

1. Sample serial number (activity number).

2. Type fuel (JP-5, MOGAS, and so on.).

3. Name and location of activity.

4. Date sample taken.

5. Approximate time the sample was taken.

6. Location of sample point (nozzle sample, filter number, tank number, refueler number, and so on.).

7. Quantity of material represented, if applicable.

8. Classification of sample (routine or special—see the following section).

9. Name of person taking sample.

10. Tests required.

11. Remarks.

Sample Classification

Samples are classified as either ROUTINE or SPECIAL. ROUTINE samples are taken when no fuel problems or aircraft problems attributable to fuel are known or suspected. An example is the periodic sampling taken as a part of a quality surveillance program. These samples should be tested for sediment and water, and for JP-5, flash point. SPECIAL samples are submitted for test because the quality of the fuel is suspected, either as the result of aircraft malfunctions or other information. SPECIAL samples should have the highest priority in handling, testing, and reporting.

Container

The container for drawing a visual sample should be at least 1 quart in size, round, and made of clear glass. The top should be as large as possible to aid in drawing the sample without spilling the fuel. The cleaning procedures previously described under sampling procedures should always be earned out when you are taking a visual sample.

Shipping Instructions

Samples are to be forwarded to appropriate testing laboratories by the most expeditious means. Wherever feasible, samples should be delivered directly to the laboratory by hand. Samples in amounts up to 10 gallons may be shipped via Railway Express.

Four l-quart samples or a l-gallon sample (1 gallon maximum) of fuel may be air shipped via military aircraft when packed according to NAVAIR 15-03-500 (USAF AMF 71-4), which further indicates that fuel samples may be transported on passenger-carrying aircraft.

Visual Inspection Procedures

Since very small percentages of water or foreign matter can cause trouble, the sampling and inspection of fuel must be done carefully. Proceed as follows:

1. The first check you make is to visually inspect the color of the sample. The color of the sample must agree with the color for the grade of fuel that the system is supposed to carry. The color of the fuel may have changed because the fuel has been mixed with another petroleum product. A definite yellow cast or darkening of color in gasoline may be caused by lubricating oil, diesel oil, or jet fuels. Lubricating oil and diesel fuel also can cause a change in color in jet fuels. Since the percentage of another petroleum product in a fuel may be so small that it cannot be detected visually, yet can make it unacceptable for use, no off-color fuel should be used until an analysis is made to determine its usability.

2. The second check of the sample should be for water. The sample should be free of any cloudiness. See the first sample illustrated in figure 3-3 for an example of acceptable fuel for this visual check. The sample must be clear enough that newsprint can be read through a l-quart sample. If the fuel is cloudy and the cloud

Figure 3-3.—Degrees of cloudiness in JP-5. The left sample is clean and bright and is the only acceptable fuel for aircraft.

disappears at the bottom, air is present. If the cloud disappears at the top, water is present. If the cloud does not begin clearing in a few minutes, it is due to entrained water or very fine particulate matter. Do NOT use any fuel containing a cloud that does not disappear in a few minutes after it is drawn or use a fuel containing any visible water to fuel an aircraft.

3. The third check should be for sediment. Swirl the sample so a vortex is formed. All sediment that has settled accumulates on the bottom of the bottle directly beneath the vortex. At the most, the total sediment should be only a point or spot of silt. In a quart sample, the sediment should be no more than a slight smudge if picked up on a fingertip.

Coarse contamination can be detected visually. Sediment in the fuel is visible when the particles are 40 microns or larger. Groups of particles less than 5 microns in size may be seen in the fuel when viewed at a right angle to a strong light. When a fuel sample is being inspected, it should be swirled and allowed to settle for a few moments. The coarse particles settle to the bottom center of the bottle and collect in a group. Any sediment that can be seen is too much for aircraft use.

The AEL Free Water Detector should be used to determine the presence of free water above the allowable limit (for aircraft) of 5 ppm. Free water at this level of contamination mayor may not be visible to the naked eye.

Fuel that is contaminated by commingling with another petroleum product is hard to detect visually. In gasoline, if the percentage of the other petroleum is fairly high, there may be a color change. JP-5 contaminated by JP-4, or vice versa, can be detected by a test for flash point and a laboratory test for distillation.

Results

If any contamination is discovered during the visual inspection procedure, stop the fueling operation immediately and notify the pilot of the aircraft, the fuels officer, or other designated person in charge as to the condition of the fuel.

Action

A contaminated sample should be suitably tagged and retained until it is determined that a laboratory analysis of the sample is not required. When any contamination is found, another sample should be taken, preferably in a new sample container. Take care to ensure that the container is thoroughly clean before drawing the sample. Once contamination is found and the system placed out of use, a check must be mad for the source and cause of the contamination and the cause corrected before the system is placed in use again. The type of contamination discovered usually gives a clue to the source and cause. Some of these indications are as follows:

1. Mixed or commingled fuels—The valve or blank flange is open between two different systems or there is a leak through a bulkhead where two tanks containing different fuels are adjacent.

2. Water—The filter/separator elements are ruptured or contaminated. Large amounts of water also indicate that the filter/separator float control valve was not operating and water stripping operations for the service tanks were inadequately performed.

3. Sediment and microbiological growth—The filter/separator elements are ruptured or contaminated. Large amounts of sediment or microbiological growth also would indicate that the storage tanks and service tanks need cleaning.

CONTAMINATED FUEL DETECTING EQUIPMENT

The equipment used in the lab is portable but only to the extent that it may be earned from one area to another. You cannot carry it around with you for daily use. It is better to describe it as movable even though PMS electrical safety checks require it to be listed as portable equipment.

A good fuels lab has the following facilities: good ventilation, hot and cold water to wash bottles, and a bottle drying rack. Bottle drying racks can be bought commercially, but most are constructed locally. See figure 3-4.

The combined contaminated fuel detector (CCFD) is a single unit that contains both the AEL Mk I and AEL Mk III. Many stations and ships have both the CCFD and the single units. The AEL Mk II is the same as the Mk I except it has a carrying handle,

The AEL Mk I and Mk II are used to measure water contamination, and the AEL Mk III is used for sediment detection. The closed cup flash-point tester is used to determine the flash point of jet fuels. The flash-point tester is not to be used to test gasoline products. The refractometer indicates the amount of fuel system icing inhibitor (FSII) present in fuels, and the hydrometer is used to measure the specific gravity.

The equipment in the lab is very good for what it was designed to do. It is also very expensive. The CCFD costs about $5000. The closed cup flash-point tester costs about $1000. Take care of "your" equipment and it will last a long time. Also, remember the equipment is only as good as the people who use it.

We are now going to go step-by-step through the operation and calibration of the equipment used in the Aviation Fuels Lab.

First, you should understand that the CCFD is a newer model of the AEL Mk III with an AEL Mk I built in the same case and that the CCFD gives the sediment reading by digital display. The theory and operation of the CCFD are the same as for the individual units.

With any of the units, for initial startup or after moving them from one space to another, you MUST allow adequate time for the unit to reach the same temperature as the space in which it is to be used. This is IMPORTANT so any condensation that may form inside the machines will not affect your readings.

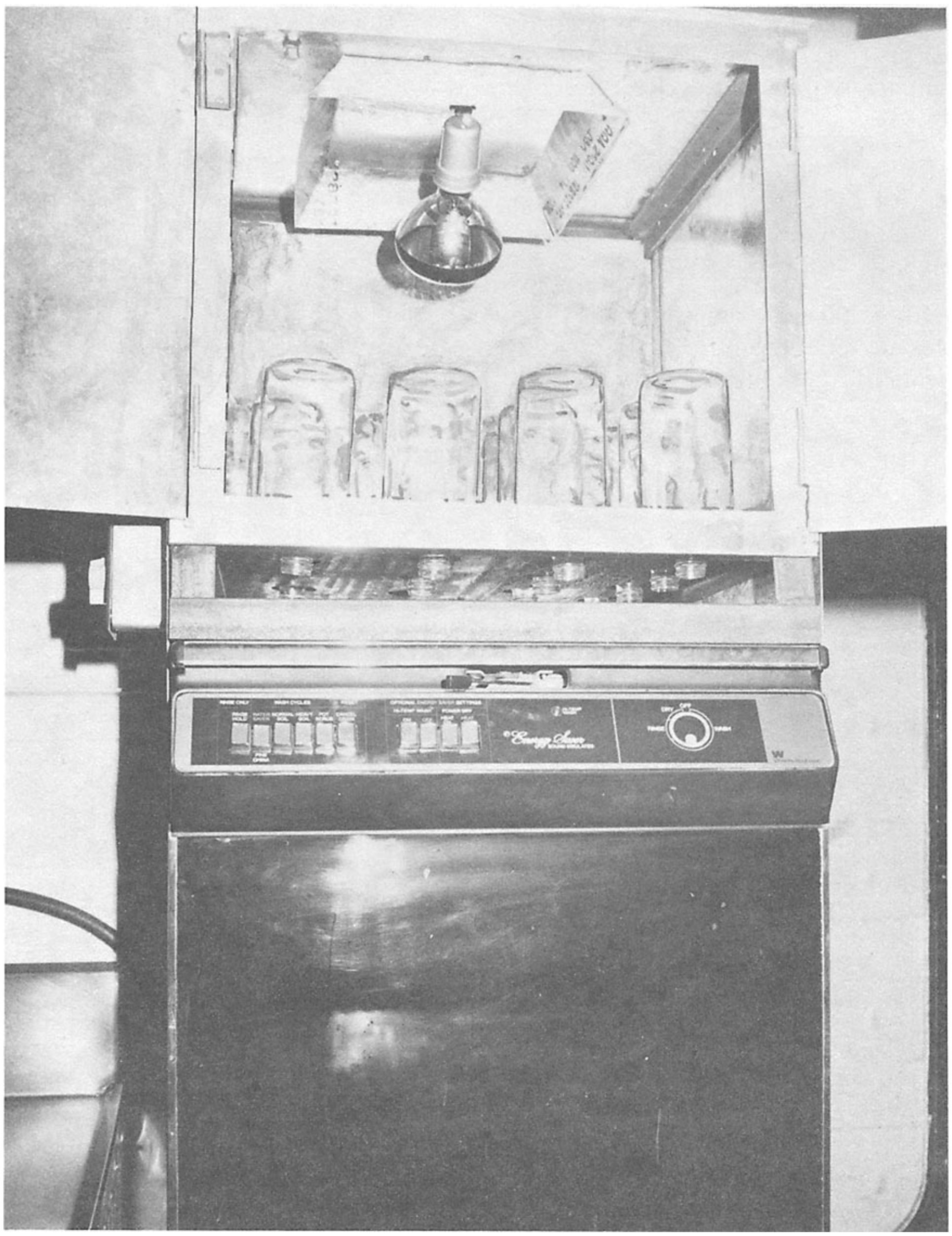


Figure 3-4.—Bottle washer and drying rack.

Also, after any maintenance on the AEL Mk III, calibration is REQUIRED.

CONTAMINATED FUEL DETECTOR AEL MK III (CFD)

The contaminated fuel detector is a portable self-contained unit. This instrument is used to determine the quantity of solid contamination present in aircraft fuels.

The detector consists of a fuel sample container, a fuel filtration system employing millipore filters, and a light transmission system for determining the quantity of solid contaminants on the millipore filters. All components necessary for filtration and measuring transmitted light are incorporated into one serviceable package. See figure 3-5.

The level of fuel contamination is measured by using the principle of light transmission through a millipore filter. A sample of fuel is filtered through the millipore membrane.

The millipore filters have 0.65 micron pores. Contaminating particles are retained on the surface of the membrane. If a beam of light is directed through the membrane, part of the light is absorbed by particles of solid contaminants.

To increase accuracy, and to eliminate any fuel color effect, two millipore filters are used in series. The first filter traps the solid contaminants, plus fuel color effect; the second filter is subjected to clean fuel and retains only the fuel color effect. Thus, the difference between light transmission through the two filters depends only on the amount of solid contamination. By measuring the difference between the amount of light transmitted through the contaminated membrane and the clear membrane, it is possible to establish the level of contamination in fuel.

The steps for preparation and use of the AEL Mk 111 are as follows:

1. Remove the power cable from inside the instrument cover and connect it to a suitable source of 110-volt, 60-hertz power. The power cable contains a ground wire to ground the instrument.

2. Turn the light switch on. The light system should be allowed to warm up for 2 to 3 minutes before use.

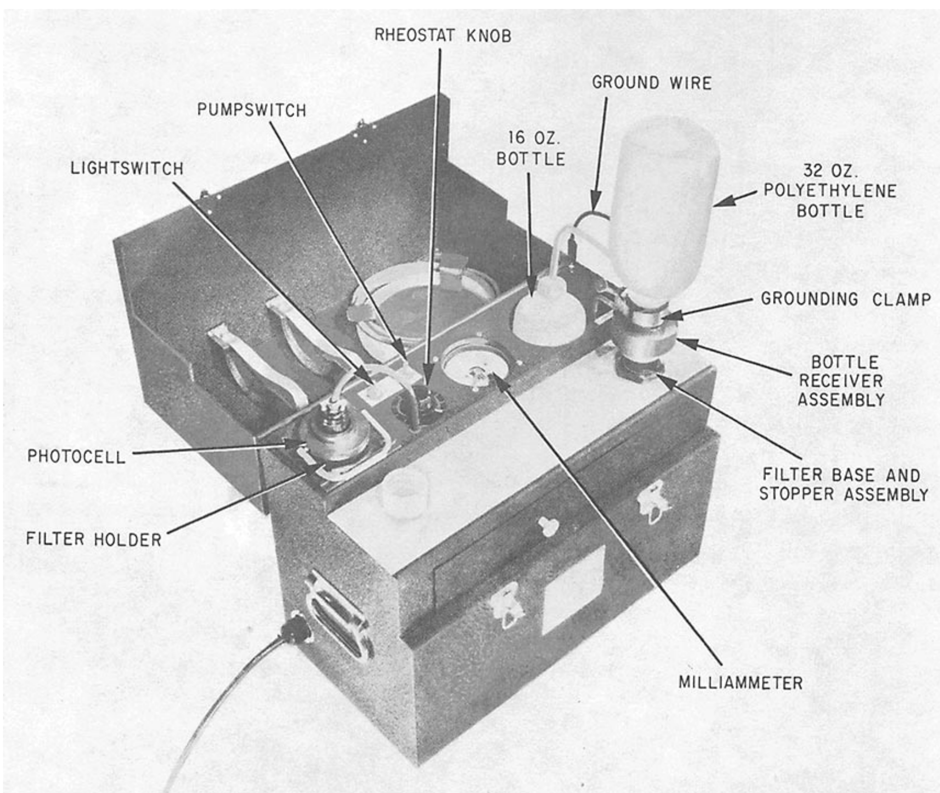


Figure 3-5.—AEL Mk III (front view).

3. Make sure the fuel flask is empty and the drain cock is closed.

4. The falter base and bottle receiver assembly located in the lid should be disassembled into its two components. The section with the rubber stopper is the filter base and should be inserted into the opening in the fuel flask.

5. The millipore filter is a paper-thin white membrane. Place two millipore filters right side up on the filter base. These filters should be handled only with forceps, and only by their edges. *Do not handle the filters with your fingers. Reassemble* the filter base and bottle receiver assembly. Rotate the locking ring carefully to prevent damage to the filters.

6. Fill the 32-ounce polyethylene bottle to the 800 milliliter (ml) mark with fuel. Place the filter base and bottle receiver over the top of the bottle.

7. Make sure that the drain cock valve is closed or fuel will be pulled out of the drain tank and flood the machine.

8. Insert the ground wire attached to the filter base and bottle receiver assembly into the opening provided. Turn on the pump switch; a vacuum pump is connected to the fuel flask to speed up filtration.

9. Insert the entire assembly (filter base, bottle receiver, and fuel sample bottle) into the fuel flask. During the filtration cycle, the fuel in the sample bottle should be agitated occasionally by gently shaking the bottle to ensure that any contaminants are washed down and not lodged on the inside surface of the bottle. If the sample bottle tends to collapse, gently loosen the bottle in the bottle holder by tilting it slightly during the filtration cycle. After all the fuel has passed through the filters, stop the pump.

NOTE

Before measuring the contamination on the filters, you should clean the photocell and light window.

10. OPEN the drain cock valve and drain the fuel from the flask through the tygon tubing into a suitable container. When the flask is empty, CLOSE the drain cock valve.

11. With the filter out of the receptacle, ensure the photocell is in the measuring position.

12. Adjust the rheostat knob for a light intensity reading of 0.6 on the milliammeter.

13. Using forceps, pick up the contaminated filter top and wet it with clean (refiltered) fuel. Ensure the entire filter becomes wet with fuel. This prefiltered fuel is called wetting fuel. It is used to keep the entire millipore filter wet. It is NOT used to wash contamination off the millipore filter. By keeping the entire filter wet you do not get a change of reading from the dry areas to the wet.

NOTE

WETTING FUEL is produced by rerunning the same sample through millipore filters several times. Although no exact number of times is required to rerun the sample to make wetting fuel, it is recommended that the sample be rerun until the light transmission readings for both filters are identical.

14. Lift the photocell (or slide out the plate on newer machines) and, using forceps, place the contaminated filter in the receptacle.

NOTE

The CCFD or DIGITAL reading instruments have a slide plate that you put the filters on and slide under the photocell. The photocell does not move. When you use this design, be careful when putting the filter in the slide and sliding it under the photocell. If you do not put the filter in the slide properly, the filter may come off inside the machine.

15. Swing the photocell (or slide in the plate) back into measuring position and ensure it is fully seated.

16. Record the reading on the milliammeter; this reading is in thousandths of a milliamp.

17. Remove the filter. Check to see that the meter still reads 0.6 milliamps; if not, adjust the meter to 0.6.

18. Repeat steps 13 through 17, using the clean (bottom) filter.

19. Subtract the meter reading obtained from the contaminated filter from the meter reading obtained

from the clean filter. This change in reading value is used with the calibration chart in figure 3-6.

20. Find this value on the left of the chart, then move horizontally until the reference line is intersected. Read vertically at either the top or bottom of the chart to determine the amount of contamination in either milligrams per gallon or in milligrams per liter.

NOTE

Each contaminated fuel detector has its own calibration chart that is marked with the same serial number as the unit.

You should recognize that this instrument is only a secondary standard and does not replace the requirements for periodic laboratory analysis; it supplements the laboratory analysis. Extensive field tests have demonstrated that the calibration chart with this unit is valid for most fuel samples. However, there are occasional samples that do not fit the normal pattern. It may become necessary to establish a new or modified calibration chart in a few unusual cases where the contaminants in a particular system do not follow normal patterns. Duplicate samples sent to the laboratory for gravimetric analysis can give a cross-check on the instrument and quickly pinpoint these unusual situations.

Light Intensity Adjustments

If insufficient adjustment is available to obtain a reading of 0.60 milliamps on the meter as outlined in step 12, proceed as follows: Set the rheostat at midscale and note the meter reading with the light on and the photocell in the measuring position, and no filter in the receptacle, Unplug the instrument and open the back. Loosen the light bulb holder slightly. See figure 3-7. If the meter reads below 0.60 milliamps, slide the bulb holder up. If the meter reads over 0.60 milliamps, slide the bulb holder down. The filament of the light bulb should be horizontal after the change is made. Temporarily close the case, plug in the instrument, turn on the light, and check the meter reading. It is not necessary to obtain an exact 0.60 reading by adjustment of the light bulb because final adjustments will be made by use of the rheostat. When a suitable position for the light bulb has been found that will permit adequate adjustment by the rheostat,

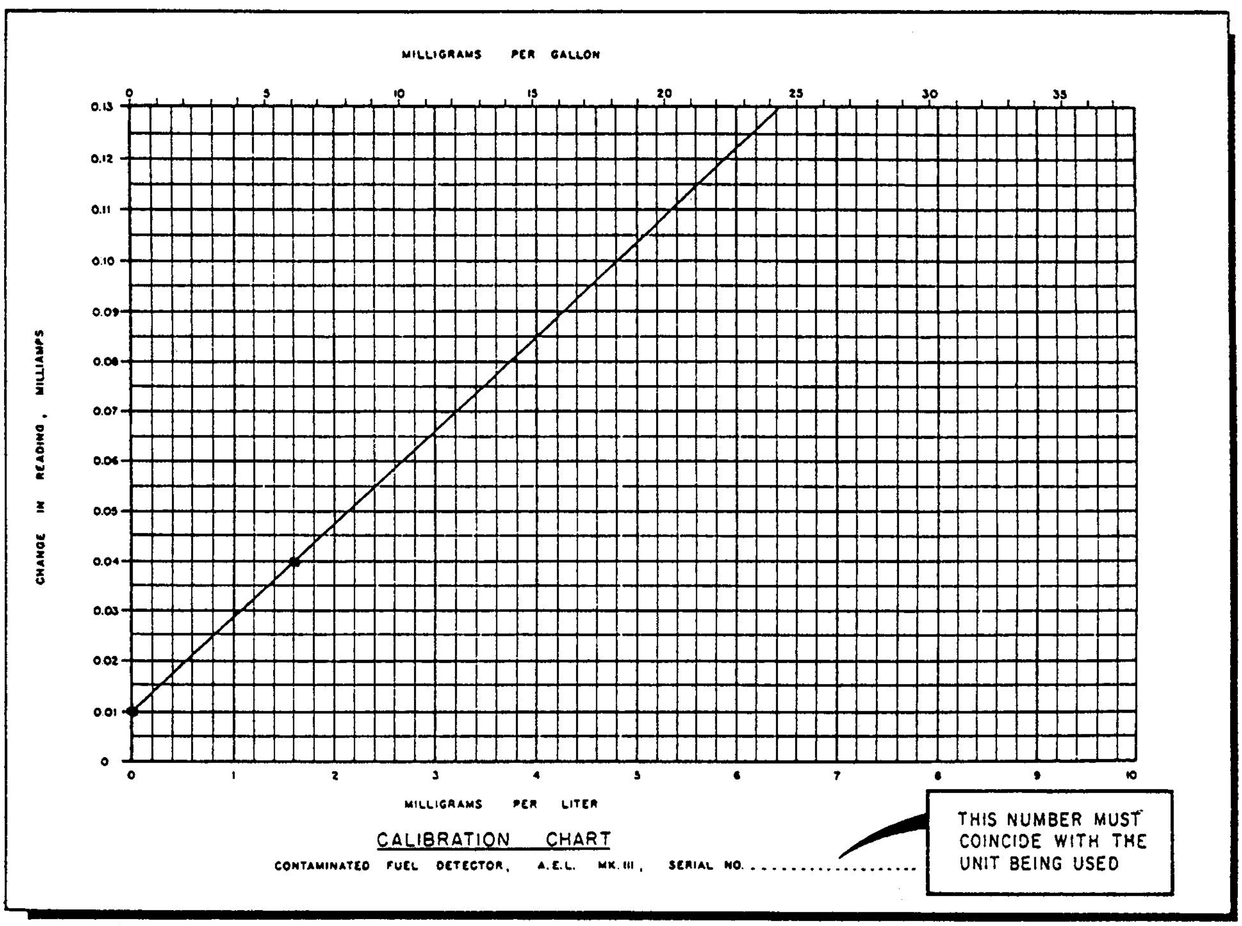


Figure 3-6.—Calibration chart.

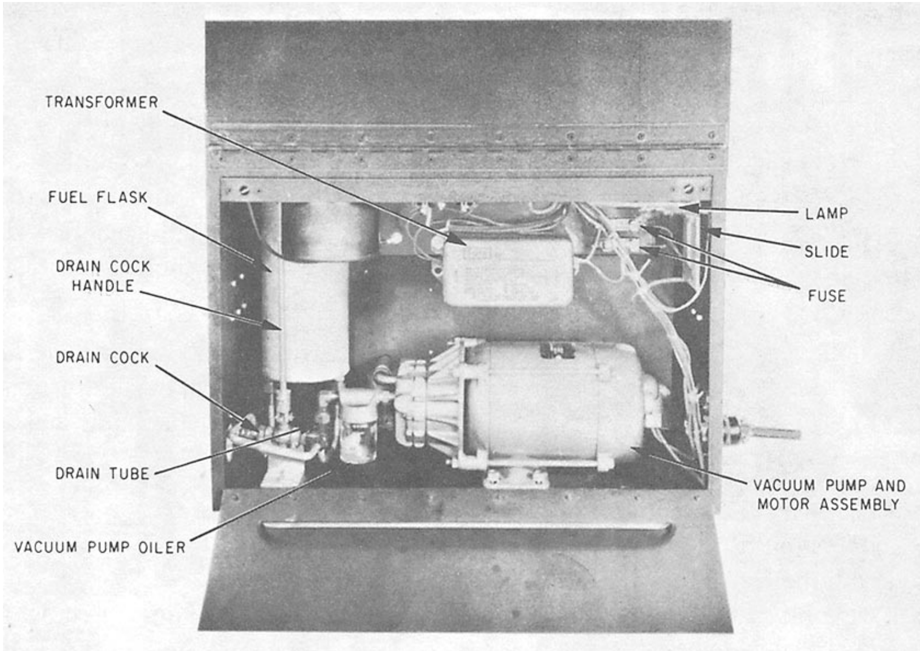


Figure 3-7.—AEL Mk III (rear view).

retighten the nuts on the bulb holder. Refasten the back of the instrument.

Calibrating the AEL MK III

The AEL Mk III comes with 2 WRATTEN calibration filters that are wrapped in silver foil. A Wratten calibration filter set is a pair of filters with a known contamination value. The filters must be kept in their silver foil wrappers so dust does not affect the readings you get.

The reason you have to calibrate an AEL Mk III is that you get wear on the photovoltaic cell, which will give you improper readings if not constantly checked.

NOTE

Calibrate quarterly or when a part is replaced according to PMS.

When you handle the filters, use FORCEPS. The area of contact should be within 1/4 inch of the edge of the filter to avoid damage to the filter's surface. The calibration should be done in the following manner:

1. Turn on the light and let it warm up for at least 3 minutes.

2. Adjust the light intensity, using the rheostat knob, until the milliammeter scale reads 0.6.

3. Pickup one Wratten filter, using the forceps. Lift the photocell (or slide out the plate) and insert the filter into the receptacle. Replace the photocell (or slide in the plate) and record the milliammeter reading in the log book.

4. After logging your results, remove the Wratten filter and put it back into the foil wrapper.

5. Readjust the rheostat, if the milliammeter reading is not 0.6.

6. Repeat steps 3 and 4 with the second Wratten filter.

7. To obtain calibration point, subtract the lower of the two milliammeter readings from the higher reading. This difference is plotted on the calibration chart versus the weight of contaminant per liter given for the set of Wratten filters. A second point is plotted at 0 milligrams per liter and 0.01 milliamps change in light reading. Example (fig. 3-6):

a. Filter contamination factor = 1.6 milligrams per liter.

b. Difference between Wratten filters = 0.04 milliamps.

c. Plot this point with the calibration chart.

d. Plot second point where 0 milligrams per liter and 0.01 milliamps BISECT.

e. Now draw a line connecting the two.

f. Date the calibration chart so as not to confuse it with the previous chart.

NOTE

On the back of the chart it is a good practice to put the serial number of the Wratten filters used and on the front it is required to have the machine serial number.

FREE WATER DETECTOR (AEL MK I AND AEL MK II)

The free water detector (fig. 3-8) was developed to measure accurately the amount of free water in fuels. This detector is used with the Contaminated Fuel Detector in the normal fuel inspection and surveillance programs; the test should be executed as soon as possible following the sampling.

The free water detector consists of an ultraviolet light source, a set of standards indicating 0, 5, 10, and 20 ppm, and water detector pads.

A test sample of fuel is passed through a chemically treated filter pad in the filter holder of the Mk III detector. The chemical on the pad is sensitive to any free water in the fuel. If water is in the fuel, the pad produces a visible fluorescent pattern when it is placed under an ultraviolet light.

Instructions for using the AEL free water detector are as follows:

1. Mark the polyethylene bottle 3 1/4 inches from the bottom. When the bottle is filled to this mark, a 500-ml sample will be obtained.

2. Fill the polyethylene sample bottle to the 500-ml mark with fuel to be tested.

3. Open a free water detector envelope and place the detector pad, orange side up, on the contaminated fuel detector base. Attach the bottle receiver to the filter base and plug in the ground wire jack.

CAUTION

Handle the detector pad with forceps only. Do not touch the pad with your fingers or it becomes contaminated before you even start the test.

4. Check to see that the contaminated fuel detector fuel flask is empty and the drain cock closed.

5. Shake the bottle containing the 500-ml fuel sample vigorously for approximately 30 seconds.

6. Immediately after shaking, turn the vacuum pump on, unscrew the bottle cap, place the bottle receiver firmly over the end of the bottle, and insert the filter over the end of the bottle. Then insert the filter base into the contaminated fuel detector. This step should be done in as short a time as possible to keep any free water in suspension.

7. After the 500-ml sample has passed through the detector pad, turn off the vacuum pump IMMEDIATELY, and remove the bottle and bottle receiver.

NOTE

DO NOT continue to draw air through the detector pad. If the moisture in the air is drawn through the pad, you get an incorrect reading.

8. Remove the pad from the filter base with forceps and place it (orange side up) in the free water detector slide depression.

9. Light the ultraviolet bulb in the free water detector by holding the light switch in the ON position, and insert the slide containing the test pad.

10. Look through the view port of the box and compare the brightness of the test pad with that of the set of standards to determine the amount of free water. Free water content is indicated in ppm by the numbers located directly above the standards.

11. If the result is over 20 ppm, take a new sample of one-half the standard sample and double the answer.

NOTE

The standards card in the free water detector must be replaced after 6 months of use according to PMS.

The standards in the box when received should be marked with the date on which the detector is first put into use. The reason for replacing the standards every 6 months is that the fluorescent inks in the pads deteriorate after prolonged exposure to ultraviolet light.

To replace the ultraviolet bulb, turn the used bulb one-quarter turn and lift it out of the fluorescent lamp

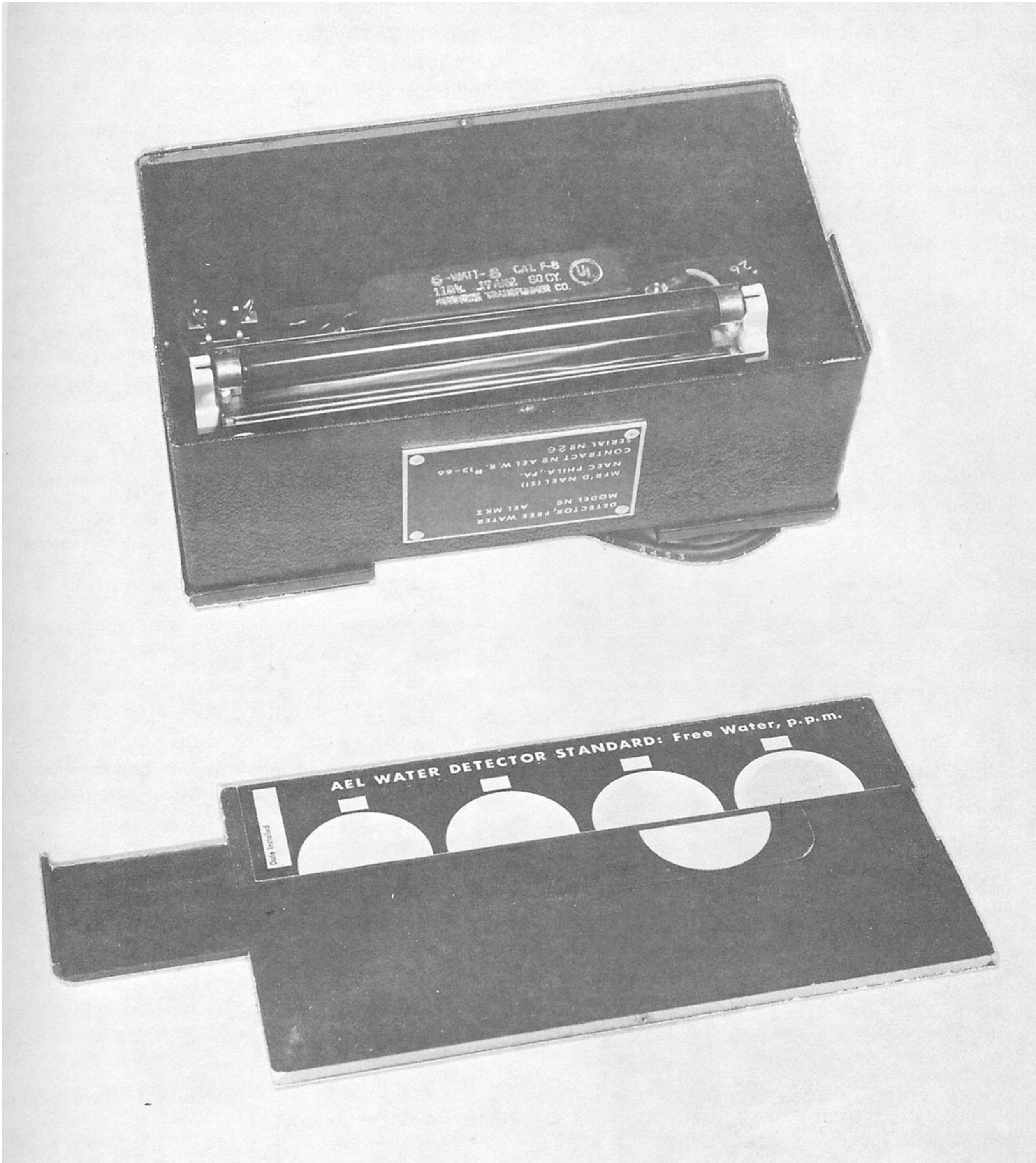


Figure 3-8.—Free water detector (light source and standards).

holder. To insert a new bulb, rotate it one-quarter turn until it is locked in place. To replace the lamp starter, twist it clockwise until the starter is released, then put the new starter back in and turn it counterclockwise until it cannot be turned any more. DO NOT FORCE THE BULB OR STARTER during removal or installation.

ELECTRIC PENSKY-MARTENS CLOSED CUP FLASH-POINT TESTER

The flash-point tester by Pensky-Martens is the standard Navywide flash-point tester. It is designed to test fuel with a flash point of 20° to 700°F, depending on the thermometer used. The ABF is to be concerned with the thermometer with indicated readings that fall within the limits 20°-230°F.

First, you must understand the term FLASH POINT. Flash point is the LOWEST temperature at which the fuel gives off a VAPOR that can ignite.

In preparation for use, the flash-point tester (fig. 3-9) is to be placed on a level, steady surface. If the room where the tests are to be conducted is drafty, it is good practice (but not required) to surround the tester on three sides with a shield about 18 inches wide and 24 inches high. Do not make the shield out of wood or wood products.

To make the flash-point test, carry out the following steps:

1. As previously mentioned, do not test gasoline products in this machine. Thoroughly clean and dry all parts of the cup and its accessories before starting any test.

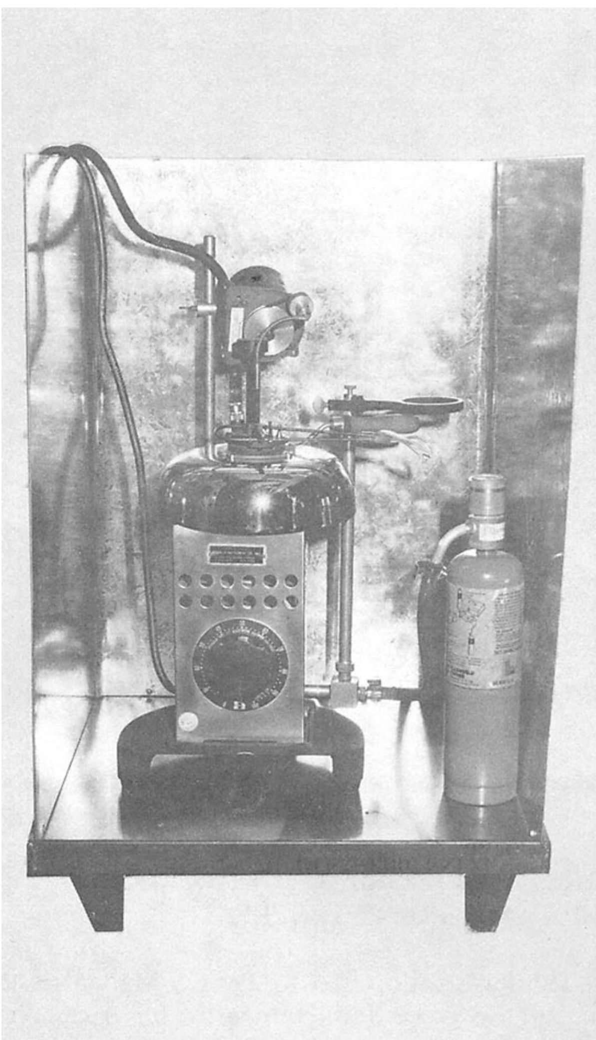


Figure 3-9.—Flash-point tester and metal shield.

2. Fill the cup with the fuel to be tested up to the level indicated by the filling mark. Fuel containing free water is not to be tested since the results you would get would not be accurate.

3. Place the lid on the cup and set the cup in the stove. Take special care because the lid has locating devices so it fits only one way.

4. Insert the thermometer. It is known that JP-5 fuel has a flash point of 140°F, so use the appropriate thermometer that has the range of 20°-230°F.

5. Light the test flame and adjust it by the valve screw on the burner block, so the flame has a 5/32-inch diameter—the same size as the bad provided for comparison.

6. Plug in the unit to a 115-volt power supply. Adjust the supply of heat by adjusting the dial on the powerstat until the temperature reading increases by not more than 11°F per minute nor less than 9°F per minute.

7. Connect the stirrer to the stirrer motor.

8. Apply the test flame when the temperature of the sample is 30° to 50°F below the expected flash point of the fuel, and thereafter in multiples of 2°F. For example, if the expected flash point is 140° (JP-5), the test flame should be applied starting at 90°F, then 92°, 94°, and so forth. You apply the test flame by operating the knurled hand knob that controls the shutter and test the flame burner. The flame is lowered in one-half second, left in the lowered position for 1 second, and quickly raised to its high position.

NOTE

Discontinue stirring during the application of the test flame.

9. The flash point is the temperature read on the thermometer at the time of the flash.

NOTE

The true flash must not be confused with the bluish halo that sometimes surrounds the test flame for the applications preceding the one that causes the actual flash.

REFRACTOMETER KIT

The refractometer kit (fig. 3-10) is used to determine the amount of fuel system icing inhibitor (FSII in jet fuels. Although it is small and made of plastic, it is neither cheap nor more durable than other equipment in the quality surveillance laboratory. This little instrument costs about $600, and the plastic can be scratched. Be careful when it is in use or in storage.

The name refractometer tells you how it works. By the prism on the front (fig. 3-11), light is refracted through the sample being tested onto the scale inside the refractometer.

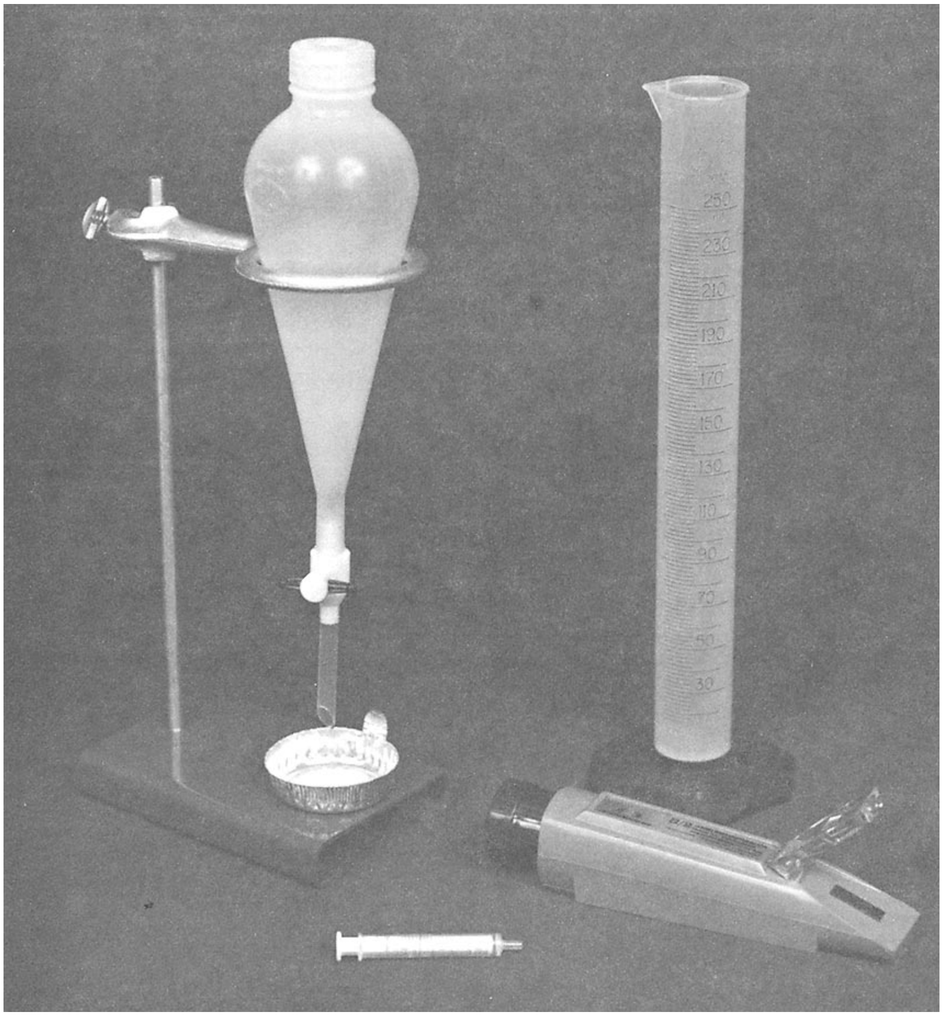


Figure 3-10.—Equipment in a refractometer kit.

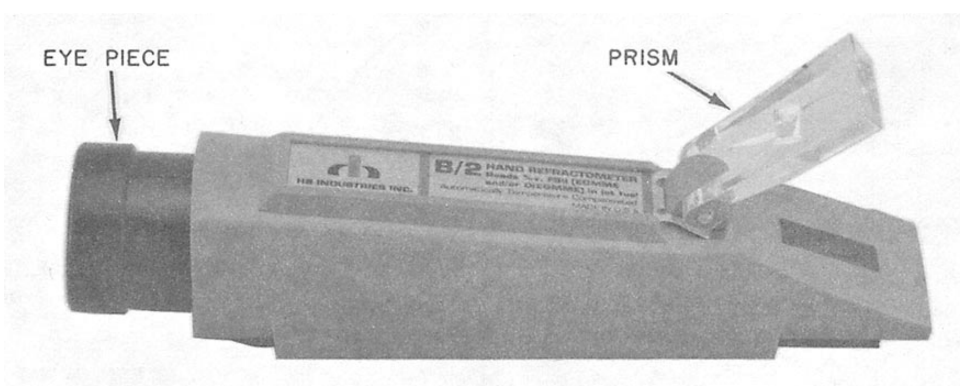


Figure 3-11.—Refractometer (top view).

Operation of the Refractometer

The refractometer is to be used in the quality surveillance lab, not on the flight deck or on the sponson. The light source can be a fluorescent or incandescent bulb, but the area must be well lighted. To use the instrument, perform the following steps:

1. Set up the ring stand assembly as shown in figure 3-10.

2. Use prescribed sampling procedures and take a 1-quart sample of the fuel to be tested in a clean sample bottle.

3. Half fill the aluminum dish with tap water.

4. Fill the graduated cylinder (fig. 3-10) and the separator funnel about one-third full with the fuel to be tested. Rinse the cylinder and funnel thoroughly to clear them of any foreign material and empty the contents.

5. Now fill the graduated cylinder with exactly 160 ml of the fuel sample.

6. Check to see if the drain cock on the separator funnel is closed. If not, close it and pour the 160 ml from the graduated cylinder into the separator-y funnel.

7. Using a piston pipet, add exactly 2 ml of water from the dish to the separator funnel. Place the capon the funnel and shake it for 3 minutes. Place the funnel in the ringstand as shown (fig. 3- 10).

8. Open the hinged plastic cover of the refractometer's window (fig. 3-11), make sure the window and cover are clean, and place several drops of water on it. Close the cover and look through the eyepiece. Observe the shadow line. Remove the black plastic rod from the bottom of the refractometer. Using the rod, adjust the setscrew (on the bottom of the refractometer) until the shadow line meets the zero line of the scale. See figures 3-12 and 3-13. By adjusting the set screw

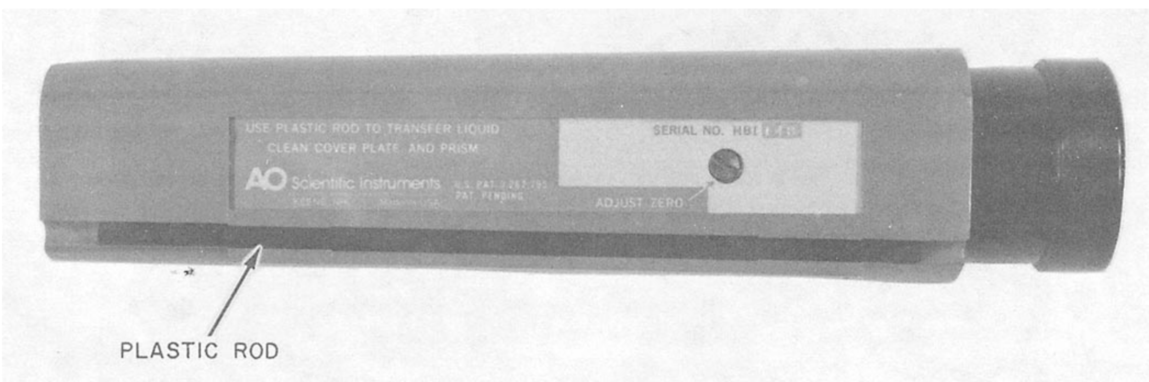


Figure 3-12.—Refractometer (side view).

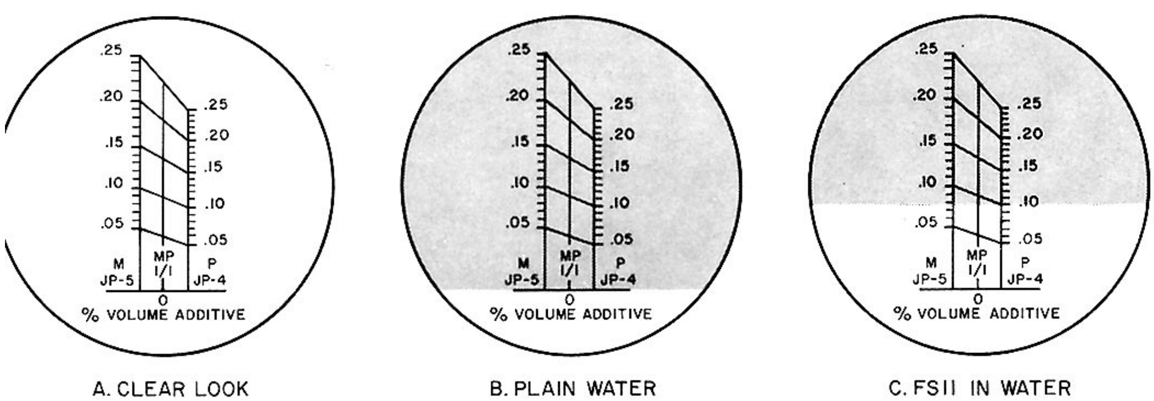


Figure 3-13.—Views through a refractometer.

until you read zero, you have made the refractometer ready to compare the FSII in the fuel to the scale inside the refractometer (fig. 3-13),

9. Open the plastic cover and wipe off the water from the window and cover.

10. Carefully turn the drain cock so several drops of liquid can trickle into a clean, dry aluminum dish.

11. Open the hinged plastic cover and place two or three drops of liquid from the funnel on the window. Close the cover. Look through the eyepiece and read the point where the shadow line is on the scale. This gives you the percentage of FSII by volume. Make a log entry of your finding. Your readings should read two digits to the right of the decimal point: for example, .08, .04, .06, etc. See figure 3-13.

12. Empty the funnel and properly dispose of the fuel. Clean the equipment with soap and water, and ensure the equipment is thoroughly clean by rinsing with water.

The minimum use level for USN and USMC aircraft that require FSII to prevent water-ice formation is 0.03 percent. Currently these aircraft are the S-3, US-3, and SH-60. All other USN and USMC aircraft do not require FSII and may use JP-5 or other ap-proved fuel even if it does not contain FSII.

If the FSII level falls below the 0.03 percent limit, the appropriate Navy or Marine Corps squadron commanding officer of a squadron containing the above aircraft. or his/her designated representative shall be notified.

Transient (USAF, USA, and visiting foreign military aircraft) crewmembers and pilots will be notified of FSII levels of 0.07 percent or less.

Care and Maintenance of the Refractometer

You must use very special care in handling the refractometer when it is in use and when it is stored. A very strong possibility of damage exists if the prism is bumped or the whole unit is dropped. When you clean the equipment, use a mild soap. NO abrasive POWDER is to be used, since it scratches the plastic. Do not submerge the unit when it is being cleaned. If you do submerge it, fluid may get inside and may affect future readings. As of now, no repair parts are available but you can contact the Naval Air Propulsion Center if an emergency arises.

HYDROMETER

When you use a hydrometer, handle it with care. It is glass and breaks easily. The hydrometer (fig. 3-14) is used to measure the specific gravity of petroleum products.

For standardization, all of your readings will be converted to 60°F. The American Petroleum Institute has developed a conversion scale from one temperature to another.

Using standard sample procedures, draw a sample. Pour enough fuel into a beaker to float the hydrometer. Take your reading on the scale inside the hydrometer at the surface of the fuel. Use the conversion chart to note the temperature of the fuel to correct the reading from the ambient fuel temperature to the specific gravity at 60°F.

QUALITY SURVEILLANCE LOG BOOKS

In a day's operation of the fuel lab on some ships and shore stations, it is common to handle over one hundred samples a day. To be able to keep track of the sample results and to maintain good records, a log book is required for all samples.

When you begin the log book, you should enter the starting date on the front cover. When the log is full, enter the ending date. This procedure will help you locate sample results from the collection of completed logs. Make your log entries in ink and use only one side of each page. If you write on both sides of the page, it

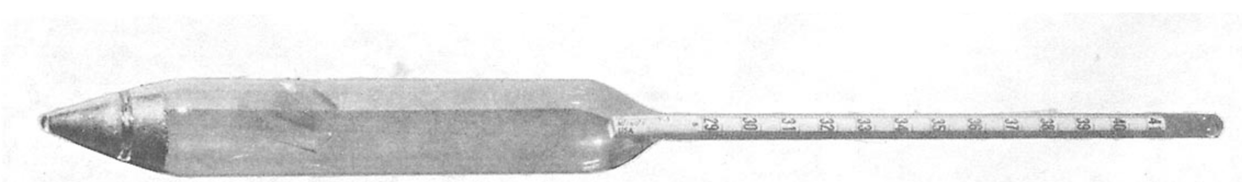


Figure 3-14.—Hydrometer.

DATE	TIME TAKEN	LAB ARRIVAL TIME	LOCATION SAMPLE	APPEAR	TIME WATER RUN	PPM	TIME SED RUN	1ST	2ND	DIFF	FINAL READING	OPERAT	TIME REPORTED LOCATION	POINT	FSII	API	SPEC	QA MAN OPERAT

SUPERVISOR ______________ DIVISION CHIEF ______________ DIVISION OFFICER ______________

Figure 3-15.—Quality surveillance log format.

is more difficult to read the entries. Also, the pages do not tear easily if you use only one side.

The QS logs are the most important log books an ABF has to deal with daily, so write or print the log entries clearly. It is useless to log the results if only one person can interpret the handwriting.

The results in the log book indicate whether or not everything is operating correctly or if a problem exists. When a problem does exist, notify your supervisors at once. Do not wait as corrective action must be taken immediately. Remember, someone's life is in that multimillion dollar aircraft.

The QS log should be in the format illustrated in figure 3-15. Keep the log book neat, clean, and dry. Good housekeeping pays off. A log that is poorly kept. dirty, or has ripped or missing pages is a direct reflection about the way the QS lab is being operated.

SUMMARY

The performance of any engine, especially aircraft engines, depends on the quality of the fuel used in it. As an ABF, the quality of fuel depends on your constant vigilance in the inspection of fuel samples and operation of purification and filtering equipment. YOUR MAJOR OBJECTIVE IS TO DELIVER CLEAN, DRY, AND CORRECT FUEL TO AIRCRAFT.

CHAPTER 4

JP-5 AFLOAT BELOW DECKS SYSTEMS AND OPERATIONS

The first time you see the pump room of a CV/CVN, it is easy to be intimidated. With its complex array of piping, pumps, valves, gages, and motors, you may feel there is just too much to learn. But the qualified pump-room operators make it look easy.

In this chapter, we will try to ease you through this complex system by breaking it down. First we will discuss the subsystems; then we will cover the many components that make up these systems; and finally we will explain operational procedures.

To operate any JP-5 fueling system safely and efficiently, the ABF must have a thorough knowledge of the arrangement and limitations of the piping systems. Although the piping arrangements are similar for all CV/CVNs, no two ships (not even sister ships) are exactly alike. Therefore, you should consult your ship's blueprints and Ships Information Book (SIB) for details on its particular system. The information and diagrams in this chapter are based on the typical arrangements of various class carriers, small or large, and old or new.

JP-5 FUELING SYSTEM

LEARNING OBJECTIVE: Identify the subsystems that make up a JP-5 fueling system.

A JP-5 fueling system consists primarily of a storage system and three separate and independent pumping systems. The pumping systems are Filling and Transfer, Stripping, and Service. The tanks in a JP-5 system are designated under two major categories: storage and service. Storage tanks are used for bulk storage of JP-5. Service tanks are used for servicing aircraft. The storage capacity of different classes of ships depends on the number and size of the ship's tanks. Approximate storage capacities for some of the different classes of ships are listed in table 4-1.

Table 4-1.—JP-5 Storage Capacities

CLASS SHIP	APPROXIMATE CAPACITY
LPD-3 (LA SALLE)	1/4 million gallons
LPH-2 (IWO JIMA)	1/4 million gallons
CV-60 (SARATOGA)	1 1/2 million gallons
CV-63 (KITTY HAWK)	1 3/4 million gallons
CVN-65 (ENTERPRISE)	2 1/4 million gallons
CV-66 (AMERICA)	2 1/4 million gallons
CV-67 (JOHN F. KENNEDY)	2 1/2 million gallons
CVN-68 (NIMITZ)	3 million gallons
CVN-71 (ROOSEVELT)	3 1/4 million gallons

Due to the difference in the types of valves, pumps, filters, and other equipment installed on various ships, this section will use general descriptions. While your ship may have a gate valve in a specific location, another ship may use a buttefly or limitorque valve in the same location. Therefore, we will use the terms *cutout valve, discharge valve, filter,* etc. Specific components will be discussed in the next section.

FILLING AND TRANSFER SYSTEM

The filling and transfer system (fig. 4-1), and its interconnecting piping and valves, serves many functions in the operation of the JP-5 fueling system. It is used primarily for receiving JP-5 aboard to fill the storage tanks; transferring JP-5 from storage to service tanks; transferring JP-5 internally from forward to aft or port to starboard (or vice versa); and filling the amidship emergency tanks (on ships so equipped) when JP-5 is required for boiler fuel. It is also used to receive and direct JP-5 from the independent defuel main to a preselected storage tank, and to receive JP-5 from the stripping pump discharge header and direct it to any storage tank for consolidation. Off-loading of JP-5 is accomplished by the service pumps through cross-connection piping to the filling and transfer system.

Filling System

The filling system includes all piping, valves, and related equipment from the filling connections on the main deck to the fill and suction tailpipe in the storage tanks.

The main-deck filling connections provide a means of attaching the refueling hose to the ship and controlling the quality and quantity of JP-5 being received. They are located on the starboard side of the main deck, outboard of the hangar deck, on fueling sponsons, or in elevator ramp recesses. The number of filling connections varies, depending on the type and class carrier. Most carriers have additional filling connections on the port side to enable refueling from a barge when moored to a pier.

The probe fueling rig is the standard fitting used at the starboard-side filling connections for underway replenish merits. It consists of a fueling probe and a probe receiver. The receiver is supported by a swivel fitting mounted on the receiving ship. A 7-inch-diameter, wire-reinforced rubber hose connects the receiver to the filling connection.

The port-side filling connections use flanges to bolt the refueling hose to the connection.

Filling connections begin with a 90° elbow and a stop valve. A flushing line is installed outboard of the fill connection stop valve on some carrier and amphibious aviation-type ships. It is used for hose flushing and to receive the initial flow during refueling. The flushing line directs fuel flow to the reclamation system and into contaminated storage tanks through the defueling main. All filling connections should be equipped with the following:

1. A sampling connection, to determine the quality of fuel being received.

2. A pressure gage, to determine the discharge pressure from the refueling source.

3. A low-pressure air connection, for blowing JP-5 in the hose back to the refueling source (if necessary).

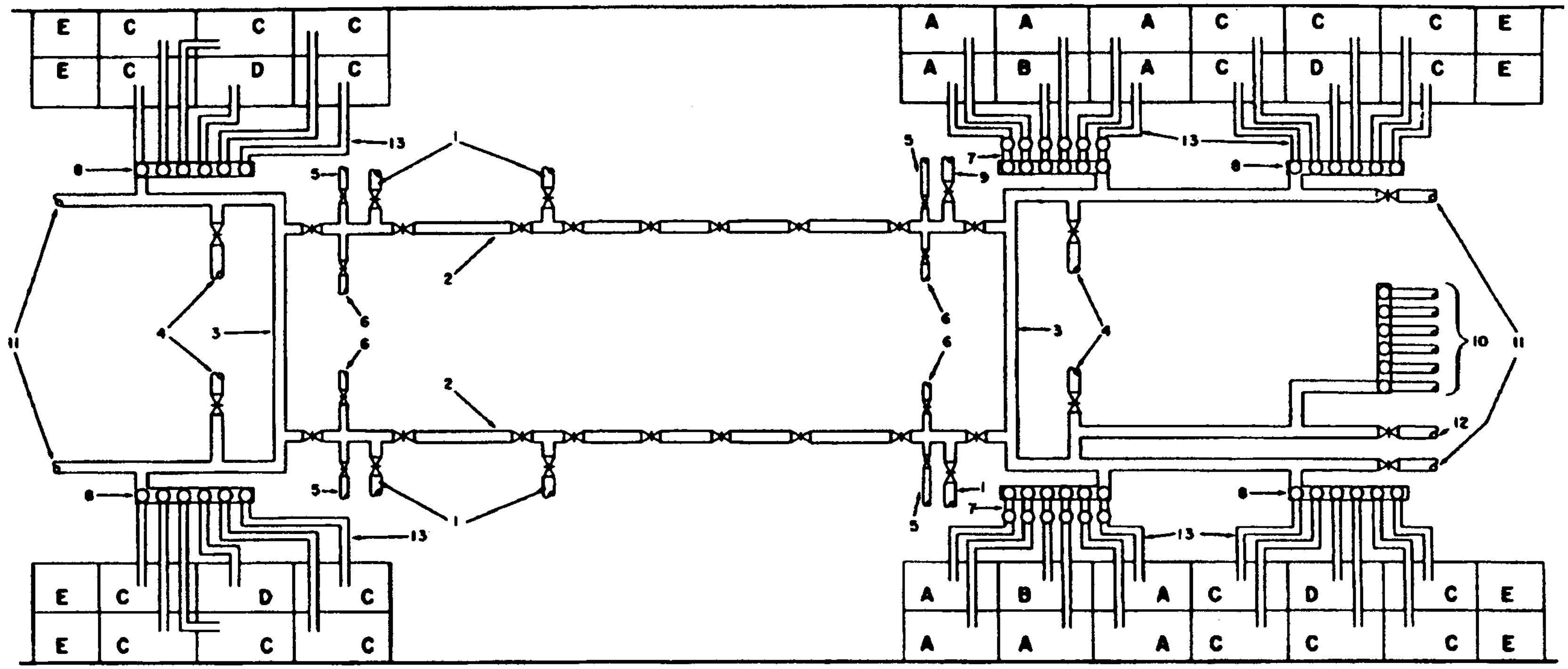
The downcomer is that section of piping that connects the filling connection on the main deck with the transfer main on the seventh deck. There is normally one downcomer for each filling connection installed.

The transfer main runs fore and aft through the bilge just below the seventh deck. New CV/CVNs have a dual transfer main that runs forward and aft on both the port and starboard sides, creating a "closed loop" transfer main. The transfer main interconnects the forward and aft group of storage tanks, and the amidship emergency tanks (on ships so equipped). In addition to being connected to the downcomers, it is also connected to the independent defuel main and the discharge headers of the transfer and stripping pumps.

Cutout valves are installed at strategic points throughout the transfer main, mostly at fore and aft bulkheads. These valves are used to isolate the system during the secured condition and to control the flow of JP-5 during various transfer and filling operations. Each valve is unclassfifed or Damage Control marked ⊗-ray.

The extreme forward and aft ends of the transfer main are connected to the transfer-main branch headers. The transfer-main branch headers extend outboard from the transfer main and interconnect the storage tank manifolds with the transfer main. Normally there are only two branch headers for each of the forward and aft groups of tanks: one port and one starboard. But on ships with double bottom and peak tanks for JP-5 storage. additional branches are required.

Located between the transfer-main branch headers and the storage tank fill and suction tailpipes are valve manifolds. All manifold valves are Damage Control marked ⊗-ray and MUST be closed when not actually in use.



A. JP-5 or ballast
B. JP-5, ballast, or overflow
C. JP-5
D. JP-5 or overflow
E. JP-5 service
1. Downcomers
2. Transfer main
3. Transfer-main branch headers
4. Transfer-pump suction headers
5. Transfer pump discharge
6. Stripping pump discharge
7. Double-valved manifold
8. Single-valved manifold
9. Defuel main
10. Double-bottom tank fill lines
11. Transfer-main branch headers (to other storage tanks)
12. Transfer-main branch header (to peak tank)
13. Storage-tank fill and suction lines

Figure 4-1.—Typical JP-5 filling and transfer system.

Transfer System

The transfer system discussed here is a typical arrangement using three transfer pumps and two centrifugal purifiers in each pump room. See figure 4-2.

The suction header, common to all three transfer pumps, is connected directly to the port and starboard transfer-main branch headers. The two valves installed in the suction header, one port and one starboard, permit the transfer pumps to take suction either from the port or starboard storage tanks independently or from both at the same time.

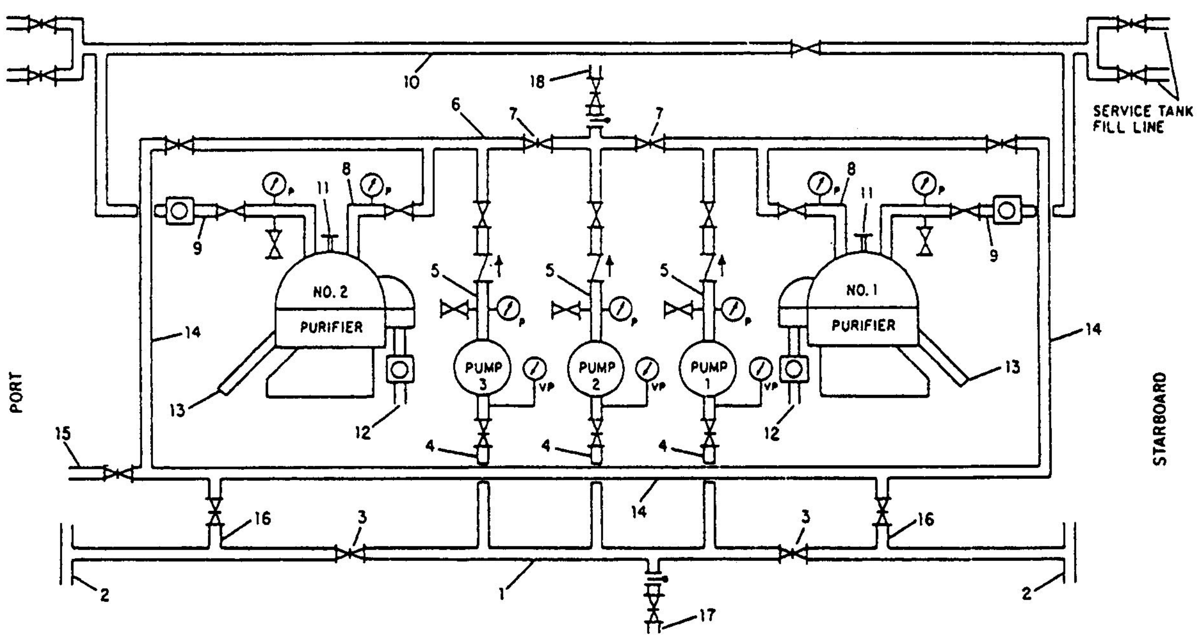
Three pump inlet lines connect the common suction header with the suction side of the transfer pumps. Each line contains an inlet valve and a compound gage.

The transfer pumps discharge into a common discharge header. Each pump discharge line contains a test connection, pressure gage, one-way check valve, and a discharge valve.

Two cutout valves are arranged in the discharge header (one between each pump discharge line) to enable both purifiers to be in operation simultaneously, using any two of the three transfer pumps. For instance, when pump 1 is aligned with purifier No. 1, either pump 2 or pump 3 can be aligned with purifier No. 2. When pump 3 is aligned with purifier No. 2, either pump 1 or pump 2 can be aligned with purifier No. 1. **Never align more than one transfer pump to only one purifier.**

This valve arrangement also permits two separate transfer operations to be performed simultaneously. For example, if pump 1 is aligned with purifier No. 1 to top off a service tank, pumps 2 and 3 can be used to transfer JP-5 from forward to aft, reclaim fuel, and so forth. The same applies for pumps 1 and 2 when pump 3 is being used with purifier No. 2.

Purifiers are bypassed for all transfer operations except when service tanks are being filled. The bypass lines extend off the extreme ends of the transfer-pump discharge header and are connected to the transfer main. Cutout valves separate the bypass lines from the discharge header. Two valved crossovers (one port and one starboard), interconnect the bypass line with the common suction header of the transfer pumps. The cross-overs are used to align the transfer system for pumping JP-5 from port to starboard, or vice versa. The purifier bypass line is also used when transferring JP-5 from



1. Suction header
2. Main branch headers
3. Suction-header control valves
4. Pump inlet
5. Pump discharge
6. Discharge header
7. Discharge-header control valves
8. Purifier inlet
9. Purifier discharge
10. Service-tank fill line header
11. Seal water inlet
12. Purifier water discharge
13. Purifier casing drain
14. Purifier bypass
15. Transfer-main connection
16. Suction header crossover to bypass
17. Cross-connection to service-pump suction header
18. Cross-connection to service-pump discharge header

Figure 4-2.—Typical transfer system.

forward to aft (or vice versa), when filling amidship emergency tanks (on ships so equipped), and when off-loading JP-5.

The common suction and discharge headers of the transfer pumps are interconnected with the suction and discharge headers of the service pumps. This arrangement enables the service pumps to be used as transfer pumps (normally for off-loading JP-5). Be-cause of insufficient (static) head lift and the low pumping capacity of the transfer pumps, they are not normally used for transferring JP-5 off the ship. The cross-connections between the respective suction and discharge headers are fitted with a spectacle flange or a line blind valve (blank side in), and a cutout valve (normally locked closed).

Reclamation System

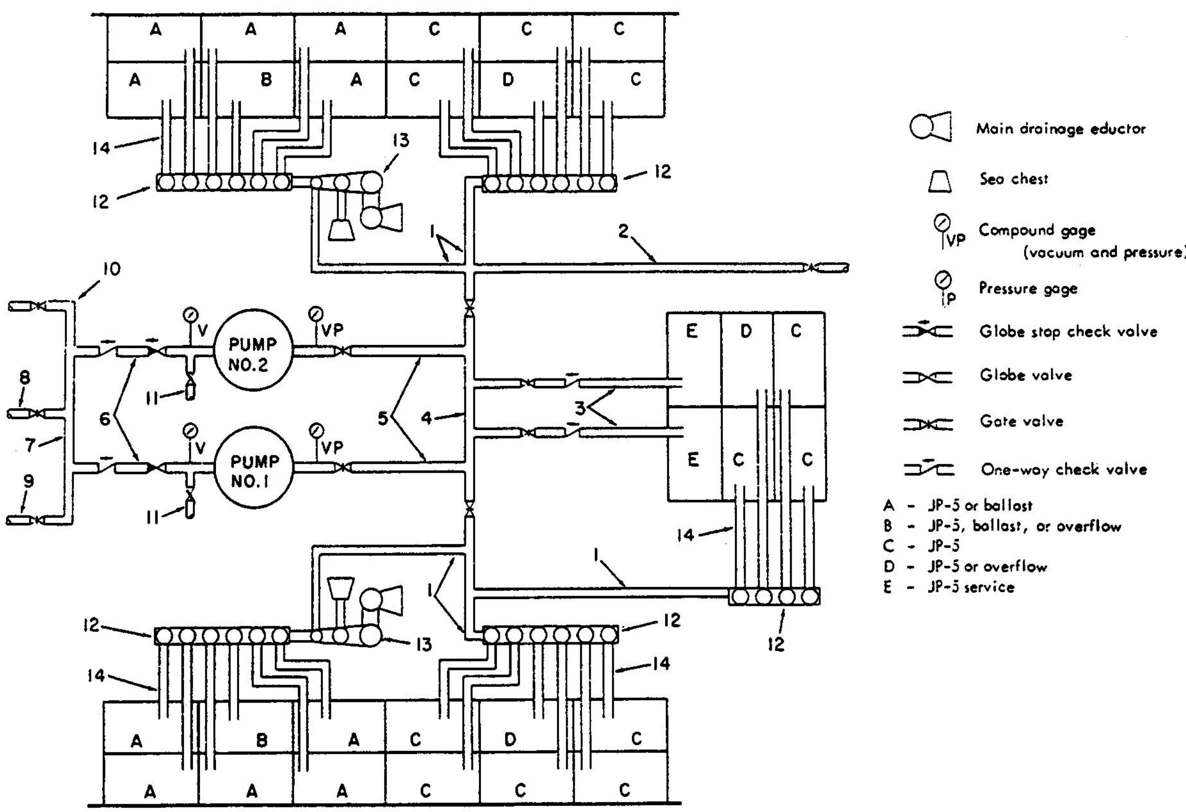
The reclamation system provides the capability to reclaim JP-5 received from hose flushings, JP-5 tank stripping operations, and the initial flow during a fueling at sea (FAS). The water and sediment received from these operations are permitted to settle out in the contaminated-JP-5 settling tanks. JP-5 drawn off by the designated JP-5 transfer pump is discharged through the reclamation prefilter and fiber/separator and then into JP-5 storage tanks.

STRIPPING SYSTEM

There are two independent stripping systems in each JP-5 pump room. One system uses motor-driven pumps and is interconnected with all JP-5 tanks (both storage and service). The other system uses hand-operated pumps and is installed in service tanks only. The systems we will describe here are the typical setup for one pump room. Since they operate independently, we will describe each separately.

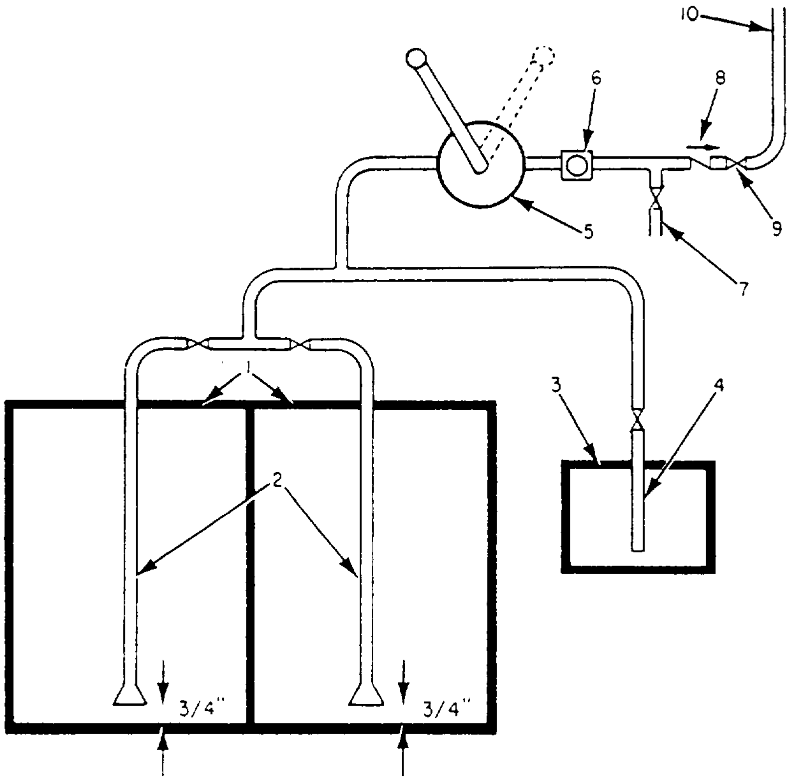
Motor-Driven Stripping System

The motor-driven stripping system (fig. 4-3) con-sists of two low-capacity pumps, manifolds, and



1. Stripping suction main (storage tanks)
2. Stripping suction main to other storage tank nests
3. Stripping tailpipe (service tanks)
4. Stripping-pump suction header
5. Stripping-pump inlet line
6. Stripping-pump discharge line
7. Stripping-pump discharge header
8. Stripping-pump discharge to transfer main
9. Stripping-pump discharge to overboard
10. Stripping-pump discharge to contaminated-JP-5 settling tank
11. Test connection
12. Single-valved manifold
13. Flood and drain manifold
14. Storage-tank stripping tailpipes

Figure 4-3.—Typical motor-driven stripping system.



1. **Service tanks**
2. **Service-tank stripping tailpipe**
3. **Purifier drain tank**
4. **Drain tank tailpipe**
5. **Hand pump**
6. **Sight glass**
7. **Sample connection**
8. **One-way check valve**
9. **Shutoff valve**
10. **Pump discharge to contaminated-JP-5 settling tank**

Figure 4-4.-Typical hand-operated stripping system.

associated piping and valves. It is designed to perform the following functions:

1. Remove settled water and solids from the bottom of the JP-5 storage tanks (during normal stripping operations).

2. Remove the last 24 inches of usable fuel remaining in the storage tanks after the transfer pumps lose suction (when consolidating fuel or before ballasting a storage tank).

3. Remove the remaining seawater left in the storage tanks by the main drainage eductors (after tank cleaning operations or deballasting a storage tank).

4. Remove the remaining 24 inches of JP-5 from the service tanks (before cleaning or for off-loading).

5. Remove the wash water from the JP-5 service tanks (after a cleaning operation).

6. Remove water from the purifier sump tank.

The storage-tank stripping tailpipe extends from 1 1/2 inches off the tank bottom and runs to the single-valved stripping manifold.

There are two types of manifolds installed in this stripping system. One is a single-valved stripping manifold used with all JP-5 storage tanks. The other is a flood and drain manifold that is installed only in the piping to those JP-5 storage tanks that are designated to be ballasted. Flood and drain manifolds are located in the stripping system between the single-valved manifolds (for all tanks designated to be ballasted) and the stripping pumps.

The stripping mains interconnect the manifold for all the storage tanks in the group with the common suction header of the stripping pumps. There are normally two stripping mains one port and one starboard. On ships equipped with deep centerlines, double-bottoms, and peak tanks, additional lines are required to strip these tanks.

The service-tank stripping tailpipe extends from 1 1/2 inches off the tank bottom and is connected directly to the suction header of the motor-driven stripping pumps. These lines are fitted with a cutout valve, and a one-way check valve or spectacle flange.

The pump piping is arranged to take suction from the common suction header and discharge into the common discharge header. The two cutout valves in the suction header permit both pumps to take suction from either the port or starboard tanks independently, or from both sides simultaneously. The pump inlet piping contains an inlet valve, a compound gage, and on some ships, a 40-mesh basket-type strainer. The discharge piping contains a valved sample connection, pressure gage, a discharge valve, and a one-way check valve. From the discharge header, the stripped liquid can be directed to the contaminated-JP-5 settling tanks, or it can be directed to the transfer main when consolidating the fuel load.

Hand-Operated Stripping System

The hand-operated stripping system (fig. 4-4) is provided specifically for JP-5 service tanks. Its purpose is to remove water and solids from the bottom of the tanks.

The hand-operated stripping system tailpipe extends from 3/4 inch off the service tank bottom and is connected to a tanktop cutout valve. The lines from each service tank in the pump room are combined and connect directly to the suction side of the hand-operated stripping pump. The discharge line contains a sight glass, sample connection, one-way check valve, and discharge cutout valve. The stripping line discharges into the contaminated-JP-5 settling tank or purifier sump tank.

SERVICE SYSTEM

The service system (fig, 4-5) contains all the piping, valves, and related equipment necessary to deliver clean, clear, and bright JP-5 from the service tanks on the eighth deck to aircraft on the flight and hangar decks.

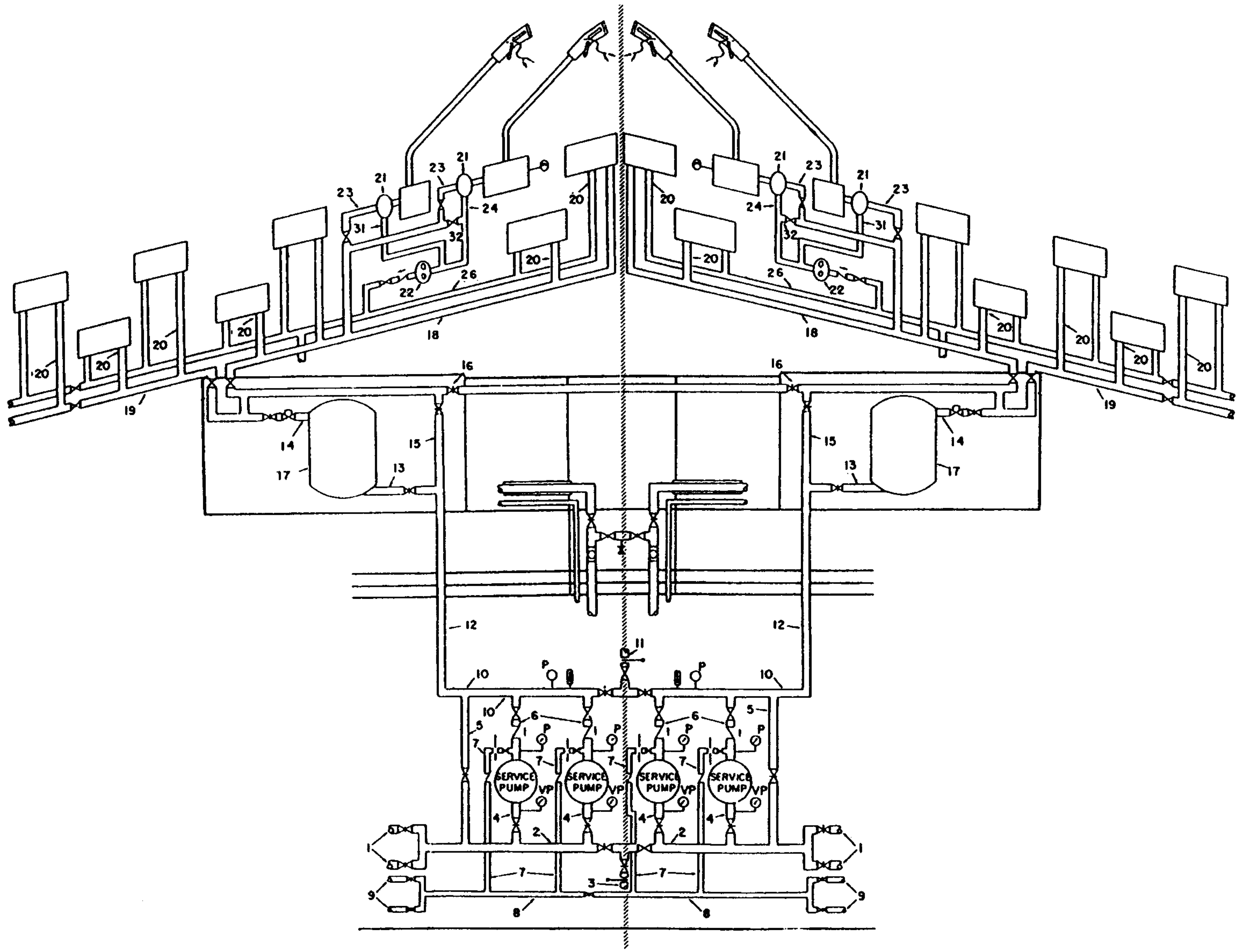
With the ability to isolate the service system into four separate quadrants, the general arrangement of this system is nearly identical on all earners. But the actual piping, valves, and related equipment will definitely vary. The service system described here is the forward section of a typical CV.

The service system piping in the pump room (fig. 4-6), begins with the service-tank suction tailpipes. These lines extend from 24 inches off the tank bottom to the service-pump common suction header. Each line is fitted with a shutoff valve to isolate the tank from the system when not in use.

The service pump common suction header is divided into a port and starboard suction header by a set of crossover valves. During normal operations, these crossover valves are open to allow the use of any service pump with any service tank. Additionally, the cross-connections from the transfer pump suction header, fitted with a spectacle flange or line blind valve, and a cutout valve interconnect with the service pump suction header between these valves. This arrangement allows two service pumps to be used as transfer pumps, and two for servicing aircraft. Of course, this would bean emergency arrangement if all three transfer pumps were disabled. Otherwise, the cross-connection is only opened to allow service pumps to be used for off-loading JP-5.

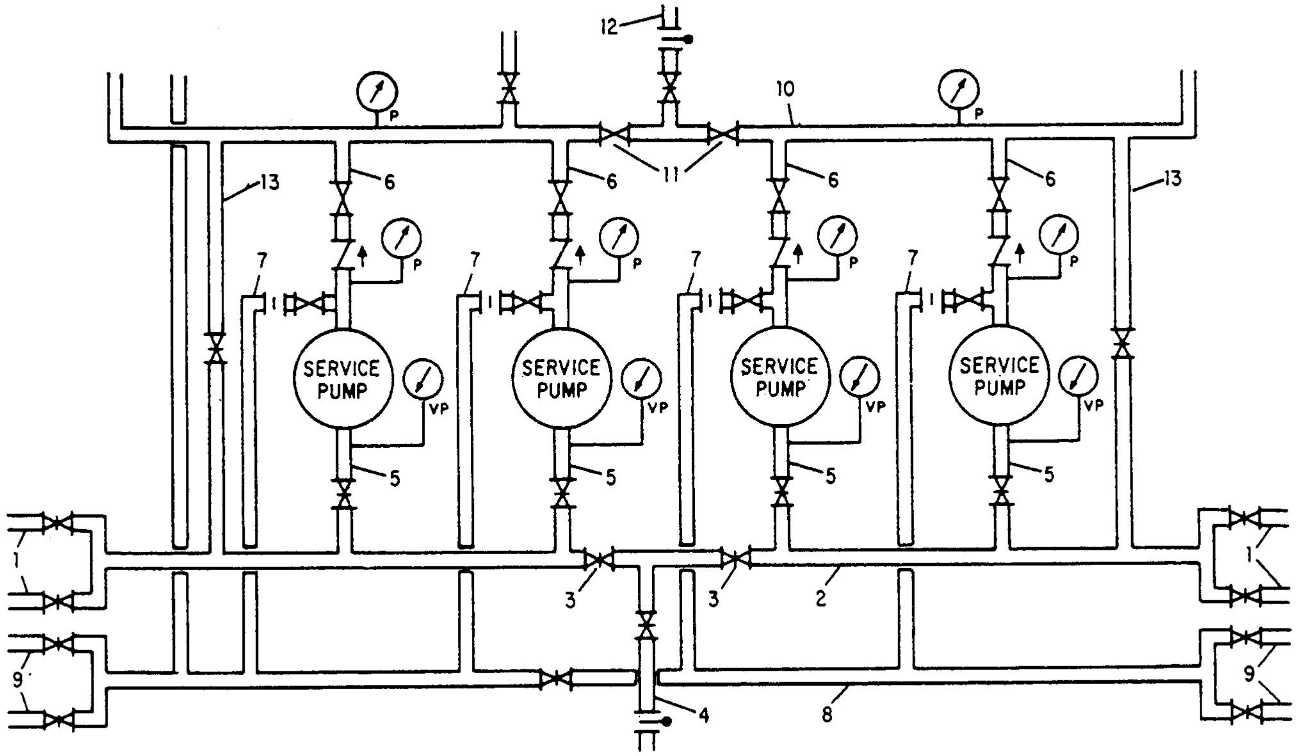
The service pumps are connected to the suction header by the pump inlet. This line contains an inlet valve and a compound gage. The discharge line, connecting the pumps to the common discharge header, contains a recirculating line, pressure gage. one-way check valve, and a discharge valve.

The recirculating line has an orifice to recirculate about 5% of the rated capacity of the pump back to the service tank from which suction is being taken. The recirculated fuel through the pump casing keeps the pump cool during standby condition. This is when the system is pressurized (pumps are running), but no fuel is being drawn topside. The recirculating lines (one for each service pump), terminate in a recirculating header. The header in turn is connected to each service tank recirculating line. These lines, fitted with shutoff valves, terminate 18 inches horizontally off the tank bottom. A number of 1-inch holes, equally spaced along the top of the recirculating line allow JP-5 to be returned to the tank without disturbing the contents of the tank. When the system is being set up for operation, the recirculating header MUST be aligned to the service tank from which suction will be taken. Also, when the service tank is changed, so must the recirculating header.



1. Service-tank suction tailpipe
2. Service-pump common suction header
3. Cross-connection to transfer-pump suction header
4. Service-pump inlet line
5. Service-pump bypass line
6. Service-pump discharge line
7. Service-pump recirculating line
8. Recirculating header
9. Service-tanks recirculating lines
10 Service-pump common discharge header
11. Cross-connection to transfer-pump discharge header
12. Quadrant distribution line
13. Filter inlet
14. Filter discharge15. Filter bypass
16. Port and starboard filter cross-connection
17. Filter
18. Forward-quadrant distribution main
19. After-quadrant distribution riser
20. Service station risers
21. Cla-Val fuel/defuel valve
22. Defuel pump
23. Cla-Val inlet lines
24. Defuel line
25. Defuel recirculating line
26. Defuel main

Figure 4-5.—Typical service system.



1. **Service-tank suction tailpipes**
2. **Suction header**
3. **Suction-header cross-over valves**
4. **Cross-connection to transfer-pumps suction header**
5. **Pump inlet**
6. **Pump discharge**
7. **Service-pump recirculating line**
8. **Recirculating header**
9. **Service-tank recirculating lines**
10. **Discharge header**
11. **Discharge-header cross-over valves**
12. **Cross-connection to transfer pump discharge header**
13. **Pump bypass lines**

Figure 4-6.—Typical service system pump-room piping arrangement.

The service pump discharge header is common to all four service pumps. Like the suction header, it is divided into port and starboard headers by a set of crossover valves. The cross-connection to the transfer pump discharge header is used with, and for the same purpose as, the cross-connection between the respective suction headers of the transfer and service pumps. They are also used to drain back the service piping for maintenance.

From the service pump common discharge header (on the seventh deck), the distribution riser extends directly to the filter room (on the third deck). JP-5 enters the service filter through the inlet section and leaves the filter through the discharge line attached to the clearwell chamber and the automatic shutoff valve. Both inlet and discharge have shutoff valves.

The filters are also provided with a bypass line. This line fitted with a shutoff valve (locked closed), is installed between the filter inlet and discharge lines. The bypass line is primarily used for draining back the distribution piping for maintenance.

As the distribution piping leaves the discharge side of the service filter, it is divided into two sections (commonly called "legs"). Each leg extends outboard; one goes forward to supply all the service stations in the forward section of the quadrant, and the other goes aft to supply all the service stations in the aft section of the quadrant. This piping may or may not run outside the skin of the ship and is known as the outboard distribution main.

The aft leg of the forward quadrant and the forward leg of the aft quadrant are connected by a set of cross-over valves. Additionally, port and starboard quadrants are connected by cross-over valves. With the correct alignment, this allows fuel to be pumped from any service pump in either pump room to any service station on the flight or hangar decks.

Service station risers extend upward from the outboard distribution main to supply the service stations on the hangar and flight decks. At the service station, the supply riser branches off to each hose reel.

Isolation valves are installed at strategic points throughout the outboard distribution piping. These valves are normally in the open position during at-sea operations, but are closed to isolate specific sections in an emergency or if damage occurs. They are located in both the outboard distribution main and the service station risers.

Jet Test System

This system provides JP-5 to the Jet Engine Test Facility located on the fantail of aircraft carriers. The system has its own pump and filter/separator. Supply to this system is from the JP-5 service-pump suction header. The system has a return line from the test stand to permit operation of jet engines at various flow rates.

Auxiliary JP-5 System

This system provides JP-5 to emergency diesel generators, auxiliary boilers, small-boat filling stations, or combat vehicle/support equipment filling station. It is an independent system and typically consists of an auxiliary pump, an auxiliary main and branches supplying each station. This system is also supplied from the JP-5 service-pump suction header.

JP-5 FUELING SYSTEM COMPONENTS

LEARNING OBJECTIVE: Identify the various components that make up the JP-5 below decks fueling system. Describe their function, principles of operation, and operating limits.

In the first section of this chapter, we talked about JP-5 fueling subsystems. We discussed their typical arrangements and where pumps, filters, cutout valves, purifiers, and other components would fit in that system. And as was stated earlier, though all JP-5 fueling system arrangements are alike the actual makeup of each system will be different.

In this section, we identify and describe specific components of the JP-5 fueling system. We cover their description, operating capacities, some troubleshooting and maintenance, and where they would typically fit in a subsystem. Remember, your individual systems may vary.

PUMPS

A pump is a machine that draws a fluid into itself through a suction port and forces the fluid out through a discharge port. The ABF uses pumps in the JP-5 below decks system to move JP-5 from tank to tank, and to lift JP-5 to the flight and hangar deck refueling stations.

Wear occurs in a pump as in any other piece of machinery. To maintain a pump at or near the efficiency it had when new and to keep maintenance at a minimum periodic tests should be made to determine the delivery capacity of the pump. When a test indicates a noticeable reduction in the delivery capacity, it is a sign of possible internal wear. The pump should be opened for inspection in accordance with PMS. If corrective action is not immediately taken total failure of the wearing parts may result in excessive repair costs as well as considerable down time of the pump. *Always follow the manufacturer's instructions in the applicable technical manuals.* The various type pumps and their functions are discussed here.

Centrifugal

Due to their simplicity and adaptability to a wide variety of operating conditions, centrifugal pumps are widely used. They can be modified to operate over a wide range of heads, can handle liquids at all normal temperatures, and operate at speeds that are standard for motors or turbines. The characteristics of these pumps are such that liquid flow from them is continuous, and their discharge can be throttled without building up excessive pressures in the pumps or overloading the driving unit.

The most common manufacturers of the centrifugal pumps used in the JP-5 below decks system are Aurora and Carver. The Aurora is the pump discussed here. But, there are other pumps installed and you should always consult the technical manual for details on the specific pump in your system.

The primary use of centrifugal pumps in the JP-5 below decks system are as service pumps. The Aurora JP-5 Service Pump is a double-suction, single-stage, centrifugal pump. The pump is designed to deliver fuel at 1,100 gallons per minute at 150 psi with a

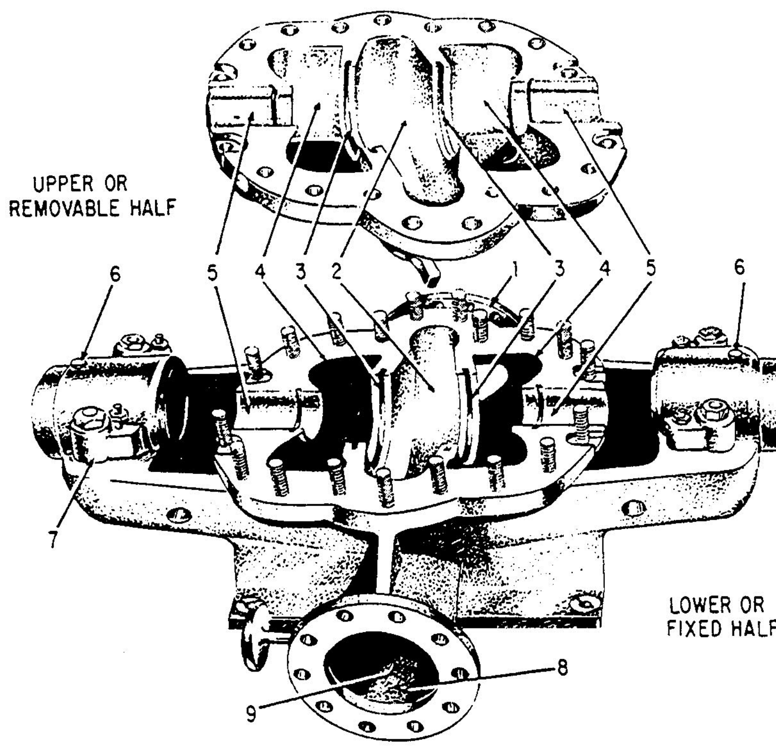
20-foot suction lift. The pump consists of a split casing, wearing rings, and rotating element.

SPLIT CASING.— The casing (fig. 4-7). is horizontally split at the shaft centerline. This enables easy removal of the upper casing half for inspection and maintenance. The casing is divided into three chambers; two suction and one discharge. The upper half of the casing contains a flange that may connect the pump to an air eliminator valve. Two external seal lines on the upper casing feed fuel from the discharge chamber to cool the mechanical seals. The lower half of the casing contains bearing housings, a suction flange and a discharge flange that connect the pump to the piping system. Drain holes and drain plugs are provided at the bottom of both flanges for draining the pump.

WEARING RINGS.—There are four replaceable type wearing rings (two rotating and two stationary) installed within the pump casing. The two rotating are installed on the impeller. The two stationary are installed in the pump casing between the suction and discharge chambers. The stationary rings are held in place and prevented from rotation by the tongue-and-groove construction. When the pump is assembled, the rotating wearing rings ride inside the stationary rings. (Check the appropriate technical manual for the correct clearance between the stationary and rotating rings.)

Wearing rings serve two purposes: (1) owing to their unique construction and close tolerances, they minimize leakage between the discharge and suction chambers and (2) they allow for the wear created between the impeller and pump casing.

Fuel passing through the pump has a tendency to recirculate from the discharge chamber back to the suction chamber. As the fuel passes through the narrow clearance between the wearing rings, a partial seal is made by the rapid rotation of the impeller. This seal minimizes the leakage between the discharge and suction chambers. After prolonged use of the pump, the clearance between the wearing rings gradually increases due to wear. This is caused by the friction created by the rapid rotation of the impeller and the fuel passing between the wearing rings. As the clearance increases, the sealing effect decreases resulting in the loss of the rated capacity of the pump.



1. Pump inlet (suction)
2. Impeller housing and discharge chamber
3. Housing for stationary wearing rings
4. Suction chamber
5. Stuffing box
6. Bearing caps
7. Bearing housing
8. Discharge outlet
9. Drain hole

Figure 4-7.—Centrifugal pump casing.

ROTATING ELEMENT. —The rotating element (fig. 4-8) consists of an impeller and pump shaft, shaft sleeves and nuts, ball bearings, mechanical seals, and a flexible coupling.

Impeller and Pump Shaft. —The impeller is a double-suction, closed impeller. It is keyed to, and rotates with, the pump shaft. The impeller is centered in the discharge compartment of the pump casing and prevented from axial movement by two shaft sleeves and two shaft nuts. The two shaft sleeves actually act as long spacers between the impeller and shaft sleeve nuts. The shaft sleeves are also keyed to, and rotate with the pump shaft. Fuel enters the center part of the impeller from both sides of the suction chamber and is pumped into the discharge chamber. The impeller blades are enclosed by side plates. The blades are designed to curve backward in relation to the rotation of the impeller to increase pump efficiency, and impart velocity to the fuel in the casing. Mechanical seals (fig. 4-9) fitted on the pump shaft guard against fuel leakage from the pump and prevent air from entering the casing around the shaft. The seals are installed in the stuffing boxes provided on each side of the pump casing.

There are two types of mechanical seals, the John Crane, and Durametalic. The principle parts of the John Crane mechanical seal are the stationary floating seat, low friction sealing washer, and spring. It is a single piece unit.

The principle parts of the Durametalic mechanical seal are the stationary insert, seal ring, compression ring and collar assembly, and the shaft packing. It is a three piece unit.

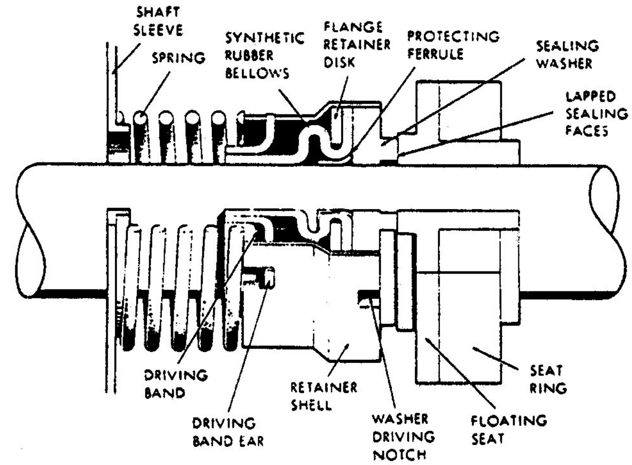


Figure 4-9.—John Crane mechanical seal.

NOTE

Some parts of mechanical seals are made of carbon and break easily. Handle mechanical seals carefully.

Bearing Cartridges. —Both ends of the pump shaft extend outside the upper half of the casing. Pump shaft ends are supported by ball bearings encased in bearing cartridges and cradled in the bearing brackets of the lower casing half. The ball bearings absorb radial and axial thrust, and ensure free rotation of the pump shaft. A single ball bearing is housed in the inboard bearing cartridge, allowing the inboard bearing some axial movement within the cartridge. Duel ball bearings are housed in the outboard bearing cartridge. The ball bearings are slipped on and held firmly against a shoulder on the pump shaft by a lock washer and locknut. The ends of the bearing cartridges that lie closer to the center

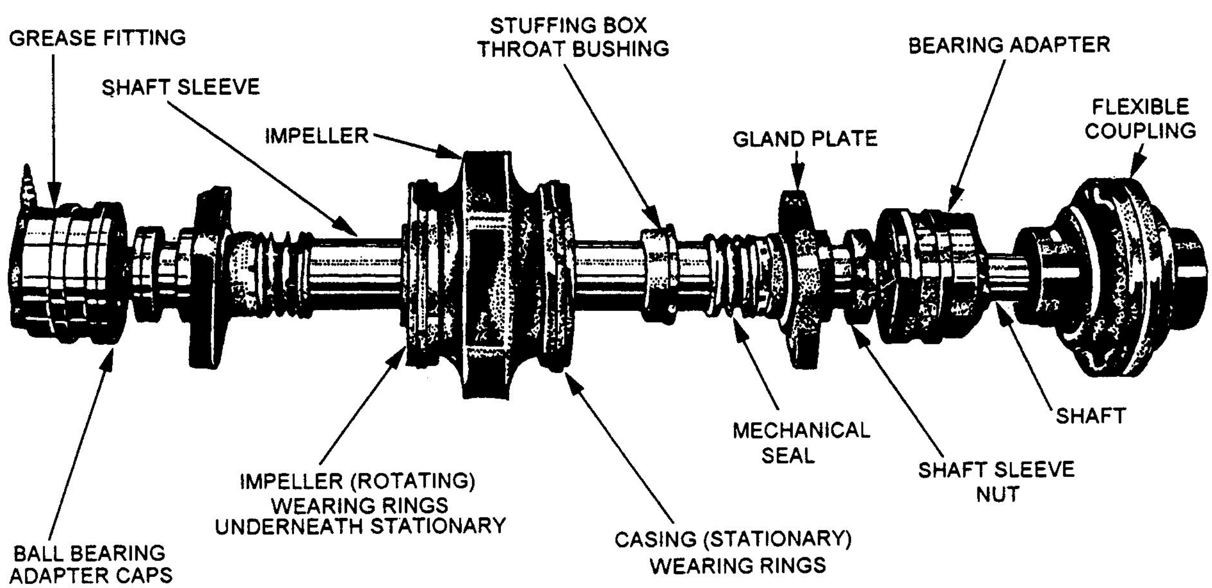


Figure 4-8.—Assembled rotating element.

of the pump are enclosed by bearing covers. The bearing covers prevent bearing grease from leaking out of the bearing cartridges. In addition, the bearing covers prevent dirt and water, or fuel from entering the bearing cartridges. The outside ends of the bearing cartridges are enclosed by bearing caps. A grease cup and a grease fitting are installed on both of the bearing caps to allow addition of grease to the bearings. Grease reliefs are also installed to release grease during heat expansion.

Flexible Coupling. —The flexible coupling is designed to allow for misalignment between the motor shaft and the pump shaft. The coupling hubs are keyed to both the pump and motor shafts and are lubricated to reduce wear in the coupling.

THEORY OF OPERATION. —The spinning impeller causes fuel to leave the discharge chamber of the pump. This creates a suction that causes a continuous flow of fuel to the pump. Fuel from the service tank simultaneously replenishes the fuel that leaves the suction chamber **as long as the pump has a positive suction head.** Centrifugal pumps WILL NOT draw a vacuum. Fuel in the suction chamber enters the center part of the impeller. The blades of the impeller propel the fuel toward the discharge chamber walls by centrifugal force. The expanding spiral shape of the discharge chamber slows the fuel which increases the pressure and creates a continuous flow through the pump. Flow is continuous as long as there is enough fuel at the suction side, air does not enter the pump, fuel discharge is not restricted, and the impeller rotates at the rated speed.

MAINTENANCE. —Maintenance on the JP-5 centrifugal service pump is done in accordance with PMS and the applicable technical manuals. Typical maintenance is discussed in the following paragraphs.

LUBRICATION. —The importance of proper lubrication of the ball bearings cannot be over-emphasized. But, it is possible to over-grease the bearings, which causes overheating and damage to the bearings. Additionally, the wearing rings and mechanical seals require JP-5 for lubrication. Running the pump dry will damage these parts.

WEARING RINGS. —Wearing rings should be inspected when the pump does not discharge at the rated capacity. They are replaced when the radial clearance stated in the pump's technical manual is reached.

MECHANICAL SEALS. —Mechanical seals require no maintenance, but should be replaced whenever leakage occurs, or when the sealing surfaces have been disturbed.

TROUBLESHOOTING. —Table 4-2 lists typical malfunctions, probable causes, and corrective action for the JP-5 service pump.

Rotary Vane

Blackmer is the most commonly used rotary vane pump in the JP-5 below decks system. These pumps come in different sizes with different operating capacities and are used as transfer pumps, auxiliary pumps, stripping pumps, and on the flight deck as defuel pumps. Each pump may vary slightly, but all are practically identical.

The Blackmer (fig. 4-10) is a positive displacement, rotary vane type pump. The pumps used for stripping are designed to pump 50 gpm at 50 psi. The pumps used

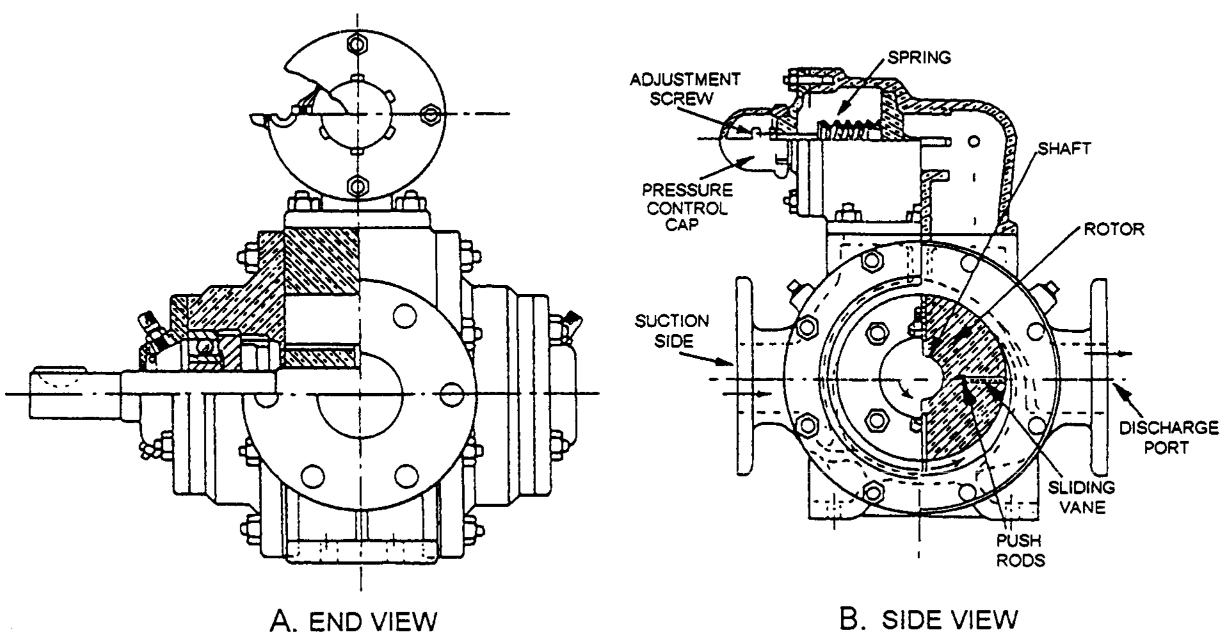


Figure 4-10.—Blackmer rotary vane pump: A. (End view); B. (Side view).

Table 4-2.—JP-5 Service-Pump Troubleshooting Guide

MALFUNCTION	PROBABLE CAUSE	CORRECTIVE ACTION
No fuel discharge from pump.	Impeller or suction line clogged.	Backflush pump to clear obstruction. Disassemble pump or suction line and remove obstruction.
Pump fuel discharge at reduced capacity or pressure.	Impeller or suction line partially clogged.	Backflush pump to clear obstruction. Disassemble pump or suction line to remove obstruction.
	Air leakage in mechanical seals.	Check mechanical seals. Replace defective mechanical seals.
	Wearing rings worn.	Replace defective wearing rings.
	Impeller damaged.	Replace impeller.
	Casing gasket defective.	Replace defective casing gasket.
Pump starts then stops fuel discharge.	Air leakage in mechanical seals.	Check mechanical seals. Replace defective mechanical seals.
Pump binding.	Impeller clogged.	Backflush pump to remove obstruction. Disassemble pump. Remove obstruction from impeller.
	Wearing rings worn or damaged.	Check wearing rings. Replace defective wearing rings.
	Impeller damaged.	Replace defective impeller.
	Pump and motor shafts misaligned.	Check pump and motor shaft alignment and alaign shafts.
	Pump shaft bent or warped.	Replace pump shaft.
	Bearings worn.	Check bearings. Replace defective bearings.
Pump noisy or vibrates excessively.	Pump bearings or motor bearings are worn.	Check defective pump or motor bearings. Replace pump or motor bearings.
	Impeller binding or obstructed.	Backflush pump to remove obstruction. Disassemble pump. Remove obstruction from impeller. Replace impeller.
	Pump and motor shafts misaligned.	Check pump and motor shaft alignment and align shafts.
	Pump shaft bent or warped.	Replace pump shaft.
	Mounting bolts loose or broken.	Tighten or replace mounting bolts.

for transfer are designed to pump 200 gpm at 50 psi. The typical rotary vane pump consists of a cylinder and head assembly, rotor and shaft assembly, and a pressure control valve.

CYLINDER AND HEAD ASSEMBLY. —The cylinder (pump casing) houses and provides a working area for the rotor and shaft assembly. The cylinder is machined to form an egg-shaped cylinder bore. The inlet and discharge ports are cast integrally with this section of the pump. The pressure control valve, located on the top of the pump, is cast integrally with the upper portion of the cylinder bore. Each side of the cylinder has machined recesses to ensure perfect fit of the cylinder heads.

The cylinder heads (fig. 4-1 1), one for each side of the pump, house the ball bearings and mechanical seals. An O-ring is installed between the cylinder heads and the cylinder to prevent leakage.

The ball bearings, located in the bearing housing within each cylinder head, support and ensure free rotation of the rotor and shaft assembly, and maintain the proper clearance between the rotor and upper position of the cylinder bore. A bearing cover, with a grease fitting at the top and a grease relief fitting at the bottom, is bolted to the end of each cylinder head.

The mechanical seal installed in each head prevents leakage of fluid along the shaft into the bearing housing. A telltale drain hole, located directly under the bearing housing, is provided on the underside of each head. These holes are intended to serve as an indication of leakage by the mechanical seal.

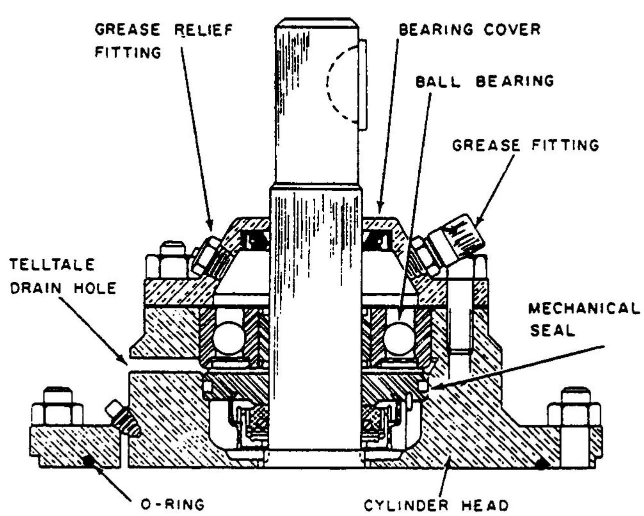


Figure 4-11.—Rotary vane pump cylinder head.

ROTOR AND SHAFT ASSEMBLY. —The rotor and shaft is a pressed fit assembly held in place by tapered pins. The rotor is centered in the upper portion of the oval shaped cylinder bore. The rotor has an even number of equally spaced slots that provide the working area for the sliding vanes. Holes are drilled through the rotor and shaft, one between each set of opposing slots, for the installation and working area of the push rods.

The sliding vanes are made of palamite. Relief grooves are provided on the forward face of the vanes to allow the escape of liquid trapped between the vanes and the slots in the rotor.

NOTE

The vanes must face the direction of rotation to allow the escape of fluids into the discharge port.

The pump shaft connects to a gear reducer shaft by a flexible coupling. The opposite shaft of the gear reducer is connected to the shaft of the drive motor, also by a flexible coupling. The purpose of the gear reducer is to mechanically reduce the motor rpm to match the rated rpm of the pump.

PRESSURE CONTROL VALVE. —The pressure control valve is provided to prevent buildup of excessive pressure that might damage the pump or associated equipment. When over-pressurization occurs, the valve directs fluid from the discharge side to the suction side of the pump. It is spring-loaded closed. An adjustment screw adjusts spring tension on the valve disc. Relief pressure is determined based on pump application and piping design. The adjustment screw has a locknut to lock it at the set pressure. The pressure control cap is screwed on the cover to protect the adjustment screw threads.

THEORY OF OPERATION. —The rapid rotation of the shaft and rotor forces the vanes in sliding contact with the cylinder bore by centrifugal force and by push rods. The passage of the vanes through the lower portion of the cylinder bore draws fluid into the pump, and at the same time, forces it out the discharge port. Rotary vane pumps are positive displacement pumps. This means they will pump air, which creates a vacuum, causing liquid to be pulled into the suction side of the pump.

MAINTENANCE. —Maintenance on the rotary vane pump is done in accordance with PMS and the applicable technical manuals. Typical maintenance includes the following:

LUBRICATION. As stated previously, proper lubrication is a MUST. But do not over-grease. After lubrication, a small amount of grease may escape from the grease reliefs under the head. This is normal. But, if grease continues to escape the grease relief fitting should be removed and inspected for damage, or the bearing removed and its grease shield inspected for damage. If grease escapes from around the pump shaft, the bearing cover should be removed and the lip on the shaft seal inspected for nicks, cuts, or distortion. Replace if necessary.

MECHANICAL SEALS. No maintenance required. Replace if leakage occurs.

HEAD O-RINGS. If leakage occurs between the head and the cylinder, the head should be removed and both machined faces inspected for burrs, a cut or damaged O-ring, or other imperfections. If the O-ring is damaged in ANY way, replace it.

VANES. If the vanes are excessively worn, swollen, or jamming in the rotor slots, replace them.

PRESSURE CONTROL VALVE ADJUSTMENT. Line up the suction side of the pump to a storage tank, opening the required valves. Make sure the pump discharge valve is closed. Start the pump, remove the protective cap, and loosen the locknut. Turn the adjustment screw until the desired pressure is indicated on the discharge pressure gage. Tighten the locknut, replace the protective cap, stop the pump, and secure the suction side piping.

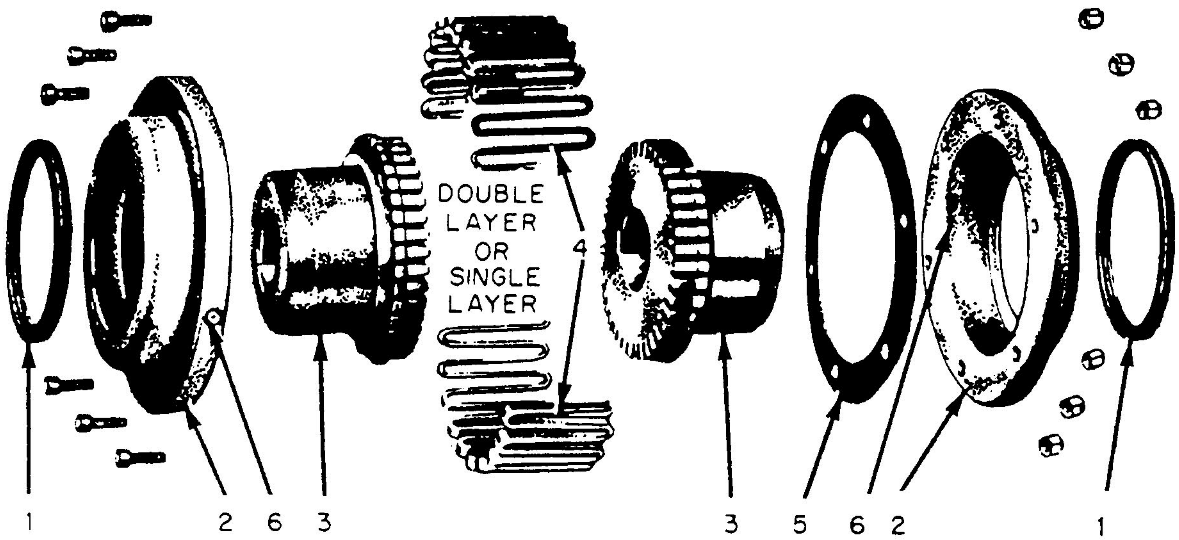
TROUBLESHOOTING. —Table 4-3 lists typical malfunctions, probable causes, and corrective action for rotary vane pumps.

PUMP COUPLINGS

All aviation fuel pumps are equipped with a type of flexible coupling. This coupling allows connection of the pump and motor (or gear reducer) shafts with a minute amount of misalignment. The flexibility of the

Table 4-3.—Rotary Vane Pump Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	REMEDY
Pump does not deliver or delivers below rated capacity.	Worn vanes. Worn heads or discs. Leaking through P/C valve.	Replace all vanes. Replace heads. a. Lap in valve seat. b. Foreign matter under valve seat. Remove. c. Valve worn out. Replace. d. Spring setting too low to hold valve shut at desired pressure. e. Valve seat worn out; replace cylinder or casing.
	Worn rotor ends. Defective bearing.	Replace rotor. Replace ball bearings.
Evidences of excessive leakage at tell-tale drain holes in heads.	Defective mechanical seal at end evidencing leak.	Replace seals as required.
Excessive grease leakage around pump shaft.	Defective grease seal.	Replace seals as necessary.



1. Seal rings
2. Cover halves
3. Hubs
4. Gridmembers
5. Gasket
6. Alemite grease fittings

Figure 4-12.—Falk Type-F Steelflex coupling.

coupling is normally gained from a gear, a spring arrangement, or a rubber insert between the coupling halves. Depending on the type of coupling, lubrication may or may not be required.

Falk Type-F Steelflex Coupling

This coupling (fig. 4-12) is a flexible, self-aligning, gridmember coupling. The two hubs are symmetrical, but may have different bores or keyways. One hub is keyed to the motor shaft, and the other hub is keyed to the pump shaft and secured axially by set screws. A flexible gridmember engages the teeth in the hubs to transmit power. A gasket and two seal rings are fitted to the covers to prevent grease leakage. The parts are enclosed in two cover halves that are bolted together.

When it is necessary to disconnect the coupling, remove the nuts and bolts, separate and draw back the cover halves, and remove the gridmember. To remove the gridmember, a round rod or screwdriver that conveniently fits into the open loop ends of the gridmember is required. Begin at the open end of the gridmember section and insert the rod or screwdriver into the loop ends. Use the teeth next to each loop as a fulcrum and pry the gridmember out radially in even, gradual stages. Proceed alternately from side to side lifting the gridmember about halfway out until the end of the gridmember is reached. Using the same procedure again, lift the gridmember until the teeth are cleared. This separates the coupling hubs.

Before reassembly, clean all parts thoroughly and check the coupling alignment in accordance with the pump's technical manual.

After the coupling is aligned, carefully insert the gasket between the hubs and hang it on either hub. Do not damage the gasket. Next, force as much lubricant as possible into the space between the hubs and grid-member grooves.

Insert the gridmembers. To accomplish this with a minimum amount of spreading, start the gridmember at either end and tap the rungs only part way into the grooves. After all the rungs are partially in their respective grooves, tap the gridmember all the way into place. The hub grooves on each hub are uniformly spaced and do not require matching. Again pack lubricant in the spaces between and around the gridmember, then wipe off the excess flush with the top of the gridmember. Lightly oil the hubs to ease the sliding of the covers onto the hubs. Mount the covers so the lubrication fittings are 180 degrees apart. Insert a screwdriver under the seal ring for venting purposes and then tighten the cover bolts. Remove the screw-driver, check the seal rings for proper seating, and align the cover to prevent wobble.

Lovejoy Coupling

The Lovejoy coupling (fig. 4-13) mechanically links the shaft of the pump to the shaft of the motor (or gear reducer). The coupling is made of two bronze coupling halves. The coupling is keyed to the shaft and held in place by socket-head setscrews. The coupling halves are cushioned by a formed rubber spider that separates the coupling halves. This rubber separation reduces wear on the coupling halves.

When the reassembly of any component of the pump unit involves re-coupling, the coupling should be checked for misalignment using a straightedge and feeler gage. As different pumps have different size couplings that require different clearances, consult the specific pump technical manual for proper clearance of your specific coupling. When adjusting the couplings, make sure each section of the coupling is tightly anchored to its respective shaft and that both sections are butted together with the correct space (according to the specifications in the technical manual) between the coupling sections and the rubber spider. The Lovejoy coupling requires no lubrication.

Rex Chain Coupling

The Rex chain coupling mechanically links the shaft of the pump with the gear reducers on motor driven stripping pumps. Each shaft has a toothed gear attached and, when both shafts are aligned, a chain is placed around both gears, connecting both halves. It resembles small bicycle sprockets placed side by side with a double wide chain connecting the two.

Although periodic inspection and lubrication are required, the main advantage is its ease of removal and alignment. The gears and chain are steel and can break if hit with a hammer. Therefore, do NOT use force. When installing a Rex chain coupling, if you feel force is needed, you are doing something wrong.

VALVES

Several types of valves are used in the JP-5 systems. Typically, the valves used in the filling and transfer system are of the gate type. Most discharge valves on pumps are of the globe type. Distribution piping may contain gate, globe or butterfly. Newer ships may have limitorque valve operators in their system. In the following paragraphs, we will discuss the various type valves, their description and construction, and their normal use. Know the type of valves in your system and their location.

Gate Valves

A gate valve (fig. 4-14) is used where a straight flow with a minimum amount of restriction is desired.

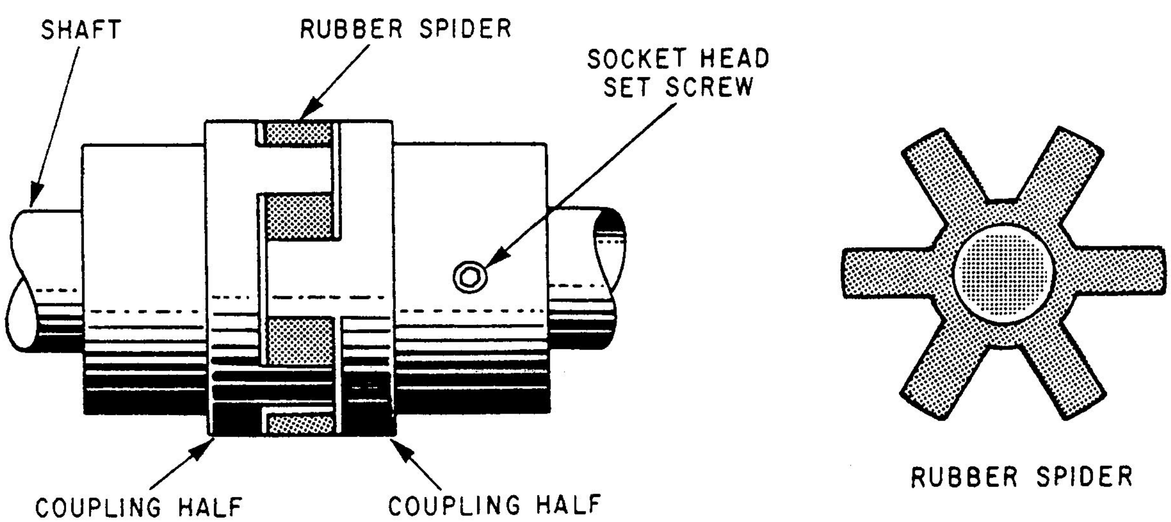


Figure 4-13.—Lovejoy coupling.

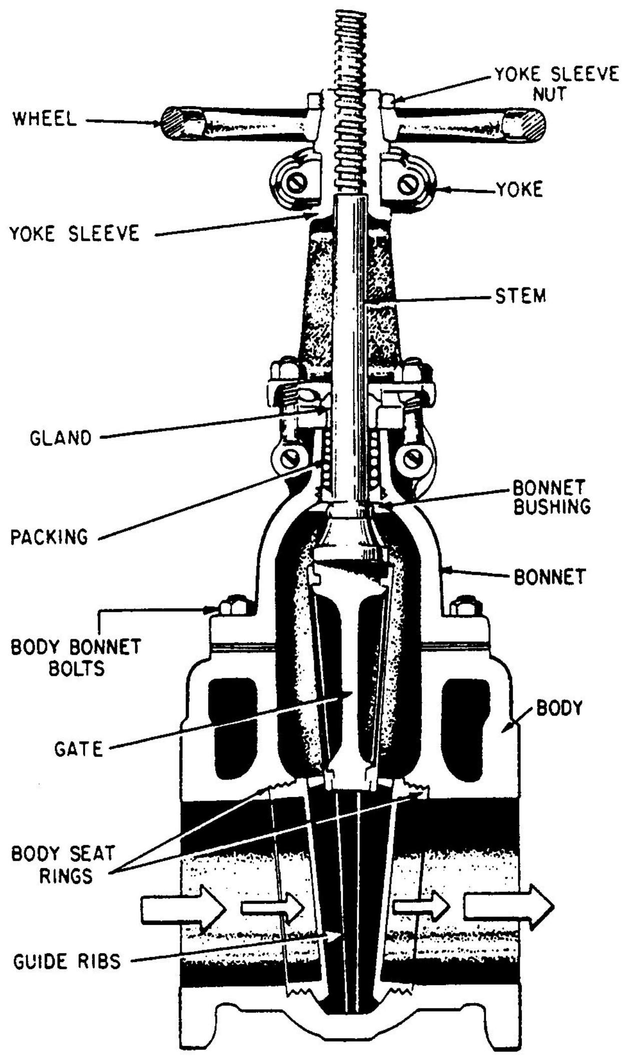


Figure 4-14.—Gate valve.

Gate valves are not designed for and cannot be used for throttling. Most gate valves have a wedge-shaped gate, but some have a gate of uniform thickness. The gate is connected to the valve stem and is positioned by rotating the handwheel. The port is the full size of the pipe and extends through the valve.

Some types of gate valves have a rising stem, and a glance at the valve will tell whether it is open or closed. In the type of valve with the nonrising stem, the stem revolves in the bonnet and the gate is raised or lowered by the threads on the internal end of the stem. On this type of valve, a pointer is usually in-stalled to indicate the open or closed positions.

Gate valves operate properly with either face on the inlet side, thus simplifying installation. Case or forged steel valves have disks and seats made of nickel-copper alloy, chromium steel, or a steel treated with a hard facing material. Valve stems are made of corrosion resistant steel. Handwheels are made of fabricated steel, brass, or aluminum. Except for malleable iron or aluminum handwheels, bronze gate valves are made entirely of bronze.

NOTE

It is a good practice to put a gate valve back together the same way it came apart. Although the valve operates with either face on the inlet side, after installation and use in a specific flow pattern, one side of the valve may wear a little differently from the other. To ensure a tight fit and smooth operation, put it back the same way it came out.

Globe Valves

Globe valves (fig. 4-15) are so called because of the globular shape of their bodies. It must be noted

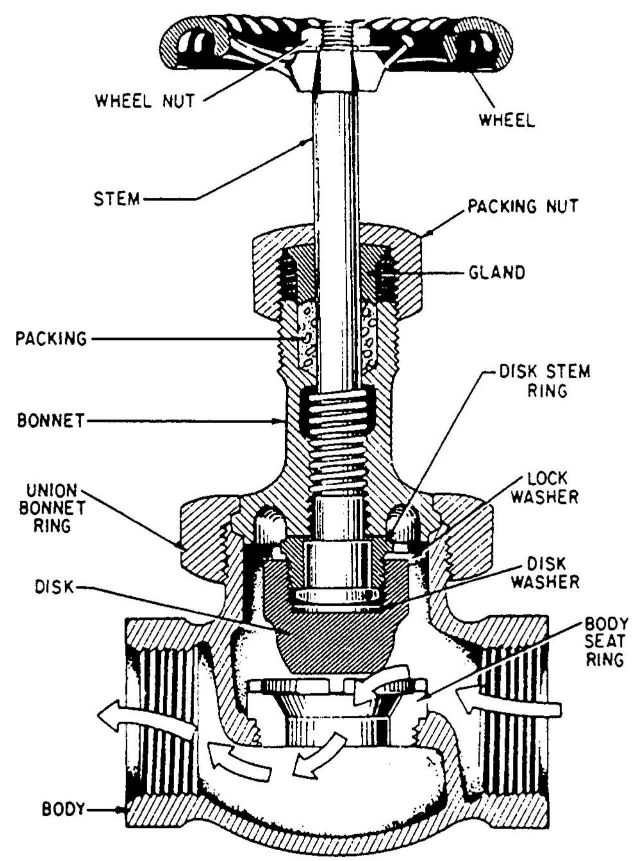


Figure 4-15. —Globe valve.

that other types of valves also may have globe shaped bodies. Therefore, the name does not always describe the valve properly.

In a globe valve, the disk is attached to the valve stem and seats against a seating ring or seating surface that shuts off the flow of fluid. When the disk is moved off its seat, fluid can pass through the valve. Globe valves may be used to limit fuel flow through the valve (called throttling) by partially opening the valve to meet the desired flow. Globe valves are most commonly found on pump discharges, tank manifolds, JP-5 purifier discharges, and any other place where there is a need for throttling fuel flow.

Globe valve inlet and outlet openings are arranged in several ways and are used to suit the requirements of the flow. There are three common types of globe valve bodies. In the straight body, the inlet and outlet openings are in line with each other. In the angle body, the inlet and outlet openings are at an angle to each other. The cross globe valve has three openings instead of two, and is frequently used in connection with bypass piping.

High Performance Butterfly Valves

The high performance butterfly valve (fig. 4-16) used in the JP-5 system is designed specifically for flammable liquids or other hazardous materials. If a fire guts a piping system or space where these valves are located, and the fire is hot enough to melt a special sealing element, a secondary metal sealing takes place providing effective shut-off of fluid flow through the piping. No feeding of the fire can take place.

The high performance butterfly valve has a single-piece flexible polymeric seat that is pressure energized to assure positive shutoff. The seat is so designed that is compensates for pressure and temperature changes as well as for wear. The design also allows no metal to metal contact during regular operations. Also contributing to the valve's effectiveness is its offset shaft and eccentric disk design that impart a camming action to the disk. This feature causes the disk to swing completely out of contact with the seat upon opening, eliminating wear points at the top and bottom of the seat.

This arrangement allows replacement of the valve seat, if it is ever required, by simply removing the body insert and then replacing the seat. You do not have to disassemble the shaft or disk. With no

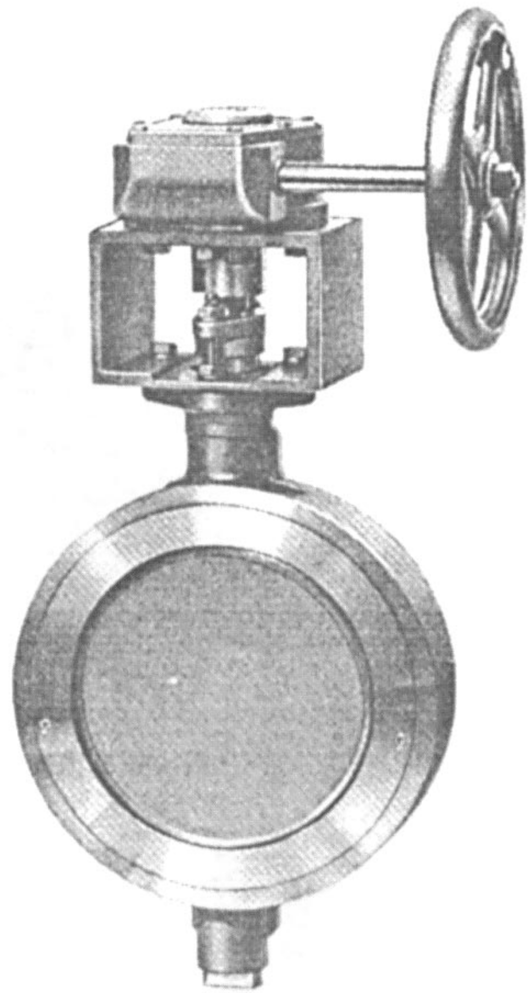


Figure 4-16.—High performance butterfly valve.

requirement to remove the shaft and disk, repair time is cut dramatically.

As with the gate valve, the high performance butterfly valve allows fluid flow in either direction. High performance butterfly valves are normally used as isolation valves in distribution piping, but they may be used nearly anywhere.

Limitorque Valve Operators

On newer CVNs, numerous valves have limitorque valve operators. Limitorque valve operators (fig. 4-17) open and close gate and globe valves from a remote location, usually the pump-room console (which will be discussed later in this chapter).

Each limitorque, in addition to operating a valve, also controls and limits the opening and closing travel of the valve. A torque limit switch on the limitorque protects all operating valve parts from overload by

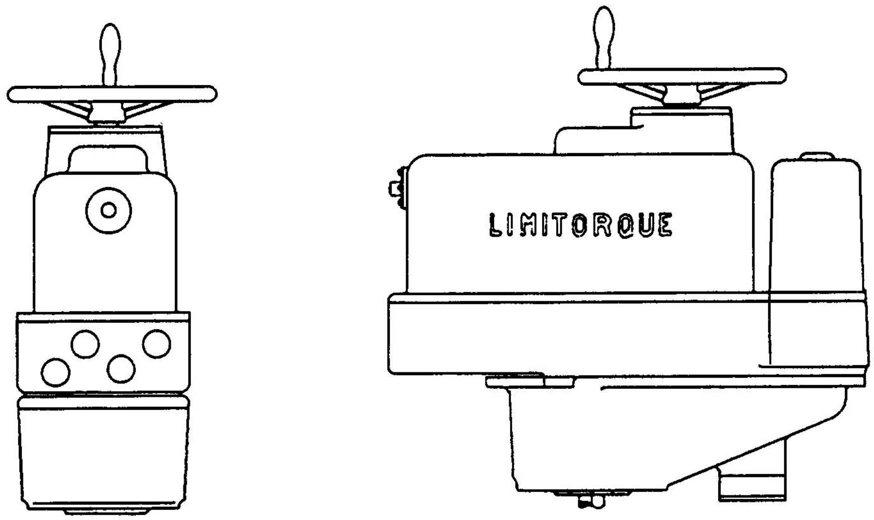


Figure 4-17.—Limitorque valve operator.

limiting the torque and thrust loads applied to the valve. It also provides a constant seating thrust, thus assuring the valve is tight on each closure. This seating thrust can be varied by a fine adjustment on the torque limit switch. The torque limit switch operates and disconnects the source of motive power should an obstruction be met while the valve is being closed.

Limit switches on the limitorque govern valve disk travel in the opening and closing directions of valve stem travel. The switches also operate position indicator lights for both the open and closed position of the valve. In case of motor failure, the limitorque unit can be operated manually by use of the handwheel. To prevent accidental operator injury, a motor declutch mechanism disengages the handwheel when the motor is energized.

Limitorque valves may be used in the following areas:

— Valves in manifolds serving JP-5 storage tanks

— Valves for filling JP-5 service tanks

— Valves taking suction from JP-5 service tanks

— Selected cut-out valves in all three sub-systems

— Selected valves in the drainage and ballast system

To the ABF, the limitorque valve operator is a valuable asset as long as it is operating and used correctly.

Swing Check (One-Way) Valves

Swing check valves (fig. 4-1 8) are designed to prevent back flow by allowing fluid transfer in only one direction in the piping systems.

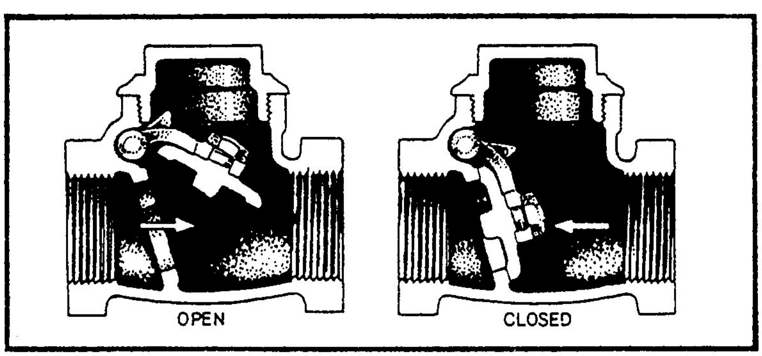


Figure 4-18.—Swing-type check valve.

Swing check valves use a disk that is attached to the valve body by a pinned hinge and is closed by gravity during a no-flow condition. This type valve is sometimes designed with a spring to assist closing the valve. Pressure caused by flow forces the hinged disk up to open the valve. But, pressure in the opposite direction will force the hinged disk back on its seat to close the valve.

The proper positioning of the valve, with reference to the horizontal, is very important to ensure proper check valve operation. Since the downward force of gravity is necessary for proper operation, a check valve installed upside down or at any angle other than horizontal may not function as intended. Also, since this valve allows flow in only one direction, it must be installed correctly. Most check valves will have a flow direction arrow on the body. If no arrow is visible, the inlet side of the valve will be the side with the hinge pin.

VALVE MAINTENANCE

All valves require proper care and maintenance, as does other more complex equipment, to ensure they are kept in optimum working order. The principle difficulties encountered with valves are leakage past the seat and disk, leakage at the stuffing box, sticking valve stems, and loose valve disks.

Losses due to leakage that is not corrected mount up considerably over time. For example, over a period of a month, a small 1/32 inch hole would waste 69.552 cubic feet of air at 100 psi, 3,175 pounds of steam at 100 psi, or 4,800 gallons of fuel at 40 psi. The ABF should know how to prevent and correct these faults.

Valve Leakage Causes and Remedies

Valve leakage, generally caused by failure of the disk and the seat to make close contact, may result from any of the following:

—Foreign substances, such as scale, dirt, or heavy grease lodged on the valve seat may prevent the disk from being properly seated. If the obstructing material cannot be blown through, the valve has to be opened and cleaned.

—Scoring of the valve seat or disk, which may be caused by erosion or by attempts to close the valve on dirt or scale, results in leakage. If the damage is minimal, the valve may be restored to proper working order by grinding. If the damage is more extensive, the valve must be reseated and then ground.

—A warped disk may result if the guides fit too tightly, if the spindle guide is bent, or if the valve stem is bent. Using a valve disk or body that is too weak for the purpose for which it is used permits distortion of the disk or seat under pressure. If this occurs, replace the valve.

Packing Gland Leakage

Packing gland leaks can be remedied by tightening the gland or repacking it. But, the gland must not be tightened nor packed so tightly that the stem binds. If the leaks persist after either or both of the remedies are applied, a bent or scored valve stem may be the cause.

Packing for the valve may be either of the string type or of the ring type. String packing is ordinarily used for small valves in low-pressure systems. Ring packing is used for large valves and for all high pressure valves. When replacing the packing on any type of valve, be sure to use the correct size and type. The packing must be large enough to fill the space between the valve stem and the packing box. It also must be made of material that is suitable for the pressure and temperature to which it will be exposed.

To pack a valve with string packing, place successive turns of packing in the space around the rod. Bevel off the ends of the packing to make a smooth fit and tighten the packing gland nut or the bonnet nut to compress the packing. String packing should always be wound in the same direction as the gland nut is to be tightened so tightening the nut does not cause the packing to fold back upon itself. To pack a valve with ring packing, cut the ends of the rings square and even so they make a level butt joint. Be sure to stagger the joints in successive rings.

In some gate, globe, and one-way check valves, the packing gland may be repacked under pressure, when necessary. These valves are constructed with the stem back-seated against the bonnet when the valve is wide open. High-pressure valves are provided with a pressure leak-off connection. The pressure leak-off connection is sealed to the outside with a pipe plug. Extreme care should be taken to see that the valve is firmly back-seated before the plug is removed. **Normally, repacking valves under pressure is NOT done by an ABF. If a valve must be repacked under pressure, ensure ALL SAFETY PRECAUTIONS are followed.**

Sticking Valve Stems

There are several of conditions that may cause valve stem troubles. If the packing is packed too tightly, or if the gland nuts are tightened unevenly, the valve stem is likely to stick or bind. Backing off on the gland nuts relieves the packing pressure. Paint or rust on the valve stem, which also causes binding, can be removed by cleaning the stem.

The valve may become stuck if the valve stem threads are burred from rough handling or upset from pressure that has been applied to move sticking and tight valves. Distorted or burred valve stem threads are very serious valve troubles. If the valve cannot be moved by any other method, the bonnet must be re-moved, the stem cut out of the yoke or bonnet, and a new stem made. If the bonnet or yoke is damaged, it also must be repaired or replaced. If burred or upset threads are detected before the stem becomes stuck, they can be dressed smooth with a file or machined in a lathe. If the sticking is due to a bent valve stem. the stem must be straightened or replaced.

MANIFOLDS

Manifolds are an integral part of the JP-5 below decks systems. They consist of several valves mounted in a compact unit, which provides a means of controlling the flow of JP-5 to and from several tanks at one central location.

Double-Valved Manifolds

Double-valved manifolds (fig. 4-19) control the flow of JP-5 to and from storage tanks that are designated storage or ballast. They give double protection against contaminating the transfer main when the storage tanks are filled with seawater by having two valves for one tanktop. These valves are known as the transfer mainside valve and the tankside valve.

The manifold HEADER is a section of pipe with several equally spaced holes in the top to accommodate the transfer mainside valves. It is sealed on both ends and has a pipe flange welded to the bottom. This pipe flange is bolted to a section of pipe leading off the transfer-main branch header.

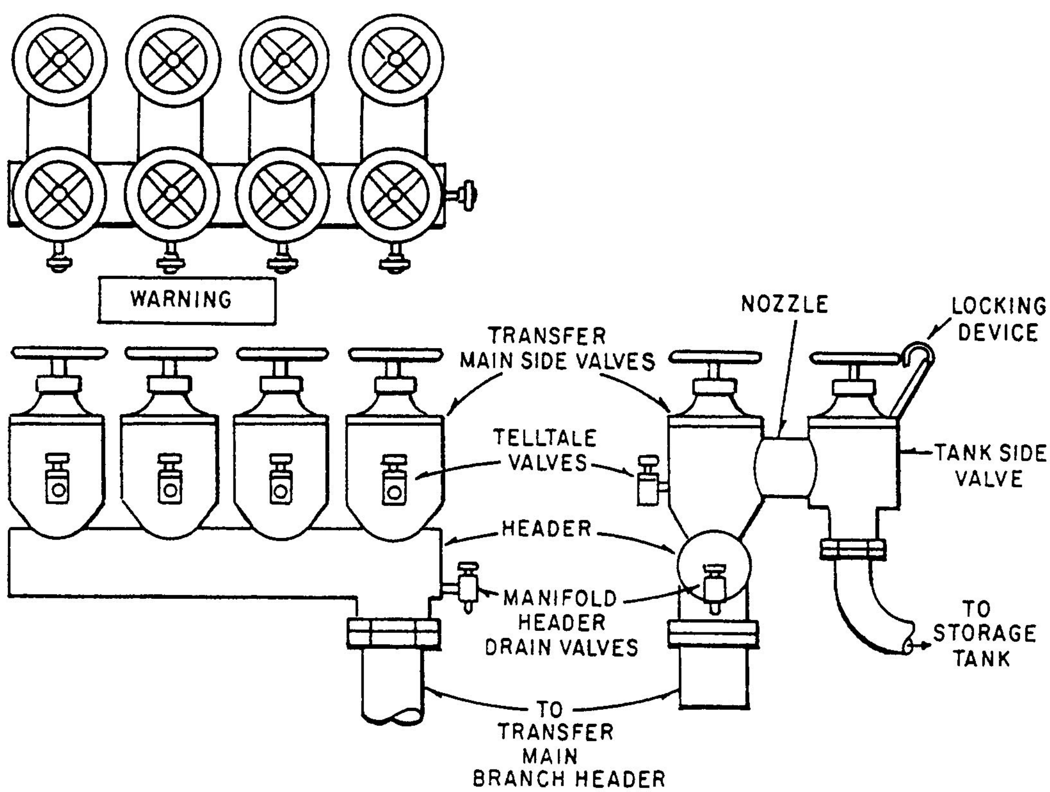
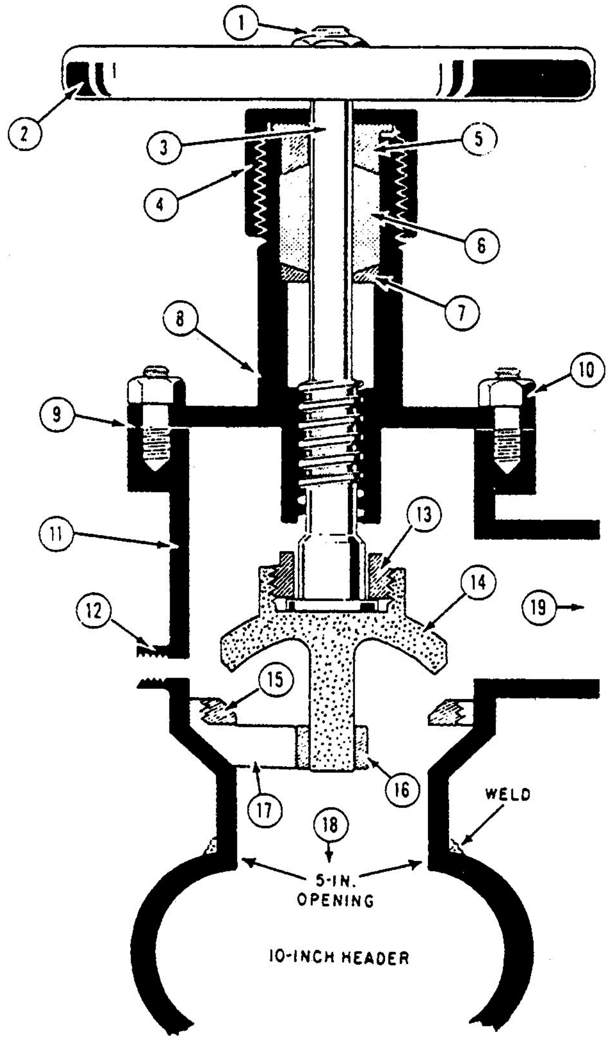


Figure 4-19.—Double-valved manifold.

The transfer mainside valves are specially designed globe valves that are welded to the top of the manifold header (fig. 4-20). They are cylindrical in shape (about 10 inches in diameter) and consist of a body and bonnet. The body houses the seat ring and a guide for the valve disk. Perfect seating of the valve disk with the seat ring is assured by the disk guide centered in the base of the valve body. The lower section of the valve body is welded to the manifold header. A hole is machined in the back of the valve body (above the valve seat) for attaching the nozzle. On the front of the valve body, a hole is drilled and tapped (also above the valve seat) for installing the telltale valve. The bonnet, which provides a working area for the stem, is bolted to the top of the valve body. Leakage of JP-5 is prevented by a gasket between the valve body and bonnet, and packing in the bonnet packing gland around the stem.



1. Handwheel nut
2. Handwheel
3. Valve stem
4. Packing gland nut
5. Gland
6. Stem packing
7. Gland ring (throat bushing)
8. Bonnet
9. Bonnet gasket
10 Bonnet studs and nuts
11. Valve body
12. Connection for telltale valve
13. Disk nut
14. Replaceable disk
15. Replaceable seat ring
16. Disk guide
17. Disk guide ribs (3 equally spaced)
18. Connection (to manifold header)
19. Nozzle (to tank-side valve)

Figure 4-20.—Transfer mainside valve (cutaway).

The tankside valve is identical to the transfer mainside valve, except there is no telltale valve connection and the bottom of the valve body is fitted with a standard pipe flange. The storage tank fill and suction tail pipe that the valve serves is bolted to this flange.

The nozzle is a short section of pipe connecting one transfer mainside valve to one tankside valve in parallel so the two valves serve only one tank.

The telltale valves are small, angle type globe valves installed on the front side of the transfer mainside valves.

NOTE

Most ships are replacing the telltale valve with a GAMMON sample connection. The GAMMON sample connections are less likely to break or leak, and require no maintenance.

There is one telltale valve for each set of manifold valves. These valves are installed on the front side of the transfer mainside valves, above the valve seat. They are used to determine the condition of the valve seats. The telltale valves should be opened periodically. If fuel leaks from the valve, it is an indication either the transfer mainside or the tankside valve is leaking. Both should be inspected as soon as possible and the leaking valve repaired.

The manifold header drain valve is installed at the bottom near one end of the header. It is used to drain the header before maintenance.

A locking device is installed for each of the tankside valves. It is typically a bar with a rotating hook to fit around and locked to the tankside valve handle. It is arranged so the valve can only be locked in the closed position. Tankside valves MUST be locked in the closed position when the tanks are ballasted.

Single-Valved Manifolds

Single-valved manifolds (fig. 4-21) control flow of JP-5 to and from storage tanks designated either JP-5 or JP-5 overflow. These ranks are not ballasted. Single-valved manifolds are also used in the service pump recirculating lines to recirculate fuel back to the service tank, and as tanktop valves in the stripping system.

The single-valved manifold is nearly identical to the tankside half of the double-valved manifold with one major exception. Instead of the nozzle connecting it to a transfer mainside valve, the nozzles in a single valve manifold connect to each other. There is NO transfer mainside valve. A minor difference is single-valved manifolds come in different sizes, based on intended use. A 90-degree ell flanged on one end is used to bolt the single-valved manifold to its respective branch header.

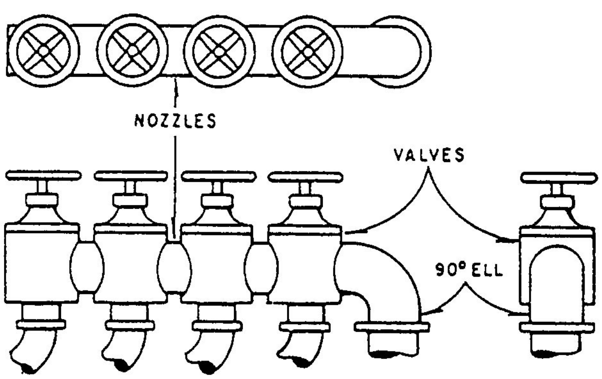


Figure 4-21.—Single-valved manifold.

Flood and Drain Manifolds

Flood and drain manifolds are located in the strip-ping system between the single-valved stripping manifolds and the stripping pumps FOR TANKS DESIGNATED AS JP-5 OR BALLAST only. They are designed to direct the flow of liquids to and from the JP-5 storage tanks during the following operations from one central location:

When designated tanks are ballasted, they direct the flow of sea water from the sea chest supply riser to the single-valves stripping manifold.

When designated tanks are deballasted, they direct the flow of ballast water from the single-valved stripping manifold to the main drainage eductor.

When the designated tanks are stripped, they direct the stripped liquids from the single-valved strip-ping manifold to the suction side of the stripping pumps.

A flood and drain manifold (fig. 4-22) consists of a manifold header and three globe type shutoff valves.

The manifold header is a common valve body for all three valves. It contains three valve seats and forms an unrestricted passage between the three valves above the valve seats. One end of the header is bolted to the single-valved stripping manifold. The other end is sealed. The upper part of the header houses the valve bonnet, which provides a working area for the valve stem. A gasket is installed between the bonnet and the header. A packing gland in the valve bonnet prevents liquids from leaking around the stem. The lower part of the header, below the valve seats, has

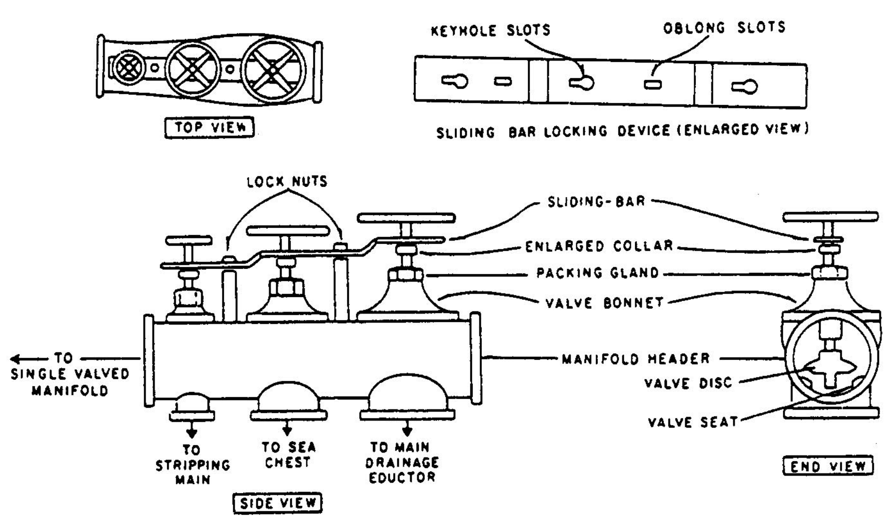


Figure 4-22.—Flood and drain manifold.

three flanged pipe connections, one for each of the three valves.

The stripping line installed just below the stripping valve seat interconnects the flood and drain manifold with the stripping main. This line is used only to direct stripped liquids from the bottom of the JP-5 storage tanks, by way of the single-valved stripping manifold, to the suction side of the stripping pumps.

The center line, installed just below the seat of the sea chest cutout valve interconnects the manifold to a sea chest supply riser. It is used only to direct sea water from the sea chest to the storage tanks during ballasting.

The other line, installed just below the seat of the main drainage eductor valve, interconnects the manifold to the suction side of a main drainage eductor. This line is used only to direct ballast water from the storage tanks to the main drainage eductor when the tanks are being deballasted.

The flood and drain manifold has a locking assembly that allows only one valve to be opened at a time. Therefore, only one operation can be conducted at a time; stripping, ballasting, or deballasting.

Each valve stem has an enlarged collar that engages a sliding-bar locking assembly. Two of the valves are always locked in the closed position. The sliding-bar is actually a long piece of metal containing three keyholes and two oblong slots. It is held in place by two locknuts on a threaded bracket, extending up from the manifold. To open a valve, the sliding-bar must be moved so that the enlarged collar of the valve

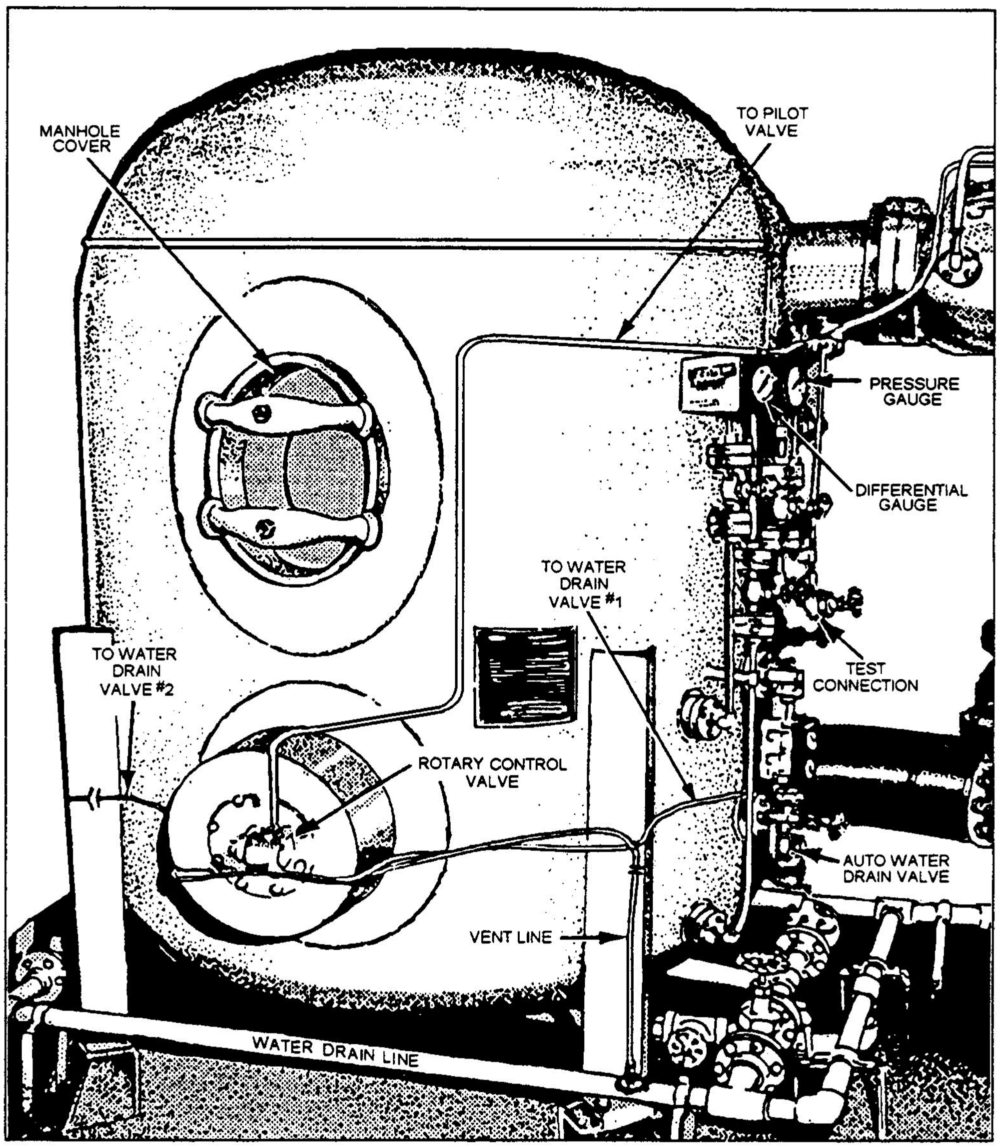


Figure 4-23.-Service fuel filter (vertical).

stem of the valve to be opened is centered under the circular part of the keyhole slot. The three keyhole slots are arranged in the sliding-bar to allow the opening of only one valve at a time. To position the sliding- bar, loosen the two locknuts and slide the bar through the oblong slots to the desired position and tighten the nuts.

SPRAY SHIELDS

Aluminized glass cloth spray shields are designed to prevent JP-5 from spraying on a hot surface or electrical equipment, or forming an atomized mist in the event of a gasket or strainer leak.

In main and auxiliary machinery spaces, spray shields are installed on flanged valve (and valve manifold) bonnets, and flanged joints (including gage lines) on piping containing flammable fluid. For areas outside main and auxiliary machinery spaces, spray shields are installed on flammable fluid piping flanged valve bonnets and flanged joints located in the direct plane of an electrical switchboard, electrical equipment enclosure, or motor.

In the event repairs are required to piping or valve flanges that are covered with spray shields, do NOT reuse spray shields that have fuel on them.

FILTER/SEPARATORS

There are several different types of filters in use in the service and transfer systems in the fleet. But, their principle of operation and hydraulic controls are similar. The major differences are their physical shape and flow direction.

Filters are designed to remove 98% of all solids and 100% of all entrained water from the fuel passing through them. This is accomplished in a two-stage operation by two separate faltering media installed within the filter shell. The first stage consists of a bank of COALESCING elements, surrounded by a hydrophobic screen, that performs the function of removing solids and coalescing water. Coalescing means the bringing together of fine particles of entrained water to form large droplets that then fall out of the fuel by gravity. The second stage consists of a bank of SEPARATOR elements that perform the function of repelling the coalesced water droplets that were too small to fall out by gravity.

The filter is equipped with a float operated rotary control valve that will automatically drain the accumulated water from the filter sump and shut off the filter discharge if more water accumulates than can be drained off automatically. This section will describe typical filter/separators, their operation and maintenance, and their automatic control devices.

Main Fuel (Service) Filters

The body of the main fuel filter (fig. 4-23) consists of a cylindrically shaped shell with a dome-shaped head welded on each end. The dome-shaped heads provide a uniform flow into and out of the filter. The interior of the filter is divided into an inlet, fall-out, and outlet (clearwell) by tube sheets.

TUBE SHEET.— The tube sheets are circular metal bulkheads installed within the filter shell where the dome-shaped heads are attached to the cylindrical shell. They are welded throughout their circumference to form a leakproof partition between the inlet, fallout, and outlet chambers of the filter. The tube sheets also provide the means of installing the filter element mounting assemblies (both coalescer and separator). Threaded holes, one for each assembly, are symmetrically arranged over the tube sheets surface.

ELEMENT MOUNTING ASSEMBLY.— The element mounting assembly (fig. 4-24) consists' of a perforated metal standpipe about 1 inch in diameter and 24 inches in length, and an end cap. One end of the standpipe is fitted with a threaded base cap to enable screwing it into the tube sheets. The opposite end is fitted with a threaded plug for attaching the end cap. The end cap is a metal disk about the same diameter as the elements.

After the filter element has been placed over the standpipe, the end cap is secured in place by a threaded bolt. A metal washer and fiber washer are provided

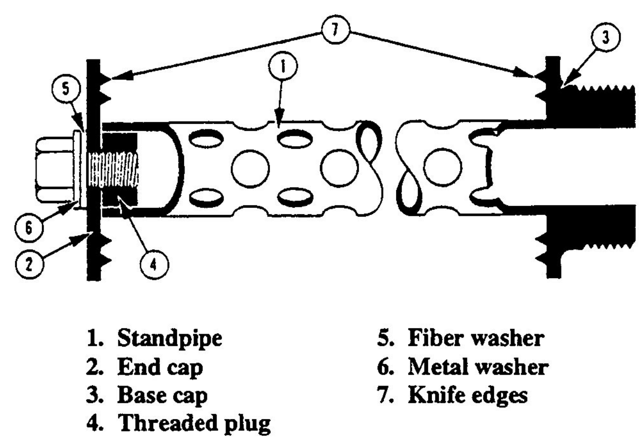


Figure 4-24.—Element mounting assembly.

between the threaded bolt and end cap to prevent leakage at this point.

Both the base cap and the end cap have projecting knife edges. When the elements are mounted on the standpipes, the projecting knife edges are forced into the synthetic rubber gaskets on each end of the elements, forming a tight seal.

COALESCING ELEMENT.— The coalescing element is a cylindrical unit 24 inches long and 3 5/8 inches in diameter. It consists basically of a pleated paper element encased by fiberglass wrappings. The fiberglass is held in place by a cloth sleeve. Each end has a synthetic rubber gasket to form a tight seal and ensure flow through the element when mounted. Flow through a coalescer element is inside to outside.

SEPARATOR ELEMENT.— The separator element has practically the same dimensions as the coalescer, but it is constructed of a different material. It consists basically of a perforated inner brass core cover with a 200-mesh, monel, Teflon-coated screen. This screen is enclosed by an additional aluminum screen. Separator elements are considered permanent and only require cleaning, unless they are damaged, in which case they must be replaced. Flow through a separator element is outside to inside.

Installing Elements.— To install an element on the element mounting assembly, proceed as follows:

1. Make sure the gaskets are in place, then slide the element over the perforated standpipe.

2. Attach the end cap, with metal and fiber gasket in place, and install the threaded bolt fingertight.

3. Center the element on the mounting assembly, and tighten the end cap bolt. The bolts should be torqued to 12 foot-pound or 144 inch-pound.

4. Check the element for tightness.

FILTER INLET CHAMBER.— Fuel enters the filter initially at the inlet chamber. This chamber of the filter is dome-shaped to provide a uniform flow of fuel to all coalescing elements simultaneously. From the inlet chamber the fuel passes through the tube sheet into the coalescing elements in the fallout chamber.

FALLOUT CHAMBER.— The fallout chamber is the center section of the filter shell. It is the largest of the three filter chambers. This area of the filter is provided to allow the coalesced water to fall out of the fuel stream by gravity as it flows from the coalescer elements to the separator elements. Both sets of filter elements are installed in this chamber.

The fallout chamber also contains a manhole cover, filter vent line, and water receiving sump.

The coalescing stage is the first stage of filtration. It consists of a number of individual coalescer elements mounted in symmetrical arrangement on the inlet tube sheet. The fuel leaving the inlet chamber must pass through these elements from the inside to outside before entering the fallout chamber. As the fuel passes through the elements, they perform the dual function of removing solid contaminants from the fuel and coalescing water.

A bolted manhole cover with gasket is installed on the side of the filter shell. This opening is provided to allow personnel to gain entrance to the fallout chamber for replacing elements and maintenance.

A filter vent line is installed at the extreme top of the fallout chamber. This line, fitted with a bull's-eye sight glass, two shutoff valves (one on each side of the sight glass), and a one-way check valve, directs fuel back into the contaminated settling tanks or overboard. The filter is vented until a solid stream of fuel is observed in the sight glass.

The separator stage is the second stage of filtration. It consists of a number of individual separator elements mounted in symmetrical arrangement on the outlet tube sheet.

Fuel leaving the fallout chamber must pass through the separator elements from the outside to the inside before entering the outlet chamber. As the fuel passes through these elements, they repel the final traces of water from the fuel stream. In addition to this primary function, the separator elements also serve as a final filter if one or more coalescer elements rupture. But, separator elements can only filter solids larger than 10 microns.

Water Receiving Sump.— The filter sump is located at the bottom of the filter vessel. The sump receives the water that has been separated from the fuel.

A reflex type sight glass is installed on one side of the sump for observing the water level within. Shutoff valves are installed in the connecting piping for isolating the sight glass during maintenance.

Centrally located on the side or the bottom of the sump is a flanged opening to which is bolted a rotary control valve. This valve is attached to, and mechanically operated by, a ball float housed within the filter sump. The float-operated rotary control valve is a part of the filter automatic hydraulic device. It will be explained in detail later in this section.

OUTLET CHAMBER (CLEARWELL).— This section of the filter is commonly called the "clear-well" because the fuel here is clear of contaminants. It has a dome-shaped head that provides an even, unrestricted flow of fuel from the separator elements.

A test connection for obtaining a sample of the fuel being discharged is located at the bottom of the outlet chamber. When it is necessary to drain the filter completely, the outlet chamber is drained into containers through this line.

Two pressure gages (one for each chamber) and a differential pressure gage are installed on a gage board conveniently located in the filter room. These gages are provided for determining the pressure drop across the filter elements. A shutoff valve is installed in each gage line to permit removal of the gages for maintenance.

OPERATION OF THE MAIN FUEL FILTER.— It is imperative that the filter be properly vented so full use of all filtering elements will occur. JP-5 enters the inlet chamber of the filter. The JP-5 then passes to the inside of the coalescing elements, where solids 5 microns and larger are retained on the inner walls of the elements. As the JP-5 passes through the elements into the fallout chamber, any water is coalesced into large droplets on the outside of the elements. These water droplets fall out of the JP-5 by gravity and into the sump as the JP-5 passes across the fallout chamber to the separator elements. JP-5 enters the separator elements from the outside and, as it passes through the elements to the outlet chamber, any final traces of coalesced water that did not fall are repelled. The JP-5 then leaves the outlet chamber of the filter from the top and flows through the automatic shutoff valve into the forward and aft legs of the quadrant. Rated capacity is 2,000 gpm.

CAUTION

Exercise care at all times when opening and closing valves that govern flow through the filter to prevent a hydraulic hammer shock to the filter. This may overstress the housing or rupture the filter elements.

Immediately after a filter with new elements is placed in operation, the pressure gages must be read and the pressures logged. A pressure differential between the inlet and fallout chambers should be noted. This pressure drop will increase in time due to the buildup of solid contaminants on the inner walls of coalescing elements.

Pressure Checks.— The inlet, outlet, and differential pressure gages should be read and recorded as indicated in the filter operating log. As solids build up on the elements, the pressure drop across the filter increases. The differential gage determines the actual differential pressure across the entire filter assembly. The pressure drop across the coalescer elements is the most critical.

As the maximum allowable pressure drop across the coalescing elements is reached, they fail to perform their designed function and must be replaced. The maximum allowable pressure drop limits for coalescer elements are found on the instruction sheet in the manufacturer's packing crate. Although pressure drop limits may vary, 15 psi is the typical pressure drop limit.

Sample Checks.— Daily checks are taken from the filter sump and outlet chamber at the beginning of initial flow and every 15 minutes thereafter. The contents of each sample should be recorded in the operating log. These samples can be used to determine the condition of the coalescer and separator elements.

If the sample taken from the filter sump contains solids, it is a probable indication that the coalescer elements have failed. If the sample taken from the outlet chamber is contaminated, it is a probable indication that the coalescer and/or separator elements have failed. In either case, the elements should be inspected and replaced as necessary.

Also, coalescer elements should be replaced at each overhaul and before deployment. If no overhaul or deployment occurs, they should be replaced in accordance with PMS. When coalescer elements are replaced, separator elements should be cleaned and inspected. Only defective separator elements need be replaced. Coalescer elements of one manufacturer may be used with the separator elements of another manufacturer.

FILTER HYDRAULIC CONTROL SYSTEM.— The filter hydraulic control system is a safety device installed on all fuel filters. It functions to drain automatically the accumulated water from the filter sump, and to shut off the filter flow if more water accumulates than can be drained off automatically.

This system consists of three hydraulic control valves and afloat operated control valve. Two hydraulic control valves (the automatic shutoff valve and pilot valve) are located in the filter discharge line. The other hydraulic control valve (the automatic water drain valve) is located in the filter sump drain line. The float operated control valve (rotary valve) is located on the side or bottom of the filter sump.

Automatic Shutoff Valve.— The automatic shutoff valve is of a modified globe valve design, using a well supported and reinforced diaphragm as a working means. A tension spring located in the upper valve chamber (above the diaphragm) assists in seating the valve when closing, and provides a cushioning when opening. The valve is opened by filter discharge pressure acting under the valve disk. The valve is closed by filter discharge pressure acting with the tension spring on the top of the diaphragm in the valve cover chamber. The pilot valve and an eductor, both located in the actuating line, control the opening and closing of the automatic shutoff valve.

The actuating line runs from the inlet to the discharge side (by passing the valve seat) of the automatic shutoff valve body.

The pilot valve is of the modified globe valve design, having a double-acting diaphragm as its working means. When fuel pressure is applied to the top of the diaphragm, the valve closes (closing off the actuating line). When fuel pressure is applied to the bottom of the diaphragm, the valve opens (allowing flow through the actuating line).

The eductor is located in the actuating line between the pilot valve and the inlet side of the shutoff valve. The eductor suction line is connected to the top of the shutoff valve cover chamber. With the pilot valve open, the eductor decreases the fuel pressure on top of the diaphragm of the shutoff valve by educting fuel from the main valve cover chamber. This decrease in fuel pressure on top of the diaphragm allows filter discharge pressure acting under the shutoff valve disk to open the valve. When the pilot valve closes, filter discharge pressure in the actuating line is directed through the eductor suction line to the top of the cover chamber of the shutoff valve. This increase in fuel pressure on top of the diaphragm cover overcomes the fuel pressure being applied on the valve disk and closes the valve. Simply put, if the pilot valve is open, the automatic shutoff valve is open. If the pilot valve is closed, the automatic shutoff valve is closed.

Automatic Water Drain Valve.— This valve, located in the water drain line from the sump, is identical to and functions in the same way as the pilot valve. When fuel pressure is applied to the top of the diaphragm in the automatic water drain valve, the valve closes and stops the flow from the filter sump. When the fuel pressure is relieved, the valve opens and allows water to be discharged from the filter sump. Vertical filters have two automatic water drain valves.

Float Operated Rotary Control Valve.— The rotary control valve, located on the side or bottom of the filter sump, is operated by the rise and fall of a captivated ball float housed within the filter sump.

The ball float is attached to the rotary valve by a float arm and gear assembly. It is designed to float on water and sink in JP-5. The rotary control valve described here is the one typically installed on vertical filters.

The rotary control valve has three operating positions: DOWN, HORIZONTAL, and UP. The valve body has four ports. Three of the ports are connected by tubing to the following:

1. A drain (vent) port to the water drain line on the discharge side of the automatic water drain valve
2. A port to the top of the diaphragm in the pilot valve
3. A port to the top of the diaphragm in the automatic water drain valve

The fourth port is the supply connection. It is on the top of the rotary control valve inside the filter vessel. The port is fitted with a wire mesh strainer.

The rotary control valve, through the action of the ball float, controls the opening and closing of the automatic water drain and pilot valves.

OPERATION OF THE FILTER HYDRAULIC CONTROL SYSTEM.— AS long as the fuel passing through the falter contains little or no water, the rotary control valve float will remain it its DOWN position. With the float in its DOWN position, the rotary control valve directs fuel to top of the diaphragm of the automatic water drain valve (keeping that valve closed), and vents fuel pressure from the top of the diaphragm in the pilot valve. Direct fuel pressure applied to the bottom of the pilot valve diaphragm opens that valve, which allows filter discharge pressure to open the automatic shutoff valve.

As coalesced water collects in the filter sump, the float rises to the horizontal position. With the float at its horizontal position, the rotary control valve vents the top of the automatic water drain valve allowing direct fuel pressure to force it open and drain the accumulated water. The top of the pilot valve diaphragm continues to be vented while direct fuel pressure continues to be applied to the bottom of the pilot valve diaphragm, keeping it open, which allows discharge pressure to open the automatic shutoff valve.

If water collects in the filter sump faster than it can be drained off, the float will rise to its UP position. With the float at its UP position, the rotary control valve directs pressure to the top of the pilot valve (closing it) which causes the automatic shutoff valve to close, stopping fuel discharge. The top of the automatic water drain valve continues to be vented allowing direct fuel pressure to keep it open to drain the accumulated water.

Simply put,

With the float in the down position: the pilot valve is OPEN; the automatic shutoff valve is OPEN; and the automatic water drain valve is CLOSED.

With the float in the horizontal position: the pilot valve is OPEN; the automatic shutoff valve is OPEN; and the automatic water drain valve is OPEN.

With the float in the up position: the pilot valve is CLOSED; the automatic shutoff valve is CLOSED; and the automatic water drain valve is OPEN.

TROUBLESHOOTING THE FILTER HYDRAULIC CONTROL SYSTEM.— If the system fails to operate properly, make the following tests:

1. Check the arrows on the automatic shutoff, pilot, and automatic water drain valves to ensure proper installation.

2. Make sure all manually operated valves are properly aligned.

3. Inspect the tubing for dents, flat spots, or internal obstructions.

NOTE

The latter is often the most likely cause of the malfunction.

If the above tests prove unsatisfactory, the rotary control valve should be removed for inspection and further testing. Cunsult the appropriate technical manual.

First-Stage Filters

First-stage filters (fig. 4-25) are commonly known as reclamation filters. That is because these filters are typically used in the JP-5 reclamation

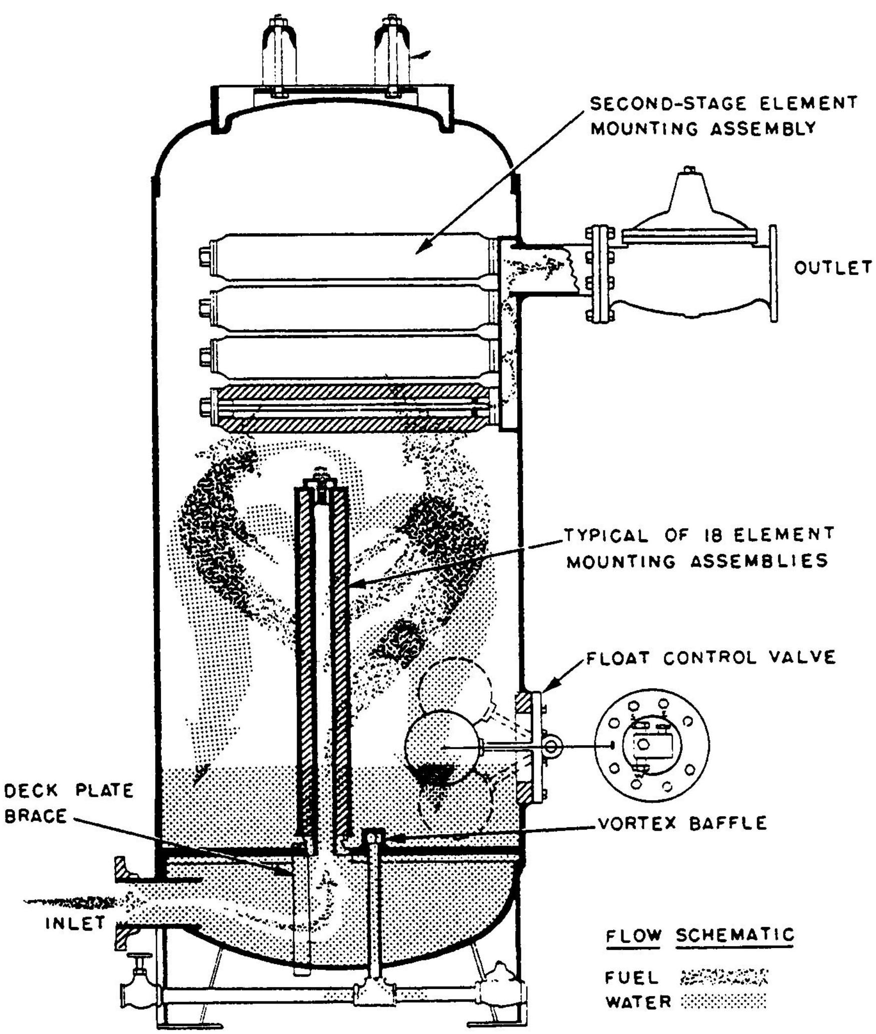


Figure 4-25.—First-stage filter.

system to filter the fuel from the contamination tanks before pumping it back into storage tanks.

These filters normally have a rated capacity of 300 gpm and an operating pressure of 100 psi. The filter is designed to remove 98% by weight all solids 5 microns or larger, and 99.9% of the water. The filter has a cylindrically shaped, welded, copper-nickel shell mounted on three legs. A bolted hand-hole cover assembly at the top of the shell provides access to remove or replace coalescer or separator elements. The interior of the shell is divided into three chambers: inlet, fallout, and outlet. The inlet chamber is at the bottom of the shell; the fallout chamber contains coalescer and separator elements: and the outlet chamber (clearwell) connects to the discharge piping.

The outside of the shell contains a reflex-type sight glass, differential gage, and an outlet pressure gage. The sight glass indicates water level in the fallout chamber. The differential gage indicates the pressure drop across the coalescer elements. The outlet gage indicates the pressure of the filtered fuel after it has passed through the separator elements and before it leaves the filter.

There are 18 coalescer elements mounted vertically on the horizontal deck plate. Fuel flows from the inlet chamber through the coalescer elements to the fallout chamber.

There are 11 separator elements mounted horizontally in individual mounting assemblies attached to the outlet chamber. Fuel flows from the fallout chamber, through the separator elements, and into the outlet chamber.

A float control valve, bolted to a flange that is welded to the shell, controls the action of an automatic water discharge valve and an automatic shutoff valve in the exact way as the vertical filter. In fact, with the exception of rated capacity, this filter operates exactly the same as the vertical filter.

Prefilters

Prefilters are provided upstream of first-stage filters to reduce the burden on and extend the life of the coalescer elements installed in first-stage filters. Basically, the prefilter consists of a cylindrical housing with valved vent and drain connections, and a differential pressure gage. The elements are a disposable type designed to remove solid contaminants.

CENTRIFUGAL PURIFIER

Centrifugal force is defined as that force which impels a thing (and any or all of its parts) outward from a center of rotation. Every time you lean in as you take a fast turn, you are counterbalancing centrifugal force. How far in you lean is determined by the amount of centrifugal force exerted in the turn. Most people do it automatically, for centrifugal force, along with gravity, is the most prevalent physical force exerted upon us and upon all matter.

The purpose of the centrifugal purifier (fig. 4-26) in the JP-5 filling and transfer system is to separate and remove water, solids, and emulsions from JP-5 during transfer from storage to service tanks. The diskbowl centrifuge is a “constant efficiency” type of separator; that is, it achieves the same degree of efficiency at the end of a run as at the beginning. The reason for the constant efficiency is that accumulated solids are stowed away from the separation zone. Separation occurs within the disk spaces, and the separated liquids are discharged from outlets that are removed from interference of the stowed solids.

Theory of Operation

Dirty fuel containing water and solids is fed to the purifier through the feed inlet of the inlet-outlet assembly. The dirty fuel then enters the top of the bowl centrifuge through the feed tube and travels down the tubular shaft, to be thrown outward and upward by the distribution cone at the bottom of the distributor, under the disk stack. The fuel is forced upward through the distribution holes in the intermediate disks, where centrifuge action separates the fuel, water, and solids.

The solids are thrown directly against the bowl wall and collect in a uniform layer on the inside vertical surface of the bowl shell. The water, thrown outward, is displaced by incoming feed material forcing the water overflow up and over the outer edge of the top disk, and discharging it through the discharge ring and the heavy phase outlet.

The clean fuel, which has a lesser density, is displaced inward and upward along the outside of the distributor to the paring disk chamber, where the spinning fuel contacts the edge of the stationary paring disk. The paring disk then acts as a pump, discharging the fuel to the purifier fuel outlet.

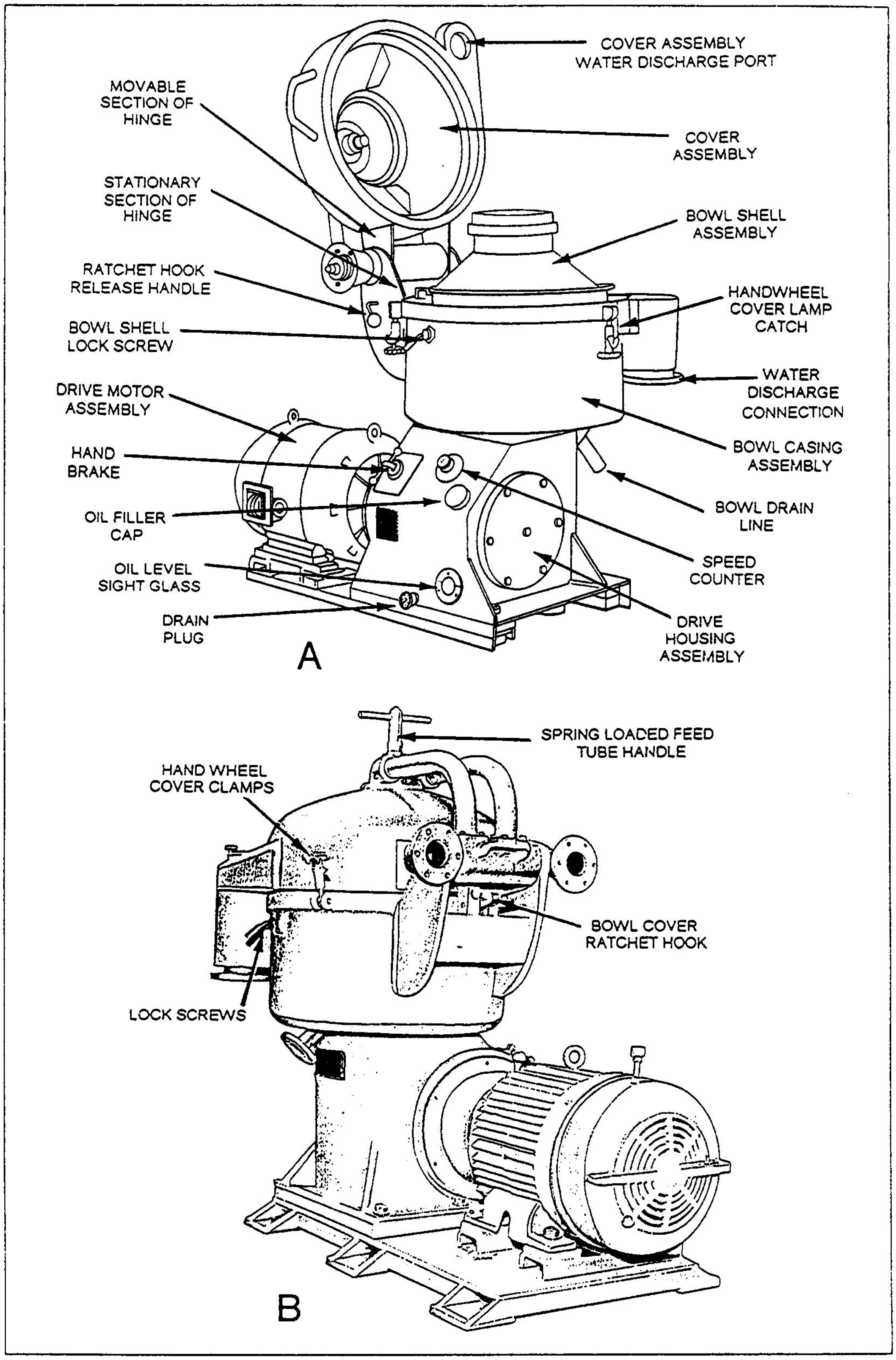


Figure 4-26.—Centrifugal purifier.

Characteristics of the centrifugal purifier are

- Capacity—200 gpm at 60°F to 90°F when purifying JP-5 (fuel temperature);
- Feed inlet pressure—9 psi;
- Back pressure of the discharged JP-5:
- Minimum—25 psi,
- Ideal—30 psi,
- Maximum—35 psi, and
- Bowl speed—4,100 rpm.

Some purifiers are being modified during shipyard periods to purify 300 gpm. Consult the technical manual for operational changes.

Cover Assembly

The cover assembly (fig. 4-27) completely encloses the top of the rotating-bowl shell assembly. The cover hinges to the bowl casing, thus allowing the cover to be lifted out of the way for disassembly and cleaning of the bowl. (See figure 4-26.)

The cover hinge, inlet, and outlet assembly functions to allow the cover to be opened without disconnecting the piping. The stationary part of the hinge is welded to the bowl casing, The movable part of the hinge is welded to the cover. A ratchet hook is provided on the stationary part of the hinge to lock the cover in the open position. A handle is provided to unlock the hook so the cover can be closed. Inlet and outlet piping connects through the hinge to the inlet and outlet tubes. The piping is stationary, but the tubes rotate with the cover. A chevron-shaped, oil-resistant rubber seal is installed between the piping and tubing to prevent leakage. Fuel pressure spreads the chevron rings to make a tight seal. When fuel flow is stopped, pressure ceases, and the chevron seals loosen enough to allow the cover to be rotated to the open position.

The feed inlet tube and the purified JP-5 discharge tube both connect into the feed tube assembly at the top of the cover. An oil-resistant seal (0-ring) prevents leakage of liquids between each tube and the feed tube assembly. The feed tube assembly directs feed into the revolving bowl and purified JP-5 out of the bowl.

A seal-water inlet, located between the inlet and discharge tubes, directs fresh water into the revolving bowl for use as a seal. A 3/4-inch plug valve and

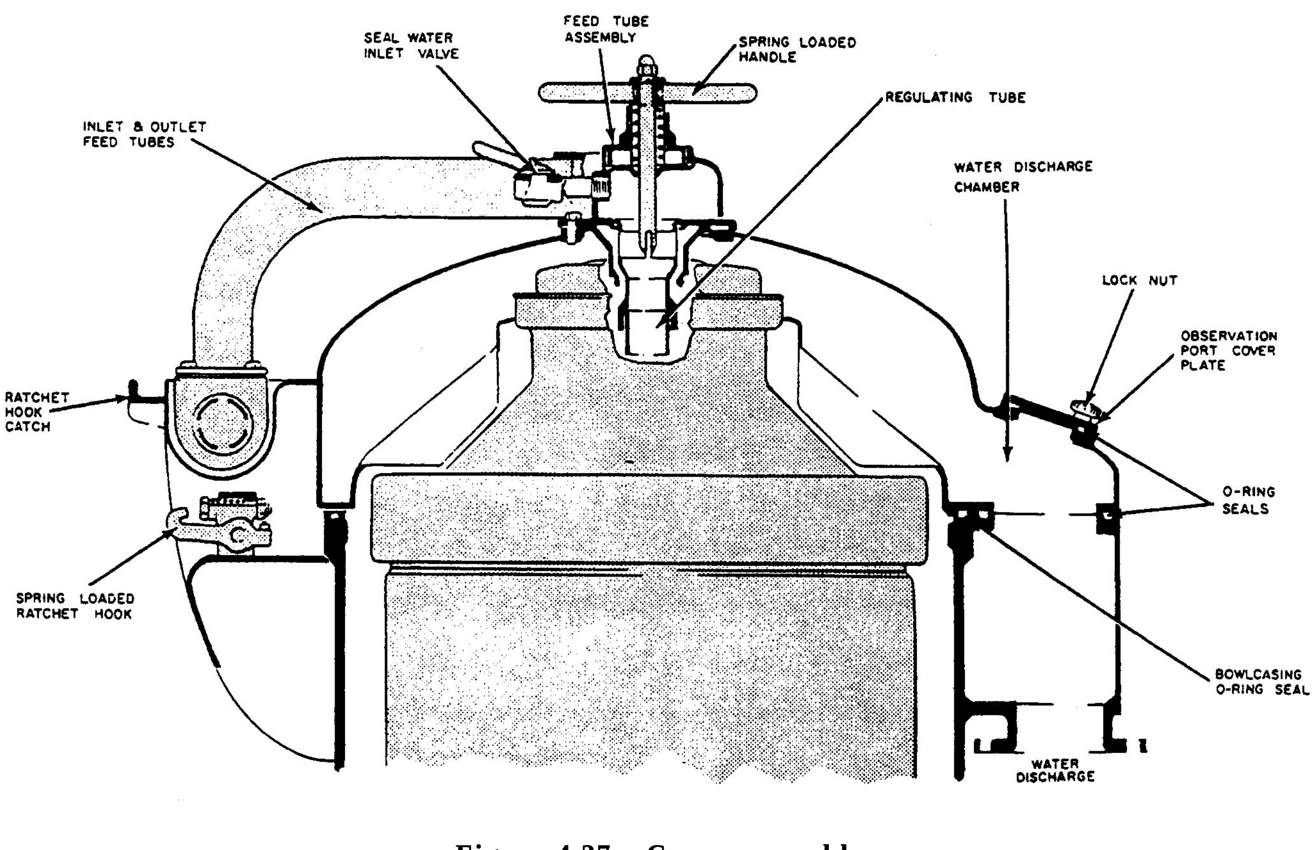


Figure 4-27.—Cover assembly.

flexible rubber hose connect the seal-water inlet to the fresh water supply in the pump room.

NOTE

As of this writing, steel-braided jacketed hose is being installed during available yard periods to replace the flexible-rubber seal-water hose.

Internally, the feed tube assembly is constructed to direct the feed and the seal water to a nylon regulating tube. The regulating tube then directs this liquid to the center of the tubular shaft (part of the bowl shell assembly).

The feed tube is also the shaft for the paring disk. The spring-loaded handle, extending out the top of the feed tube assembly, is used to screw the feed tube into the paring disk. The handle remains down when the two are engaged. When not engaged, the spring forces the handle and feed tube up and away from the paring disk.

CAUTION

The feed tube has left-hand threads. The feed tube must be disengaged from the paring disk before the cover can be opened.

Equally spaced around the bottom of the cover are three handwheel cover clamp catches. These hook-shaped catches are used to lock the cover in the closed position.

Inside the dome-shaped cover is the water-discharge chamber. This chamber normally receives the water discharged from the revolving bowl. This water is directed to the water-discharge outlet area of the water-discharge chamber. An observation port is provided to enable a visual check of the discharging water. The port has a metal cover that is swung to one side when it is opened. The port, when open, is just a hole. No glass or other transparent medium is provided to cover the open port.

Bowl Casing

The bowl casing is a circular stationary tub that houses the rotating-bowl shell assembly. The stationary part of the cover hinge, inlet, and outlet assembly is welded to the outside of the bowl casing.

Three handwheel cover clamps are equally spaced around the top of the bowl casing to lock the cover in the closed position. Each handwheel cover clamp has a hook that engages the catch on the cover. Rotating the handwheel screws the hook down upon the catch, which in turn pulls the cover down. Handtight is sufficient for proper locking of the cover in the closed position. A large oil-resistant ring provides a liquid-tight seal between the cover and the bowl casing when the cover is closed.

Two bowl-shell lock screws (fig. 4-28) are housed in the upper part of the bowl casing. These locking devices lock the bowl shell assembly during disassembly and assembly. They are engaged to prevent the bowl shell assembly from rotating. A threaded bushing in the bowl casing allows the lock screws, which are also threaded, to be screwed into or out of the lock position. When the lock screws are in the lock position, they engage a slot in the revolving-bowl shell assembly.

CAUTION

The two bowl-shell lock screws must be removed before starting the purifier. Two bowl-shell lock screw plugs are provided to plug up the threaded hole in the bowl casing when the lock screws are removed.

A water-discharge connection is welded to the upper portion of the bowl casing. This connection is aligned with the water-discharge connection in the cover assembly when the cover is closed. An

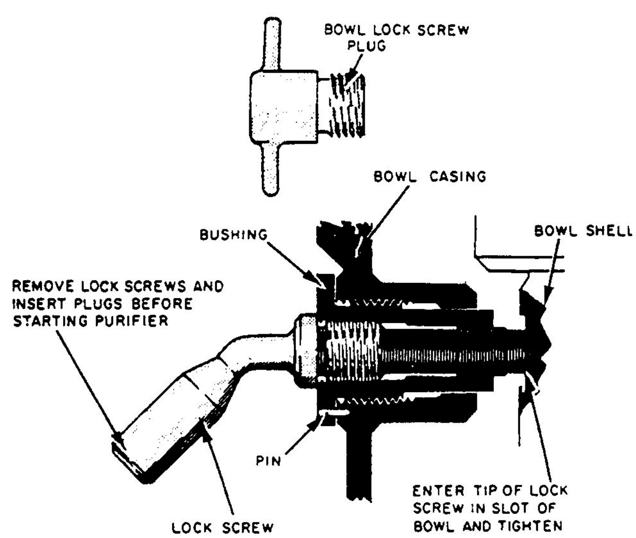


Figure 4-28.—Bowl-shell lock screw and plug.

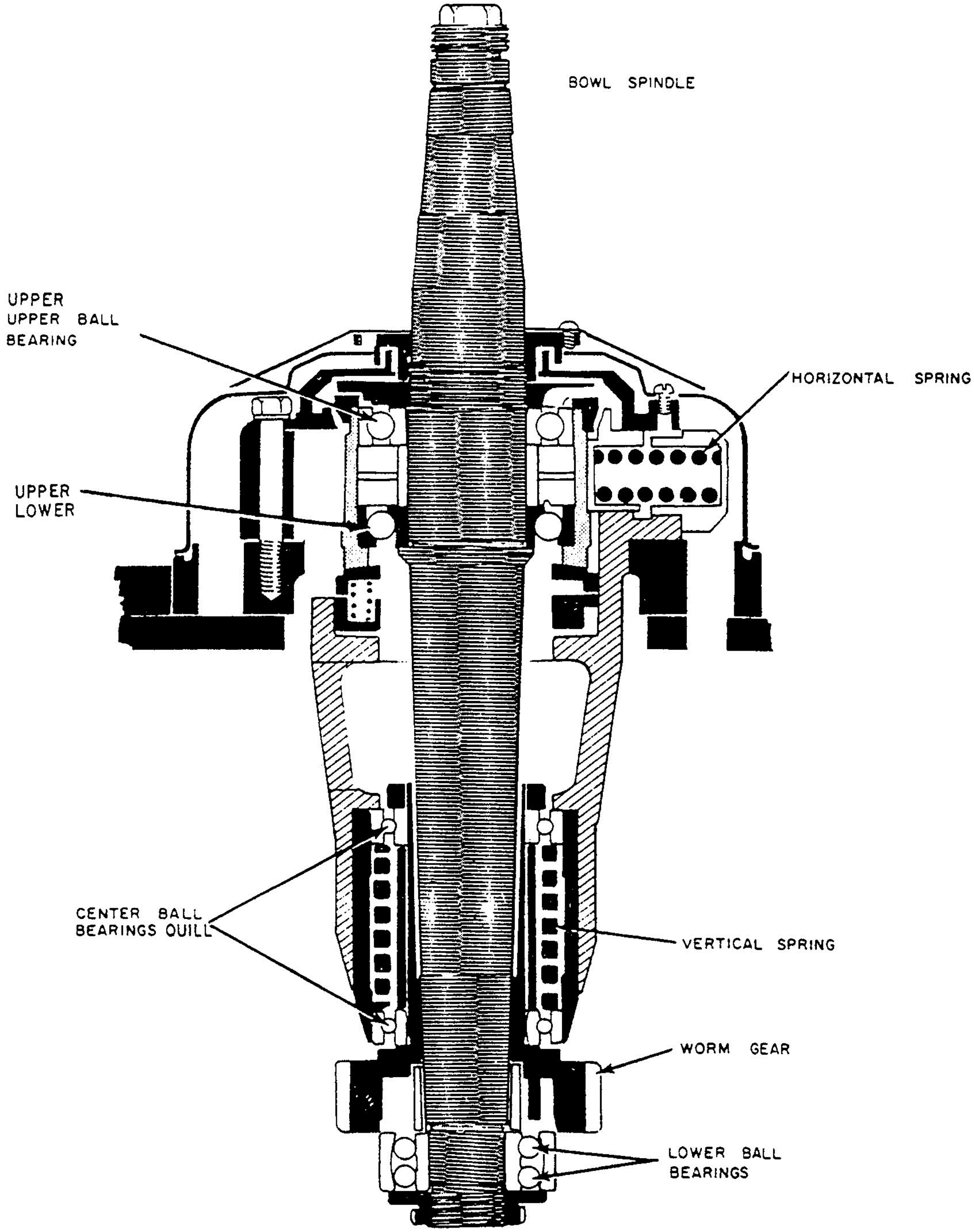


Figure 4-29.—Spindle assembly.

oil-resistant 0 ring forms a liquid-tight seal between the water-discharge connections of the cover and bowl casing when the cover is closed. The lower end of the bowl casing's water-discharge connection is flanged to the water-discharge line. The water-discharge line directs water into a sump tank. The water-discharge line contains a flexible pipe connection between the purifier and the connection piping that is firmly braced to the ship's structure. This flexibility allows for safe passage through the critical vibration range when starting and stopping the purifier.

A bowl casing drain line protrudes from the bottom of the bowl casing. This line drains any liquid that may enter the annular space between the revolving bowl shell assembly and the stationary bowl casing. A locked-open globe valve is installed in this line. It is imperative that this valve be open before starting and during starting, operating, and stopping cycles of the purifier. The bowl casing drain line directs drained liquid into the sump tank. A short length of rubber hose is installed in this line to perform the same function as the flexible pipe connection in the water-discharge line.

Drive Housing and Assemblies

The drive housing bolts to and supports the bowl casing, cover, and bowl shell assembly. The drive housing contains the spindle assembly, direct drive assembly, speed counter, brake, and lubrication system.

The spindle assembly (fig. 4-29) is the vertical drive shaft for the bowl shell assembly. Three sets of ball bearings support the spindle assembly; a set at the top, a set at the center, and a set at the bottom. All three sets of ball bearings are lubricated by oil. Located between the upper and lower bearings of the center set of ball bearings is a large vertical spring. This spring acts as a shock absorber to absorb any vertical thrust of the spindle's shaft when the purifier is started. Six equally spaced horizontal springs surround the upper set of ball bearings. These springs absorb and cushion any horizontal movement of the bowl shell assembly and thus reduce vibration. The lower end of the spindle's shaft is geared to the horizontal drive shaft of the direct drive assembly. The direct drive assembly transmits drive motor power to the spindle, which, in turn, transmits power to the bowl shell assembly. The direct drive assembly (fig. 4-30) connects the purifier to the motor shaft by a flexible coupling. The coupling consists of two coupling halves, with the motor end fitted to the motor shaft and the purifier end fastened to the brake drum with four bolts. Each coupling half has protruding studs (which are offset of each other) that engage a rubber cushion installed between the two coupling halves.

The drive motor shaft turns the coupling, which turns horizontal drive shaft. The horizontal drive shaft is supported by two ball bearings; an outer and an inner bearing. The outer and inner shaft bearings are lubricated by oil. A worm wheel gear is keyed to the drive shaft. This gear engages the gear at the base of the spindle assembly. A smaller gear, which is part of the worm wheel gear, is used to drive a speed counter.

The speed counter (fig. 4-31) is used to determine the rpm of the bowl shell assembly. Basically, it consists of a shaft that penetrates the drive housing. One end is

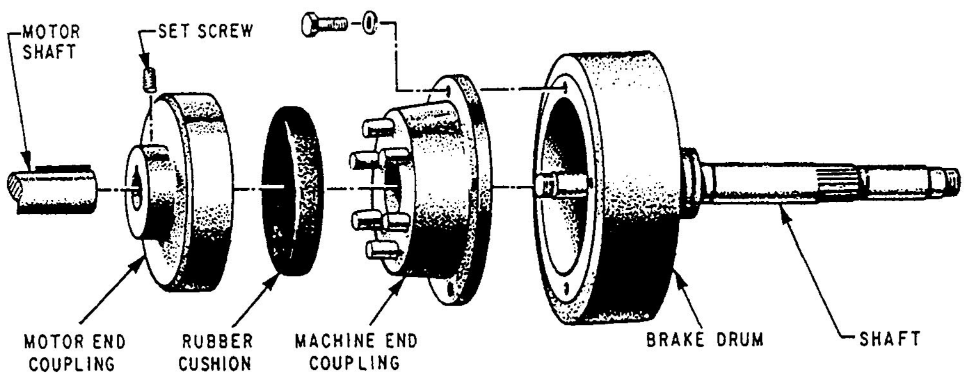


Figure 4-30.—Direct drive assembly.

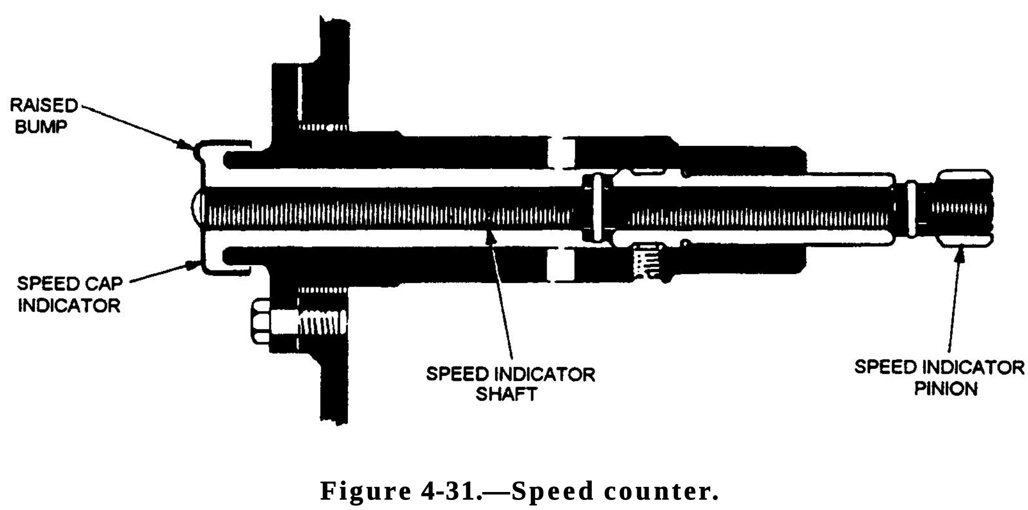


Figure 4-31.—Speed counter.

inside the drive housing and the other end is outside. The inside end is geared to the worm wheel gear; therefore, when the direct drive assembly rotates, the speed counter shaft rotates. The speed counter, but, rotates at a much slower rate because of the gear ratio. The outside end of the speed counter shaft is covered by an attached cap. The cap has a raised bump on one side of its top. Bowl speed is determined by the operator who places his finger on the outer edge of the cap and then counts the number of times the raised bump touches his finger in 1 minute. During full bowl rpm, the count should be between 146 and 150 times per minute.

Because of the gear ratio, the drive motor rotates at 1,770 rpm, the bowl rotates at 4,100 rpm, and the speed counter rotates at 146 to 150 rpm. A handbrake (fig. 4-32) is provided to stop the purifier. This brake is for emergency use only. It consists of a spring-loaded brakeshoe and an eccentric handle. The brakeshoe has a replaceable section of bonded brake lining. When the handle is down, the brake is off. When the handle is raised to the up position, the brake is on. In the on position, the spring forces the brakeshoe and lining against the outer surface of the brake drum. Friction, thus created, causes the purifier to come to a stop.

In the base of the drive housing is an oil sump for the oil lubrication system (fig. 4-33). All the bearings on the spindle and drive shaft are lubricated by this oil. The drive housing is divided into two compartments. One of these compartments contains the direct drive assembly coupling and the other contains the gears and bearings that are lubricated by oil. A metal partition separates the two compartments. The direct drive shaft passes through this partition and a gasket is installed around the shaft to prevent oil from entering the direct drive coupling compartment. The worm wheel gear on the drive shaft is partially submerged in the oil. Rotation of this gear splashes the oil about within the oil

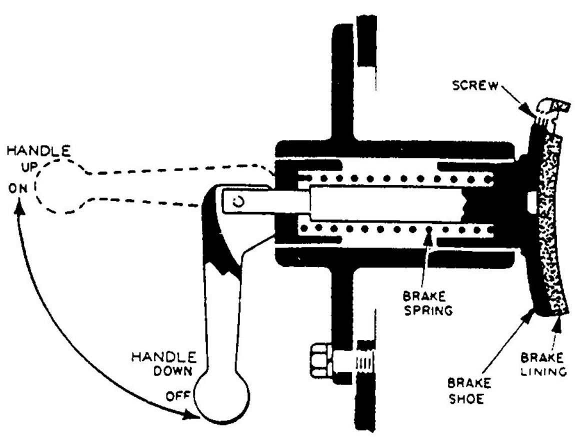


Figure 4-32.—Brake assembly.

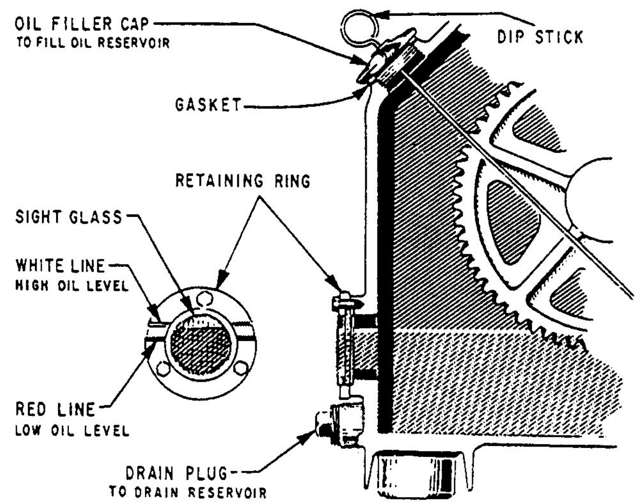


Figure 4-33.—Oil lubrication system.

lubrication compartment, thus supplying oil to the bearings and gears. The oil sump holds from 8 to 8 1/2 quarts of grade 90 gear oil. Proper oil level is determined by a circular sight glass on the side of the drive housing. The glass retaining ring has two inscribed lines to indicate proper oil level. The white, top line, is the high or full oil level. The red, bottom line, is the low oil level mark.

On some installations where the oil sight glass could not be seen easily in its normal position, the sight glass has been extended out and turned to give a clear view to the operator, or a dip stick has been added to the oil filler cap. The dip stick has two marks. The lower mark indicates lubricating oil should be added. Fill to the upper mark. To check the oil level, pull the stick completely out through the cap. Wipe with a clean, dry rag. Push the stick all the way in through the cap and pull it out again to read. Be sure the stick always rests on the cap.

An oil fill cap is located near the top of the drive housing. An oil drain plug is at the base of the oil sump.

Bowl Shell Assembly

The bowl shell assembly (fig. 4-34) provides the working area for separation of contaminants from JP-5. The entire bowl shell assembly sits on top of the spindle assembly. The spindle assembly causes the bowl shell assembly to rotate. This rotation is transmitted to the fuel, thus providing the necessary centrifugal force to cause separation to take place. During operation, the bowl shell assembly contains a fresh water seal to prevent loss of the JP-5. Most of the separated solids and emulsions are retained within the bowl shell assembly, but are completely removed from the line of flow of the liquids.

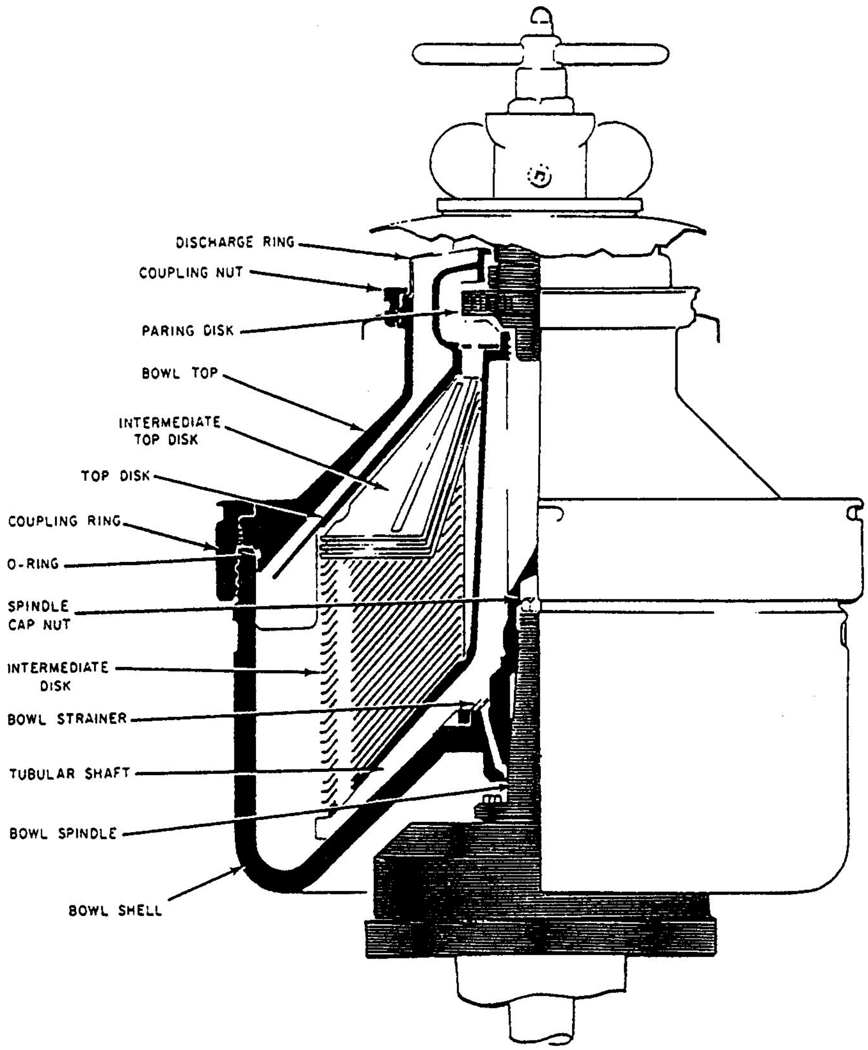


Figure 4-34.—Bowl shell assembly.

The bowl shell confines the liquids being separated. Housed within the "tub-like" bowl shell are the strainer, disk stack, paring and discharge ring.

The bowl shell has eight equally spaced drain holes around the raised center of its bottom. These holes facilitate draining the bowl when the purifier is in its stopping cycle. The draining liquids are directed into the annular space between the bowl shell and the bowl casing and then out the bowl casing drain line.

To ensure that the drain holes will not become clogged by dirt from the bowl shell, a conical-shaped strainer is installed over the top of the drain holes.

The bowl shell seats on the tapered portion of the top of the spindle shaft. The threaded top section of the spindle shaft protrudes up through the raised center of the bowl shell. A spindle capnut is then screwed down over the threads to force the bowl shell down onto the tapered portion of the spindle shaft.

A slot is provided on each side of the bowl shell on its outer surface near the top. These two slots engage the bowl shell lock screws during disassembly or assembly of the bowl shell. A notch at the upper/outside edge of the bowl shell engages the bowl top.

The tubular shaft is the base and the center of the disk stack. It forms a circular bulkhead between the feed inlet liquids and the disk-stack discharge to the paring disk.

The base of the tubular shaft has three unequally spaced pins that interlock with three unequally spaced slots around the raised center of the inside-bottom of the bowl shell. Thus, the tubular shaft can be installed in one position only, ensuring that the tubular shaft will rotate.

The flared base of the tubular shaft is the bottom of the disk stack. A liquid passage. between the bowl shell and the underside of the tubular shaft's base, is provided by 12 inner spacers. The inner spacers are part of the tubular shaft, and serve two purposes-they keep the tubular shaft off the bowl shell to provide the liquid passage, and they give a circular motion to the feed inlet liquid, since they act as rotating paddles. The 12 inner spacers run from the top-inside area of the tubular shaft and follow its contour down and under the flared base to the outer edge of the base.

Twelve equally spaced holes are provided near the outer edge of the tubular shaft's flared base. These holes are located between the 12 inner spacers.

The outer edge of the tubular shaft above the flared base has 12 equally spaced outer spacers. These outer spacers perform the same function for the purified JP-5 that the inner spacers perform on the feed inlet liquids. One of the outer spacers has a key to which each of the disks in the disk stack lock. This ensures that the disks will rotate.

The intermediate disks form the main part of the disk stack. There are 127 individual intermediate disks. Each has a number stamped on its top side near its outer edge. The disks are numbered 1 through 127; number 1 disk is on the bottom and number 127 is on the top.

NOTE

Additional intermediate disks can be added to the top of the intermediate disk stack to make sure correct disk stack compression is maintained.

The intermediate disks are identical except for their stamped numbers. In shape, the disk resembles a metal lampshade, large at its base and small at the top. A small lip flares out from the base and a small lip flares inward from the top.

Twelve equally spaced holes are located around the base of the disk. A thin sliver of metal (0.050-inch thick) runs from between each hole inward to the inner lip. These pieces of metal, located on the top of each intermediate disk, act as spacers. Since the disks seat one on top of the other, the thickness of the space between each disk is determined by the thickness of the spacers.

The top inner lip of each intermediate disk has a notch that interlocks with the key on the tubular shaft. This interlocking ensures that the disks rotate and that the disk holes will be aligned vertically.

Some purifiers will have an intermediate top disk that seats on top of the topmost intermediate disk. Its purpose, also, is to ensure correct disk stack compression. This disk is similar in construction to the 127 intermediate disks except that the flared lip around its base is only half as large as the lip on the intermediate disks, and it does not have a stamped number or the raised ribs.

The top disk seats on top of the intermediate top disk and is the top disk of the disk stack. Being wider than the other disks in the stack, the top disk covers the disk stack like an umbrella. This is the only disk that does not have holes around its base. The inner-upper portion of the top disk is the pump casing for the paring disk. The lower portion of the pump casing has a notch that interlocks with the key on the tubular shaft, thus insuring that the top disk will rotate.

Twelve outer spacers, equally spaced around the top side of the top disk, extend from beyond the rim of the base inward to the top of the pump casing. The outer end of each spacer extends below and partially up the underside of the top disk. These spacers perform the same function to separated water as the outer spacers on the tubular shaft perform on the purified JP-5.

A vane-type centripetal pump, the paring disk, is housed within the pump casing area of the top disk. The paring disk does not rotate; it is threaded onto the feed tube assembly (see "Cover Assembly"). In this pump, the pump casing revolves around the impeller; thus, the flow is from the outside/in. This flow, being centripetal, is just the reverse of a centrifugal pump. The feed tube of the cover's feed tube assembly is the pump shaft. A nylon collar fits snugly around the top of the paring disk. When the feed tube is screwed into the paring disk, the paring disk is raised until the nylon collar contacts the upper/inside area of the pump casing. In this position, the nylon collar acts as a wearing ring for the paring disk.

A bowl top seats on the top of the top disk's spacers. Discharging water flows up through the space between the top disk and the bowl top. The conical-shaped bowl top is thicker at the bottom than at the top. Part of this thick base rests on top of the bowl shell and part of it extends down inside the bowl shell.

The part of the bowl top extending down inside the bowl shell has an 0-ring retaining groove. An oil-resistant 0-ring installed in this groove forms a liquid-tight seal between the bowl top and the bowl shell. This seal ensures that the liquids involved in the purifying process will be confined to their normal flow through the bowl shell assembly.

A large coupling ring is threaded down over the base of the bowl top to the upper/outside edge of the bowl shell. This ring holds the bowl top in place.

A protruding rectangular tab on the underside of the outer rim of the bowl top engages a notch in the bowl shell to ensure rotation of the bowl top.

The top edge of the bowl top has a retaining groove into which is inserted an oil-resistant rubber seal ring. This ring is a flat rubber washer, not an 0-ring. A discharge ring seats on top of this seal ring.

The outer edge around the top of the bowl top is threaded to receive a coupling nut. The coupling nut screws down over the discharge ring, forcing the discharge ring down onto the rubber seal ring. This seal ensures that discharging water will flow up through the center of the discharge ring.

The coupling ring, as previously stated, forces the bowl top down onto the top of the bowl shell, thus completing a seal. As the coupling ring is screwed downward, it forces the bowl top down onto the disk stack. This action compresses the disk stack and ensures that each disk will seat tightly on its adjacent disks. The space between each disk is thereby assured to be correct.

To ensure correct tension on the disk stack, an aligning mark is stamped on the coupling ring and the bowl top. These two marks must be lined up when tightening the coupling ring. An indicating arrow and the word "OPEN' are also stamped on top of the coupling ring. These marks show the direction of rotation to remove the coupling ring.

CAUTION

The coupling ring and coupling nut have left-hand threads.

Four T-shaped slots are equally spaced around the outside/upper rim of the coupling ring. A special wrench engages these slots for removal or installation of the coupling ring.

A discharge ring, seated on top of the bowl top, acts as a dam to maintain the proper line of separation between the water and the JP-5 within the bowl shell assembly.

Each purifier is furnished with a set of seven discharge rings. The outside diameters of the discharge rings are the same. The inside diameters of the discharge rings are different. The inside diameter size is etched on each ring. The inside diameters range from 220 millimeters to 250 millimeters in 5-millimeter increments (220, 225, 230, 235, 240, 245, and 250).

The coupling nut locks the discharge ring in place. Like the coupling ring, the coupling nut also has an indicating arrow and the word "OPEN" stamped on its top.

The coupling nut has four circular slots equally spaced around its outer edge. A special wrench engages one of these slots for removal or installation.

Purifier Operations

The operations described in this section deal with starting from two different conditions-with a clean bowl and with a dirty bowl.

Regardless of the condition of the bowl, there are some preliminary steps to follow before starting the purifier. These steps are as follows:

1. Open the bowl cover.

2. Ensure the handbrake is in the OFF position.

3. Remove the two bowl shell lock screws.

4. Insert the two bowl shell lock screw plugs.

5. Turn the bowl by hand. If the bowl does not turn freely, investigate and correct the cause.

6. Check the level of oil in the oil sump. If the oil is at or below the red line, add sufficient oil to raise the oil level to the white line.

7. Close the bowl cover and engage and tighten the three handwheel cover clamps.

8. Engage the feed tube to the paring disk.

9. Ensure the seal water inlet hose is connected to the purifier seal water inlet valve.

10. Ensure the purifier sump tanks are empty.

The following starting and stopping procedures are for transferring fuel from one port wing storage tank, through one transfer pump, through the port purifier, to one port wing service tank. Since transfer is from wing tank to wing tank within the same group of tanks, and on the same side of the ship, there is very little change to the list and trim of the ship. The starboard service tanks can be filled from starboard storage tanks in the same manner. But, the transferring is accomplished by using only one transfer pump to pump into one purifier, since they both have the same capacity.

Starting with a clean bowl is accomplished as follows:

1. Close the following valves:

   a. Sample connections.

   b. Purifier inlet valve.

   c. Purifier discharge valve.

   d. Purifier seal water inlet valve.

2. Open the following valves:

   a. Designated manifold tankside valve.

b. Designated manifold transfer mainside valve.

c. Designated transfer-pump inlet valve.

d. Designated transfer-pump discharge valve.

e. Designated transfer-pump inlet and discharge gage valve.

f. Freshwater supply valve (seal water supply).

g. Bowl casing drain valve (locked open).

h. Designated service-tank fill valve.

i. Purifier discharge valve.

3. Start the purifier (press start button).

4. When the purifier bowl shell assembly attains 4,100 rpm (146 to 150 bumps per minute within 11 minutes), open the seal-water inlet valve.

5. Open the main water-discharge observation port on the cover assembly.

6. When water discharges past the observation port, close the seal-water inlet valve.

7. Start the designated transfer pump (press start button).

8. Slowly open the purifier inlet globe valve and throttle to maintain 9 psi inlet pressure. Then throttle the purifier discharge globe valve to maintain 30 psi back pressure.

9. Log the time the following were started:

a. Transfer pump.

b. Purifier.

CAUTION

Certain conditions will occur that will require the purifier to be left running for brief periods of time with no fuel flow. The purifier must then be placed in the standby mode to prevent overheating of internal parts.

NOTE

TO PLACE THE PURIFIER IN STANDBY MODE:

- Shut the purifier inlet valve.
- Stop the designated transfer pump (press stop button).
- Manually open the seal water valve to the purifier and admit a small flow (trickle) of seal water to the purifier.
- Check after 5 minutes and every 5 minutes thereafter to ensure the inlet-outlet housing and purifier bowl cover are cool to the touch.
- If the housing and cover are not cool to the touch, increase the flow of seal water.

10. While the purifier is running:

a. Log the designated transfer pump inlet and discharge gage readings.

b. Log the purifier inlet and discharge gage readings.

c. Take inlet and discharge samples:

(1) Analyze samples with the AEL Contaminated Fuel Detector Mk III.

(2) Log the results of the analysis.

11. When the designated transfer pump loses suction on the storage tank:

a. Close the purifier inlet valve.

b. Open the manifold valves for the next storage tank to be emptied.

c. Close the manifold valves for the already empty storage tank.

d. Repeat step 8.

12. When the service tanks are 95 percent full, stop the transfer operation. The procedure for stopping the purifier is as follows:

a. Close the purifier inlet valve.

b. Stop the designated transfer pump (press stop button).

c. Stop the purifier (press the stop button).

d. Do not engage the brake.

e. The purifier will coast to a stop (about 45 minutes).

f. As the purifier slows down:

(1) Centrifugal force diminishes.

(2) Feed inlet pressure will drop to zero.

(3) Discharge pressure will drop to zero.

g. Close the purifier discharge valve.

h. Close all valves still open.

i. Log the time the following were stopped:

(1) Designated transfer pump.

(2) Purifier.

j. Log the gross gallons removed from the storage tanks.

k. Log the net gallons transferred into the service tank.

Emergency stopping procedures are:

1. Press the purifier stop button.

2. Apply the hand brake (handle up).

3. Stop the transfer pump (press stop button).

4. Close the purifier discharge and inlet valves.

NOTE

Since the purifier discharge and inlet valves are closed in that order, JP-5 trapped in the purifier places an added resistance to rotation, thus helping to stop the purifier.

The procedure for starting the purifier with a dirty bowl is as follows:

1. Complete all the preliminary steps.

2. Complete steps 1, 2, and 3 as when starting with a clean bowl.

3. Open the purifier seal water inlet valve. The seal water flowing into the purifier keeps the bowl balanced as the purifier comes up to speed.

4. When the purifier attains full rpm, complete steps 5 through 12 as when starting with a clean bowl.

The position of the line of separation between the JP-5 and water is important to proper purification. For good purification, this line should be outside the disk stack but well under the top disk. If the line of separation is too far out, some or all of the JP-5 will dis-charge with the water. If the line of separation is too far in, water will discharge with the JP-5. The position of the line of separation depends upon the selection of the proper discharge ring. The discharge ring depends on the specific gravity of the JP-5. Once the specific gravity is determined, refer to the chart of discharge ring sizes (fig. 4-35).

Find the specific gravity number along the base of the chart. From this point, inscribe a vertical lineup the chart until it intersects with the solid curved reference

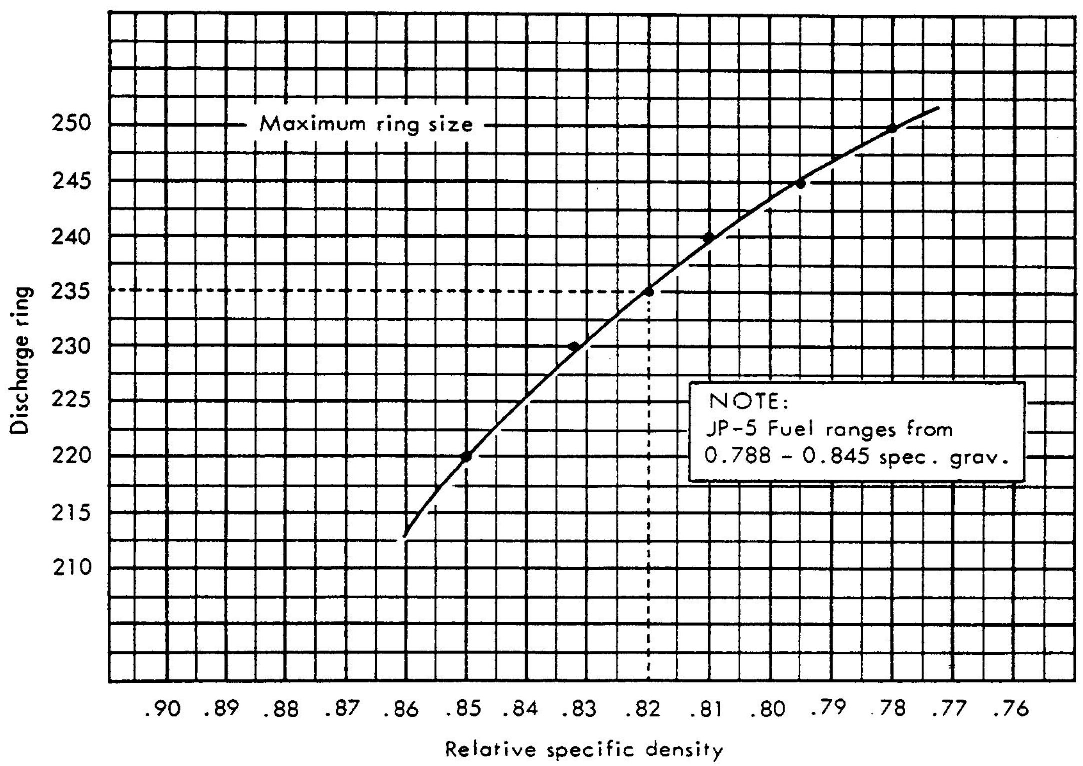


Figure 4-35.—Discharge ring size chart.

line. From the point of intersection, inscribe a horizontal line to the left-hand border of the chart. The numbers along the left-hand border do not exactly point to a ring number; always use the next smaller ring.

Install this ring in the purifier. Operate the purifier, and observe the JP-5 and water-discharge sight flow gages. If all of the discharge goes out the water discharge, the discharge ring is too large. Stop the purifier and install the next smaller ring. Make another trial. If necessary, repeat until JP-5 is properly discharged from the bowl shell assembly. If more than one trial is required, it generally indicates a mistake was made in determining the correct specific gravity or in using the discharge ring size chart.

CAUTION

When the seal water is cold, a small amount of JP-5 may discharge with the water at first. This will cease as the water, JP-5, and purifier heat up. In this case, it will not be necessary to change the discharge ring.

If water discharges with the JP-5, the discharge ring is too small; try the next larger ring.

When the proper size discharge ring is established, do not change it. As a general rule, the most satisfactory purification occurs when the discharge ring is the largest size possible without causing loss of JP-5.

During normal operations, there should be no more than a small discharge from the water outlet. The bulk of the discharge should be out the purifier JP-5 outlet.

If a large discharge from the water outlet is observed, it indicates excessive water in the feed, or the water seal has been lost. The operator should immediately determine whether the excessive discharge is water or JP-5.

If the excessive discharge is JP-5, the bowl has lost its seal. Stop the flow of feed; reprime the bowl; and slowly resume the flow of feed.

If the seal is again lost, immediately stop the purifier and check the discharge ring size and the bowl shell assembly's two robber seal rings. Correct the cause and resume operation.

If the excessive discharge is water, secure the operation and determine the source of the water. Sound the storage tanks with water-detecting paste and restrip the storage tanks as necessary.

NOTE

If the tanks have been properly settled and stripped, there should never be more than a trace of water in the feed.

If water has been put into the service tanks, they must also be stripped. If no water is found in the storage tanks, check the piping in the bilge, voids, etc., for leaks or other possible sources of water.

Purifier Maintenance

Establish and maintain a regular cleaning schedule, considering the following factors:

1. Accumulation of a large quantity of heavy solids in the bowl shell will cause the bowl to run rough. The bowl must be cleaned before the wet cake exceeds 30 pounds or 1 1/2-inch thickness at its thickest point.

2. If the purifier is to be inactive for less than 12 hours, it must be flushed out with freshwater while it is still operating, by using the priming water.

3. If the purifier is to be inactive longer than 12 hours, it must be disassembled and thoroughly cleaned.

4. In any event, the bowl must be disassembled and thoroughly cleaned at least once a week.

The purifier bowl should be inspected for corrosive pitting. If pitting is found, the bowl should be thoroughly cleaned with a mild abrasive cleaner in combination with stainless steel sponges. If pitting continues, the bowl should be reconditioned at the earliest opportunity.

Where pitting has progressed to 1/4-inch in depth, replace the bowl.

CAUTION

Continued use of deeply pitted bowls can be potentially hazardous.

When disassembling and assembling the bowl shell assembly for cleaning, you must remember that the parts are heavy. For this reason, a chain hoist and trolley have been provided to lift the parts and transport them to a deep sink. Be careful when raising, lowering, and transporting the parts. It is imperative that the chain hoist be centered directly over the center of the spindle before any part is raised or lowered.

To disassemble the purifier for cleaning, proceed as follows:

1. After stopping the bowl, remove the plugs and insert the lock screws. The two lock screws (one on each side of the purifier) enter the slots in the bowl shell, locking it in position.

2. Using the spring-loaded tee handle on top, unscrew the feed tube until it is free from the paring disk.

3. Loosen the three handwheel cover clamps and swing the bowl casing cover back until it engages the ratchet hook. This will automatically lock the cover in the open position.

4. Unscrew the bowl top coupling nut (fig. 4-36), using the special tool (inset, fig. 4-36) and remove the discharge ring and rubber ring.

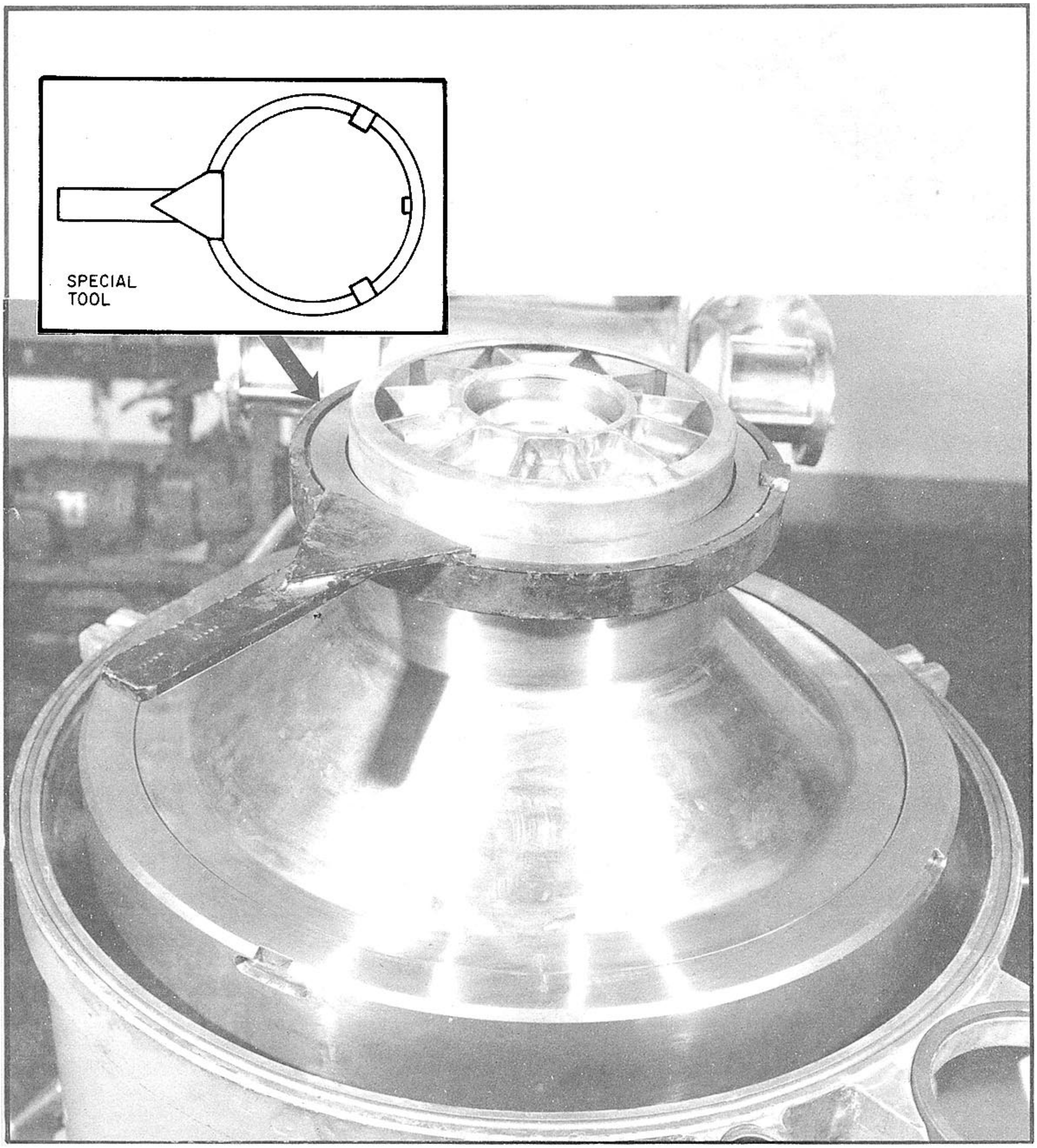


Figure 4-36.—Removing bowl top coupling nut (with special tool).

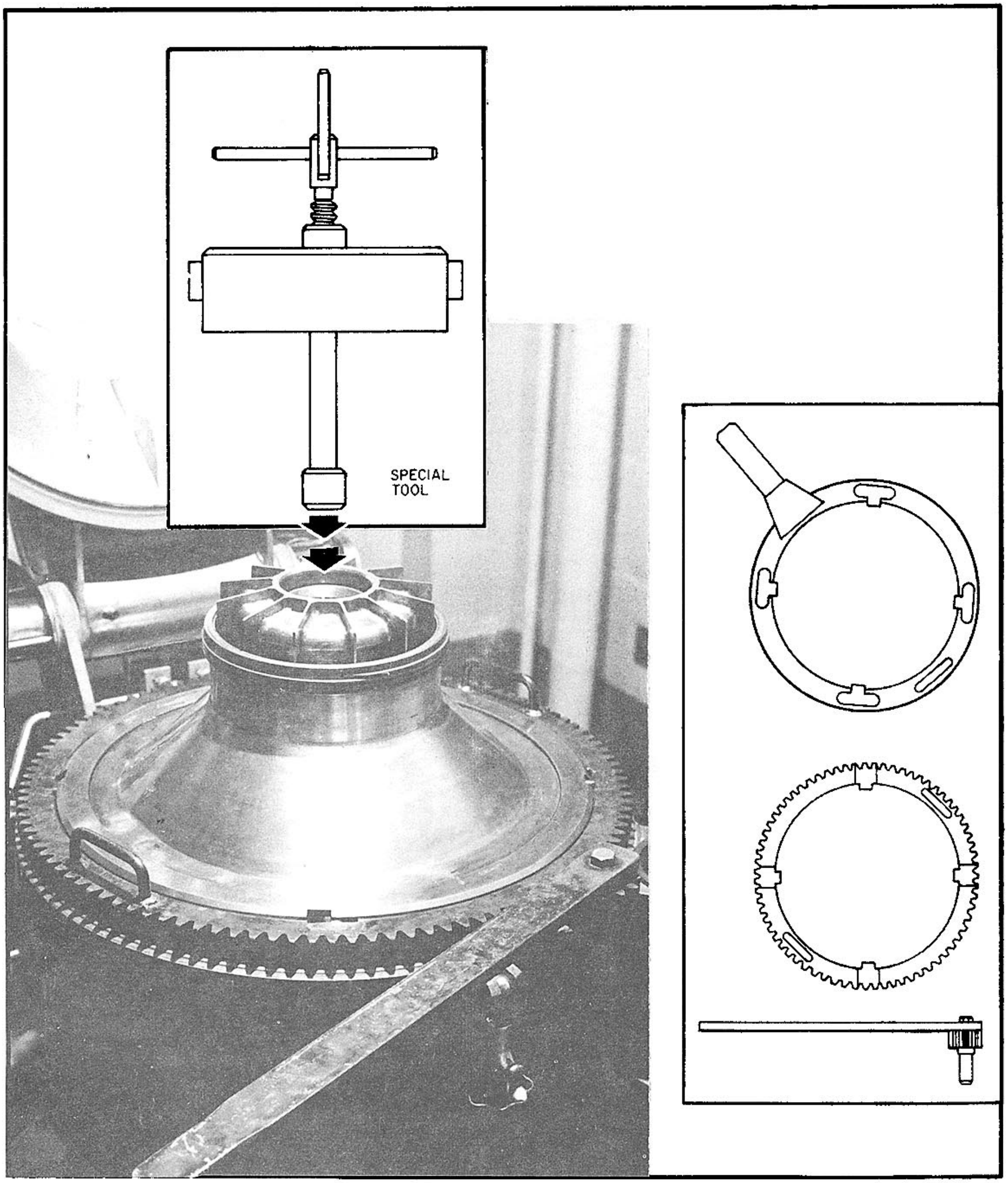


Figure 4-37.—Removing coupling ring (with special tool).

5. Remove the coupling ring (fig. 4-37) by loosening it first with the gear wrench, then unscrewing the coupling ring with the special tool.

6. After removing the coupling ring, screw the lifter into the bowl top. When you turn in on the T-handle jackscrew on top of the lifter, the bowl top will let loose from the bowl shell. Using the chain hoist, lift the bowl top off, being careful with the rubber ring. Remove the rubber bowl ring and lay it flat.

7. Remove the tubular shaft, top disk, paring disk, and intermediate disks, with the chain hoist, using the special tool provided. (See figure 4-38.)

8. If removal of the bowl is required, lift out the bowl strainer. Remove the spindle cap nut and back out

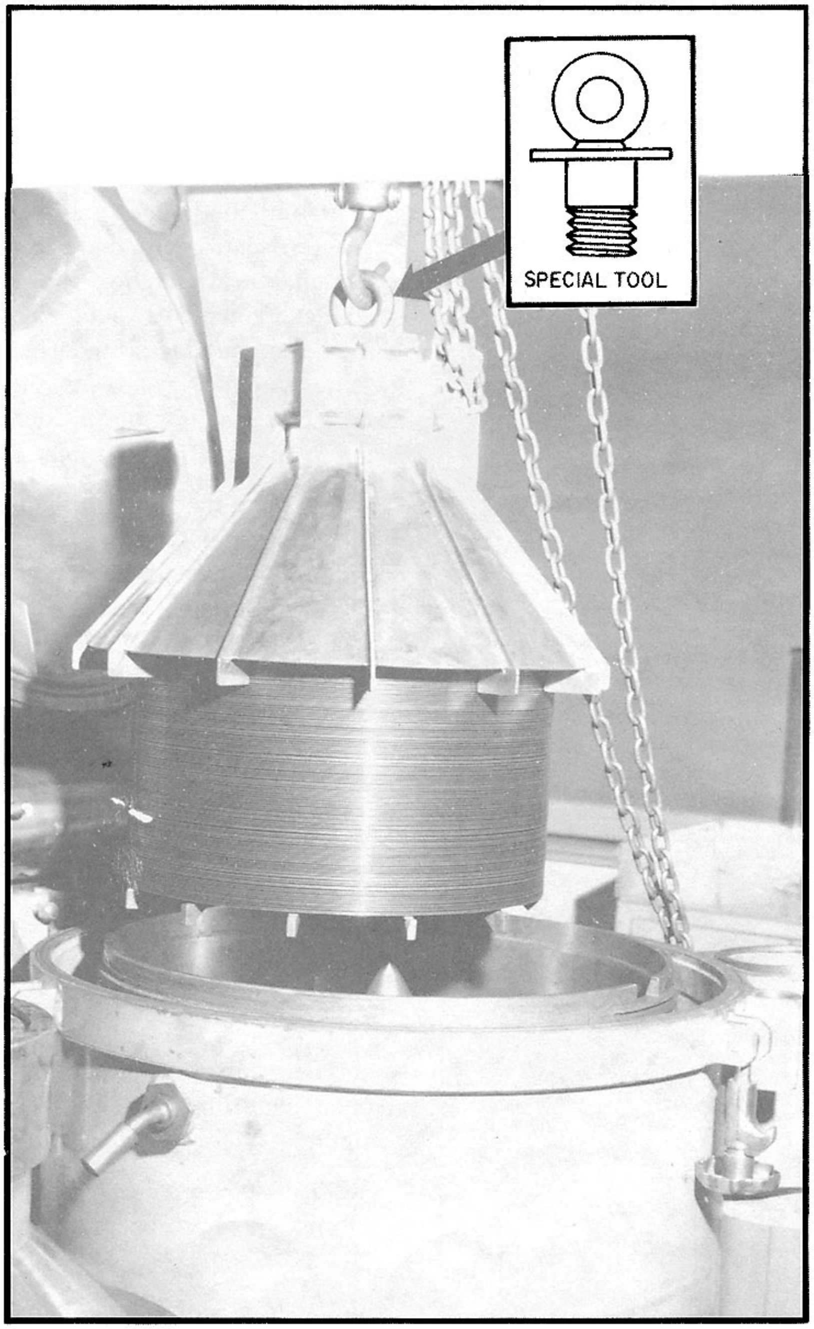


Figure 4-38.—Removing disk stack.

both lock screws. Screw the lifter (fig. 4-39) onto the bowl shell, and by turning in on the jackscrew the shell will loosen from the spindle. Using the chain hoist, lift the shell from the frame.

After the bowl parts have been disassembled, remove the rubber rings and clean the tubular shaft and disks with a brush, using JP-5 as the cleaning fluid. Reassemble in the reverse order.

0-rings and gaskets should never be hung vertically; lay them neatly on a clean, flat surface. Hanging will seriously distort the shape of 0-rings and gaskets. When installing 0-rings, always inspect them for nicks, cuts. or abrasions; use only good 0-rings. Examine the 0-ring retaining slots and other contact surfaces for nicks and burrs, and remove such before installing the ring. Make sure that the retaining slot and contact surface are clean, and coat the 0-ring with a light machine oil before installation.

Maintain the lubrication system in a perfect condition. Refer to the manufacturer's instruction manual and current Instructions about the type and amount of lubricant.

PRESSURE GAGES

Pressure gages are used throughout the AvFuels system to measure and indicate pressure so the operator of the equipment can maintain pressure at safe and efficient operating levels. A wrong pressure indication is often the first sign of trouble with the equipment. Any excess or deficiency in pressure should be immediately investigated.

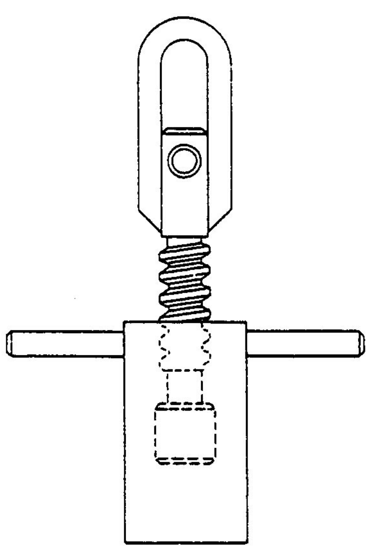


Figure 4-39.—Bowl shell lifter.

There are three types of gages the ABF will typically use in operating the AvFuels system: Simplex pressure gages, compound gages; and differential pressure gages.

Simplex pressure gages measure pressure only. The gage readings range from zero to the gage's maximum rated pressure. A Simplex pressure gage has two pointers: One, usually black or white, indicates the actual operating pressure of the system the gage is attached to; the other, usually red, is manually positioned to indicate the normal operating pressure of the system the gage is attached to. These gages are normally installed on the discharge side of pumps.

Compound gages are nearly identical to simplex pressure gages, with one exception. Compound gages can measure vacuum. The gage readings typically start at 30 inches of vacuum and increase to the gage's maximum rated pressure. The pointers are exactly the same as on the simplex pressure gage. These gages are normally installed on the suction side of pumps and the main deck filling connections.

Differential pressure gages are used to measure the pressure between two pressure lines. A differential pressure gage has only one pointer and does NOT measure actual pressure. It measures the pressure DIFFERENTIAL between two pressure sources. These gages are normally installed on vertical and reclaim filters.

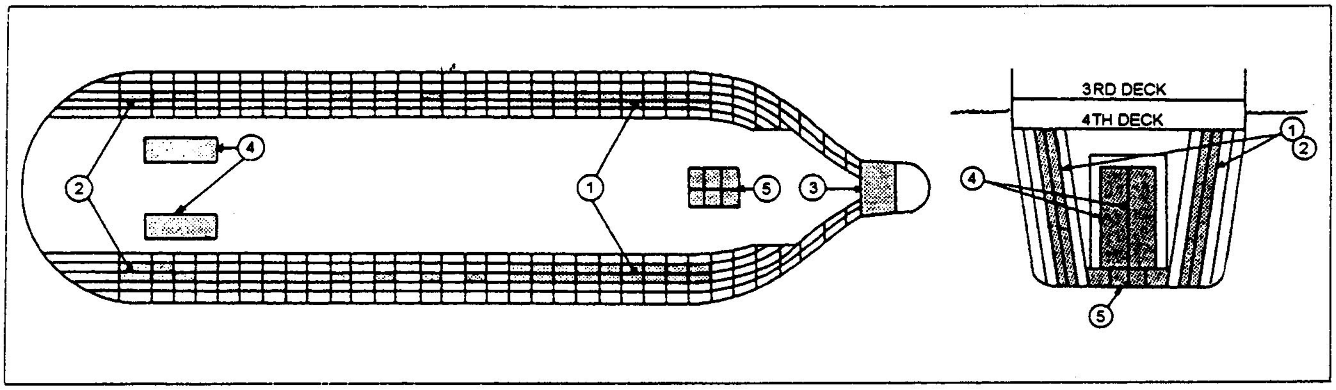
TANKS

Storage of aviation fuel aboard carriers has always presented a serious fire and explosion hazard. With the introduction of JP-5 as the primary jet fuel, hazards in handling were lessened and, because of the high flash point of JP-5 (minimum 140°F), protective storage is not required.

Basically, there are four types of JP-5 tanks: wing, deep centerline, double-bottom, and peak tanks. See figure 4-40 for the types and locations of JP-5 tanks.

Tank types generally relate to the relative location of the tanks in respect to the hull of the ship.

Wing tanks are deep tanks located in a forward and aft row along the contour of the hull on the port and starboard sides of the ship. There are normally two rows of wing tanks on each side. These tanks are located between voids and are an integral part of the ship's underwater protective system. The top of the



1 JP-5 wing tanks (forward group)
2. JP-5 wing tanks (after group)
3. Peak tanks
4. Deep centerline tanks
5. Double-bottom tanks

Figure 4-40.—Types of JP-5 tanks.

tank is at the fourth deck level, and the bottom is the shell of the ship. There are an equal number of port and starboard wing tanks in the forward group and in the after group. Each port tank has an identical twin of the same shape and capacity located directly opposite on the starboard side. These twins are operated as a unit; that is, they are filled and emptied as if they were one tank, to preserve the list and trim of the ship.

Deep centerline tanks referred to here were the original AvGas tanks on CVs that were converted to JP-5 tanks. Normally, all forward tanks and the after port tanks were converted. The cofferdams for the converted tanks are either filled with fresh water or used as service or storage tanks.

Seagoing vessels have two bottoms: a bottom and an inner bottom. The space between double bottoms is divided into many watertight compartments, which are used for storage of fuel, water, or ballast. These are called double-bottom tanks. The bottom of these tanks is the bottom or outer shell of the ship. The top of these tanks is the inner bottom, which is also the deck of the bilge. Double-bottom tanks are, by necessity, shallow tanks.

Peak tanks are deep tanks, which are located in the extreme bow and stem of the ship below the waterline. Only the bow tanks are used for JP-5 storage presently. The shell of the ship forms two sides and the bottom of each peak tank.

Fuel tanks, like all compartments aboard ship, are numbered to identify their location. Each tank has its own number. The first number indicates the deck level, the second indicates the frame, and the third indicates the tank's position in relation to the ship's centerline. Knowing the location of the tanks is a tremendous asset in learning your ship's fuel system. It will also help you locate the sounding caps for each tank's sounding tube. Generally, the cap will be one or two decks directly above the tank it serves. Every sounding cap is marked with its tank number. Sounding caps are X-ray fittings and must be replaced tightly after each use.

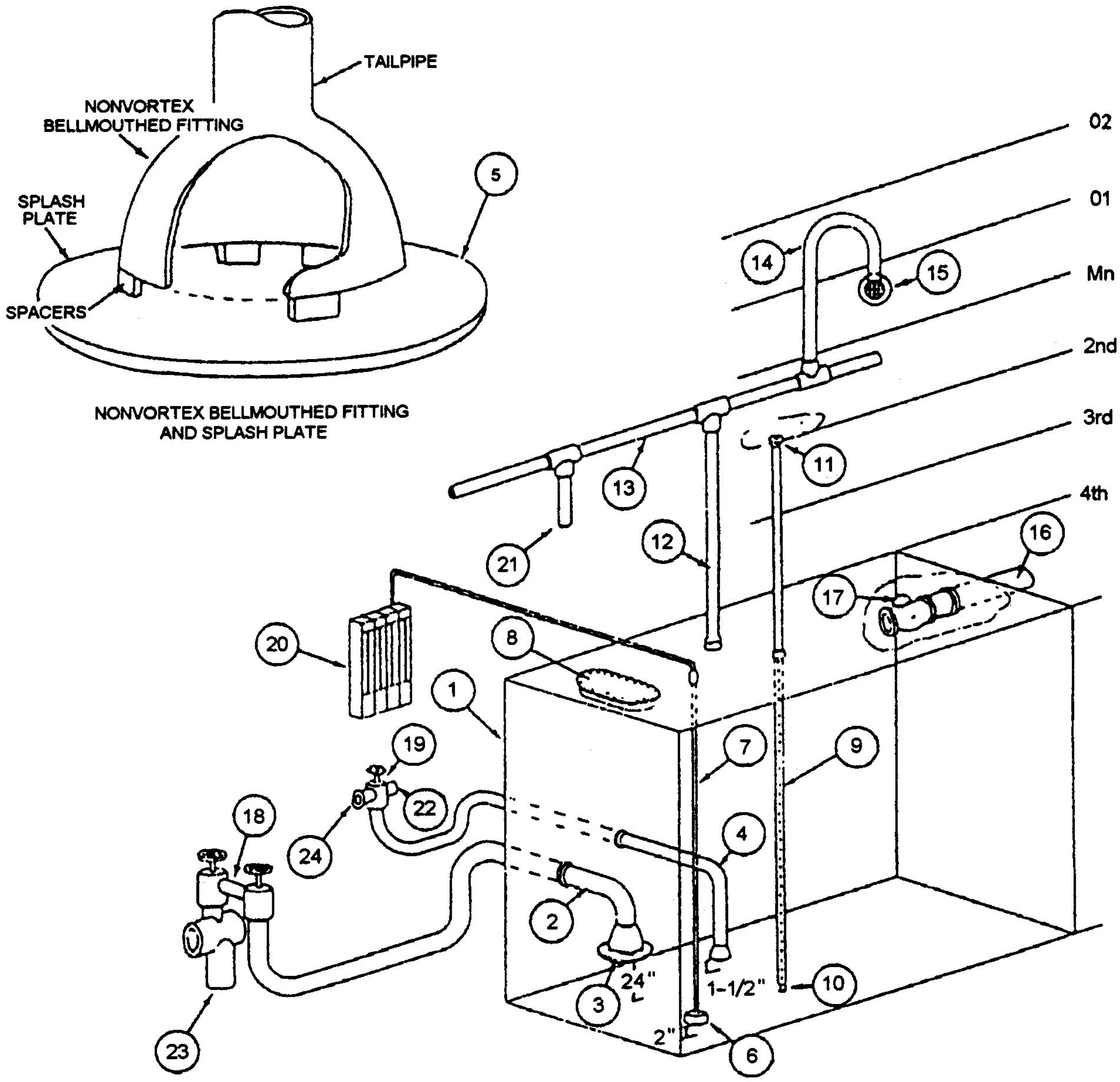
JP-5 tanks are designed and constructed to fulfill specific purposes and are classified under two major categories: STORAGE and SERVICE.

A *storage tank* is any tank used for the bulk storage of JP-5. Any wing, deep centerline, double-bottom, or peak tank can be used for bulk storage. A service tank is any tank used for storage of JP-5 suitable for issue to aircraft. The JP-5 in a service tank has been passed through either a filter or a centrifugal purifier before being pumped into the *service tank*. Generally, only wing or deep centerline tanks are used for this purpose. Service tanks have but one purpose: servicing aircraft. But storage tanks can be used for several purposes. The designation of each tank indicates purpose of that tank.

JP-5 Storage Tanks

A typical JP-5 storage tank with associated piping is shown in figure 4-41. Each JP-5 storage tank and the piping within the tank are sandblasted

is shown in figure 4-41. Each JP-5 storage tank and the piping within the tank are sandblasted to bare metal and coated with a protective coating to minimize rust formations. An air escape riser that vents the tank to the atmosphere extends from the top of the tank to an air escape



1. Tank
2. Fill and suction tailpipe
3. Nonvortex bellmouthed fitting and splash plate
4. Stripping tailpipe
5. Nonvortex bellmouthed fitting
6. Magnet-equipped float
7. TLI transmitter
8. Manhole
9. Sounding tube
10. Striker plate
11. Sounding tube cap
12. Air escape riser manifold)
13. Air escape main
14. Air vent
15. Flame arrester
16. Overflow line
17. One-way check valve
18. Suction and fill manifold (double or single-valved
19. Stripping manifold
20. TLI receiver
21. Connection to other tank air escape risers
22. Connection to other tank valves
23. Connection to transfer main branch header
24. Connection to flood and drain manifold

Figure 4-41.—Typical JP-5 storage tank.

The air escape riser (vent line) prevents a buildup of pressure when the tanks are being filled and prevents a vacuum from forming when the tanks are being emptied.

There are usually four air escape mains serving the forward and after groups of tanks: two forward (one port and one starboard) and two aft (one port and one starboard). A cane-shaped vent line extends up from each main to just below the 02 level and loops back down to just below the 01 level, where it terminates in scan. One end of the can, which contains a flame arrester, penetrates the skin of the ship and is open to the atmosphere. The outboard end is covered with a ratproof screen, and the inboard end is closed by an inspection plate. The flame arrester is cleaned quarterly.

CAUTION

The ship's side cleaners should be cautioned about spray painting near these vents. Sprayed paint can stop the flow of air through the vents by clogging the flame arrester.

An overflow line extends from near the top of the storage tank to an overflow tank. This line is considerably larger than the tank fill line to prevent rupture of the storage tank in the event of overfilling at high pressure. When the tank is full, it will overflow via a one-way check valve into the overflow tank for that nest of tanks.

NOTE

A *nest of tanks* is that small unit of tanks within a group of tanks that is serviced by one overflow tank. The forward and after groups of storage tanks consist of several nests of tanks.

A bolted manhole cover provides access to the tank for inspection, cleaning, and maintenance. A sounding tube extends from the extreme bottom of the tank to the second or third deck. The lower end is secured to a striker plate, and the upper end is closed by a threaded access cap. That section of the sounding tube within the tank has evenly spaced holes to ensure that the level of fuel in the tube is the same as that in the tank. Sounding tubes are provided for measuring the quantity of JP-5 in the tank, detecting water, and thieving a sample.

The suction and fill tailpipe extends from the manifold to terminate between 6 to 24 inches off the bottom at the lowest end of the tank. A nonvortex bellmouthed fitting and a splash plate are installed on the end of the tailpipe. This fitting reduces turbulence when filling, prevents a vortex from forming when emptying the tank, and prevents taking a suction directly off the bottom. Storage tanks are filled and emptied through this line.

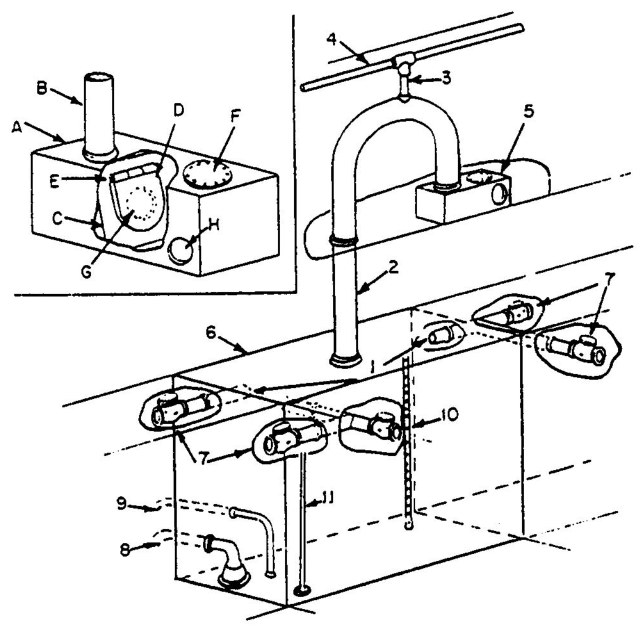
The stripping tailpipe is similar in design to the suction and fill tailpipe except it is smaller and has no splash plate. This line extends from the stripping manifold to a maximum of 1 1/2 inches off the bottom at the lowest end of the tank. The stripping tailpipe is used to remove water and sludge from the bottom of the tank and to completely empty the tank by removing the last 24 inches of usable JP-5 when consolidating the fuel load. The stripping tailpipe is also used when ballasting and deballasting the storage tanks.

NOTE

JP-5 storage tanks have a filling rate of 500 gpm per tank, with the required minimum of six tanks on the line.

JP-5 Overflow Tanks

Overflow tanks (fig. 4-42) have the same fittings previously described for the storage tanks, except for



A. Overflow box
B. Overflow line
C. Dividing bulkhead
D. Flapper check valve
E. Hinge
F. Access cover
G. Hole through dividing bulkhead
H. Hole through ship's skin
1. Overflow from storage tanks in the nest
2. Overflow line
3. Air escape riser
4. Air escape main
5. Overflow box
6. Overflow tank
7. One-way check valves
8. Fill and suction tailpipe with nonvortex fitting
9. Stripping tailpipe
10. Sounding tube
11. TLI transmitter

Figure 4-42.—Typical JP-5 overflow tank.

the large overflow line and the arrangement of the vent line. In addition to serving as a regular storage tank, they are also designed to receive the overflow from the other storage tanks in their respective nest.

The overflow tanks are actually a safety feature to prevent rupturing of storage tanks if they are over-pressurized during a filling operation. The overflow tanks overflow overboard when they are full. The large overflow line extends up from the top of the tank to just below the second deck. Here it loops back down and discharges into an overflow box on the third deck. The overflow box contains a flapper check valve that allows JP-5 to be discharged overboard but prevents seawater from entering the tanks. An inspection plate located directly over the valve allows access for cleaning and maintenance. In the past, flapper check valves have frozen open due to corrosion, and seawater contamination of JP-5 has resulted. These valves must. therefore, be inspected at least every 6 months (more often if necessary).

The overflow tanks are vented via an air escape riser from the top of the loop in the overflow line to one of the common air escape mains. Overflow tanks are the last tanks to be filled when receiving JP-5 aboard and are the first tanks to be emptied when transferring internally.

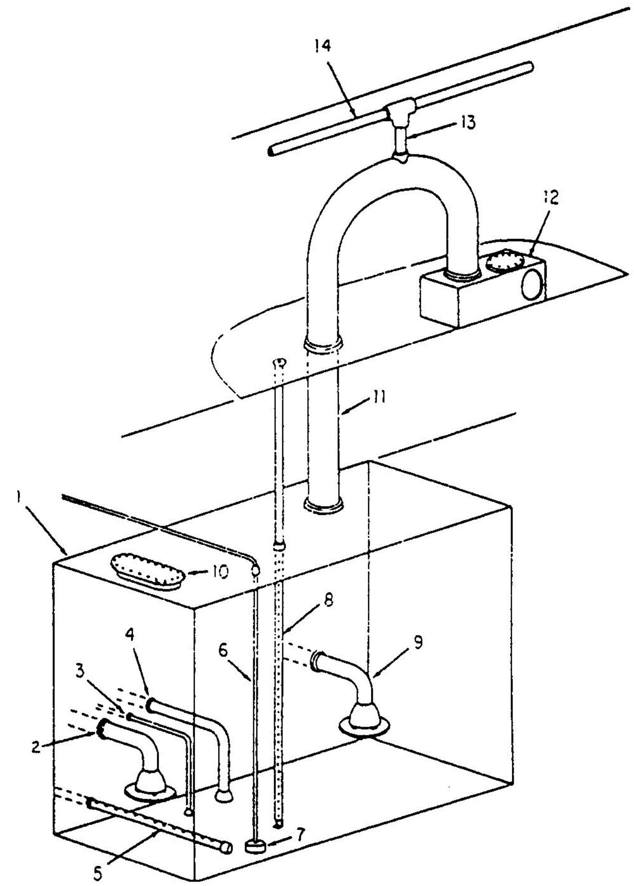
Contaminated-JP-5 Settling Tanks

The contaminated-JP-5 settling tanks are designated tanks that receive JP-5 from hose flushings, defuels, tank stripping operations, and the initial flow during a refueling at sea. In addition to standard piping, these tanks have piping branching from the defuel mains. Each branch of defuel piping going into a contaminated settling tank must terminate about 48 inches above the bottom of the tank, with a perforated horizontal run about 24 inches long to reduce turbulence.

After stripping, JP-5 transferred from these tanks will be transferred via a JP-5 reclamation prefilter and JP-5 reclamation filter/separator, in that order, to the storage tank manifold of the selected storage tank to be filled.

JP-5 Service Tanks

Although much of the equipment in the service tanks (fig. 4-43) is similar to that described in the storage and overflow tanks, the piping arrangement is different and additional equipment is required.



1. Service tank
2. Filling tailpipe with nonvortex fitting
3. Hand pump stripping tailpipe
4. Motor-driven stripping tailpipe
5. Horizontal recirculating line
6. TLI transmitter
7. Magnet-equipped float
8. Sounding tube
9. Suction tailpipe with nonvortex fitting
10. Manhole
11. Overflow line
12. Overflow box
13. Air escape riser
14. Air escape main

Figure 4-43.—Typical JP-5 service tank.

Service tanks have an independent filling tailpipe and an independent suction tailpipe. The filling tailpipe branches from the service tank fill line header in the JP-5 pump room to terminate in a non-vortex bellmouth fitting between 6 to 24-inches off the tank bottom. Additionally, the termination height will beat least 3 inches lower than the suction tailpipe. Service tanks are NEVER filled directly from a tanker, barge, or pier. They are always filled from settled storage tanks, via the centrifugal purifiers.

The suction tailpipe extends from the service pumps common suction header to terminate in a non-vortex bellmouth fitting either 12 or 24-inches off the tank bottom in the opposite end from the fill line.

NOTE

Height of termination above tank bottoms for service tank suction tailpipes for CV/CVNs, LHAs, and LPHs is 24 inches for wing tanks and 12 inches for innerbottom tanks. For other ships, the height is 12 inches.

A shut-off valve is installed in this line between the service pump common suction header and the service tank.

Two independent stripping systems, one hand-operated and the other motor-driven, are installed in each service tank. The hand operated stripping is used for normal stripping of the service tanks. The use of the low velocity hand operated pump eliminates turbulence in the tank while stripping, which improves the efficiency of the stripping operation. The tailpipe for the hand operated stripping pump extends from a maximum of 3/4-inch off the service tank bottom to the hand operated pump in the pump room.

The motor-driven stripping system for service tanks is primarily used to completely empty the tanks and to remove the wash water after a cleaning operation. The tailpipe for the motor-driven stripping pump extends from a maximum of 1 1/2-inches off the tank bottom to the common suction header of the motor-driven stripping pumps. This line contains a shutoff valve, a one-way check valve, and a blank flange.

A recirculating line is installed horizontally 18-inches off the tank bottom in the opposite end from the suction tailpipe. This line provides a means of returning to the service tank the recirculated fuel from the discharge side of the service pump. A number of 1-inch holes, equally spaced along the top of the recirculating line allow JP-5 to be returned to the tank without disturbing the contents of the tank. Foaming is minimized since the recirculating line is always covered with JP-5.

Tank Inspection and Cleaning

WARNING

No person is to enter any JP-5 tank for inspection or cleaning until the conditions for safe entry specified by the Gas-Free Engineer (or his authorized representative) have been strictly complied with.

If the inspection reveals that bulkheads, stiffeners, and flat surfaces have collected solids that are readily visible, storage tanks are washed with sea water from a firehose. Service tanks are normally just wiped clean, but if washing is required, use fresh water only. Wash water is removed from storage tanks designated JP-5 or ballast by the main drainage eductor, and from service tanks and storage tanks (designated JP-5 only) by the JP-5 motor-driven stripping pumps.

The above procedures are followed if the operation is conducted at sea. If conducted in port, assistance by a shore activity and changes in the wash water removal procedure are required to prevent harbor pollution.

Due to the ease with which deposits can be washed out of JP-5 tanks with a firehose, steaming is not required nor should it be employed since the tank coatings may be damaged.

JP-5 tanks are never cleaned by the chemical cleaning processes using solvent-emulsifier type compounds. Small quantities of chemical type cleaners remaining in the tanks will contaminate the coalescer elements in the filter/separator and destroy their coalescing ability.

When conducting the inspection and cleaning of JP-5 tanks, refer to applicable Maintenance Requirements Cards for correct procedures and safety precautions to be followed.

GEMS TANK LEVEL INDICATING (TLI) SYSTEM

The Gems TLI system (fig. 4-44) consists of a transmitter, jumper cables, receiver, and a magnet-equipped float.

The transmitter is mounted vertically within the tank by brackets or flanges. A voltage divider network is located inside and extends the full length of the transmitter assembly. This network is comprised of magnetic reed switches tapped in at one-inch intervals between the switch centers. The switches are connected, in turn, through series resistances, to a common conductor, and by means of the cable system to the indicating meter in the receiver. The ends of the voltage divider are connected to the power supply output. The power supply output is adjusted to 10 volts dc by the calibrate potentiometer in the primary receiver.

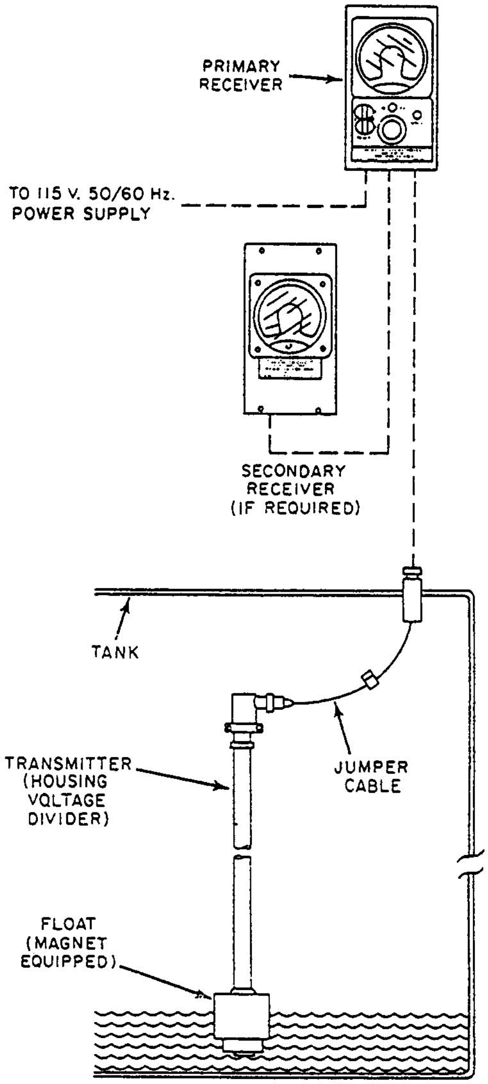


Figure 4-44.—Gems TLI system.

Depending on the size and shape of the tank being gaged, the transmitter assembly may be a single unit, or a number of units connected together. Figure 4-45 shows two transmitters being used to gage a tank.

The magnet-equipped float moves along the transmitter as the liquid level changes. As the float moves. the magnetic field pattern of the float operates the tap switches. The tap switches are so arranged inside the transmitter that voltage drops are read at the receiver for each 1/2-inch of float travel.

The primary receiver is connected to the transmitter by the cable system. Since the receiver meter indicates the voltage drop from the bottom of the voltage divider to the point of tap switch closure, the readings correspond directly with the liquid level. Included in the primary receiver housing, in addition to the indicating meter, are the dc power supply, electrical slosh dampening control, and all system and alarm controls.

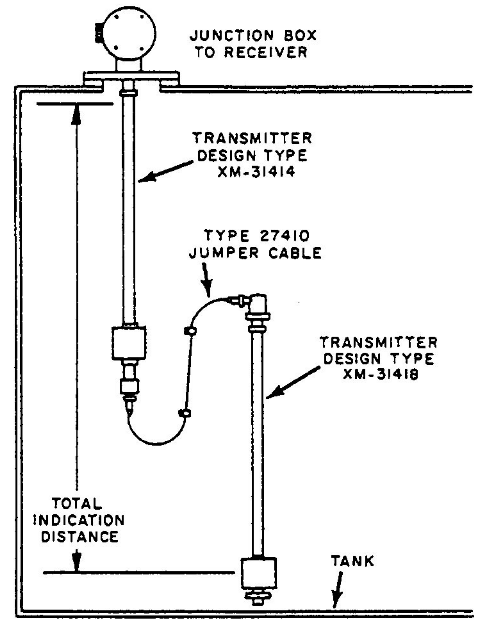


Figure 4-45.—Multitransmitter arrangement.

See figure 4-46 for the various types of primary and secondary receivers.

The primary receiver also provides for connection of one or more secondary receivers. The secondary receiver, if used, contains an indication meter only.

The system is safe, since currents in the transmitter circuit are so low as to be incapable of causing an explosion, even with the transmitter located in the most volatile liquids or hazardous vapors.

CAUTION

The transmitter or receiver should NOT be tampered with or modified in any way other than as directed in the operation and maintenance manual.

The following is a brief description of the system controls.

ON-OFF-FULL REF. TOGGLE SWITCH: Operates as follows to control the ac input to the power supply and the indicating meter circuit:

Toggle in ON position (normal operation): 115 volt, 50/60 Hz applied to the power supply. Indicating voltmeter connected through series resistance to the transmitter tap switches.

Toggle in OFF position: Power supply line and indicating meter circuits are open. System is off.

Toggle in FULL REF. position (must be held in this position): ac line voltage is applied to power supply. Indicating meter is connected across entire transmitter voltage divider and cabling for system calibration.

CALIBRATE POTENTIOMETER. Screwdriver adjusted, with toggle switch held at FULL REF. position, it is adjusted to provide 10 volts dc across the entire transmitter, voltage divider, and cabling, as indicated by a full-scale meter reading. With the potentiometer properly adjusted. when the toggle switch is placed in the FULL REF. position, a full-scale meter reading indicates that all cables and electrical connections are good.

ELECTRICAL SLOSH DAMPENER. To prevent meter fluctuation as a result of erratic float

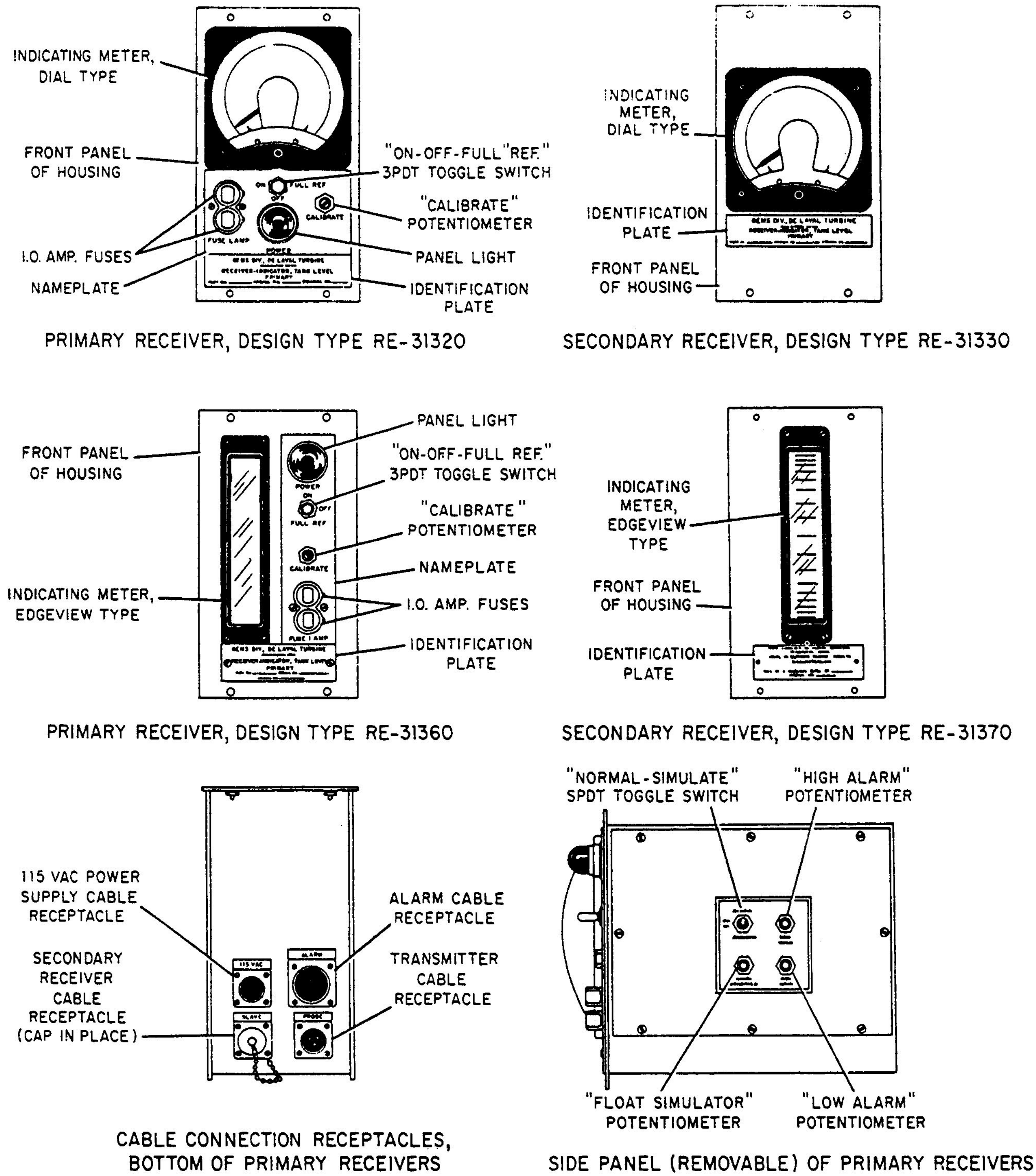


Figure 4-46.—Primary and secondary receivers.

movement caused by sloshing in the tank, a capacitor is connected across the indicating meter to delay the response (normally 3/4 second) of the meter to the transmitter signal.

ALARM CONTROL SYSTEMS. Known as a SENS-PAK alarm, its controls function integrally with the tank level indication system to sense high, low, or intermediate levels of tank liquids (as appropriate) and actuates an alarm. The modular, plug-in SENS-PAK units (fig. 4-47) are actuated by voltage signals from the indicating system transmitter. These units may or may not be included in the primary receivers.

Although all primary receivers are prewired for a maximum of two SENS-PAK units, normally used for high and low level alarms, additional control units may be incorporated in separate housings within the same system on advice from the factory.

SENS-PAK alarm control adjustments are located on the side of the receiver (refer to figure 4-46 [side panel]) and function as follows:

Normal simulate switch—Substitutes the float simulator circuit for the transmitter in the indicating meter circuit for alarm adjustment.

Float simulator potentiometer—Simulates the total transmitter voltage divider resistance change over the full range of float travel.

High alarm potentiometer—Sets the actuation voltage level of the high alarm SENS PAK.

Low alarm potentiometer—Sets the actuation voltage level of the low alarm SENS PAK.

This system surpasses the 3% accuracy requirement of military specifications. But, the accuracy will vary depending on the size tank being gaged and the type receiver used.

NOTE

The Gems TLI systems are also approved for indicating the interface level of two liquids having different specific gravities.

With the ON-OFF-FULL REF. toggle switch on the primary receiver in the ON position, operation of the system, and alarms if included, is completely automatic. Tank liquid level is read directly from the indicating meter on the primary or secondary receiver as required. No further attention is necessary, as the Gems TLI system can operate indefinitely without any component degradation.

The only maintenance that should be required is cleaning of the transmitter and float when tanks are opened for inspection and cleaning.

CONSOLES

The control console ushered in the modem era for the ABF. It provides us with the ability to control and monitor nearly all operations from one central location. While the console relieves you of a lot of footwork, it requires an in-depth knowledge of your ship's systems and capabilities.

Each console (fig. 4-48) consists of a control panel with a mimic diagram, various selector

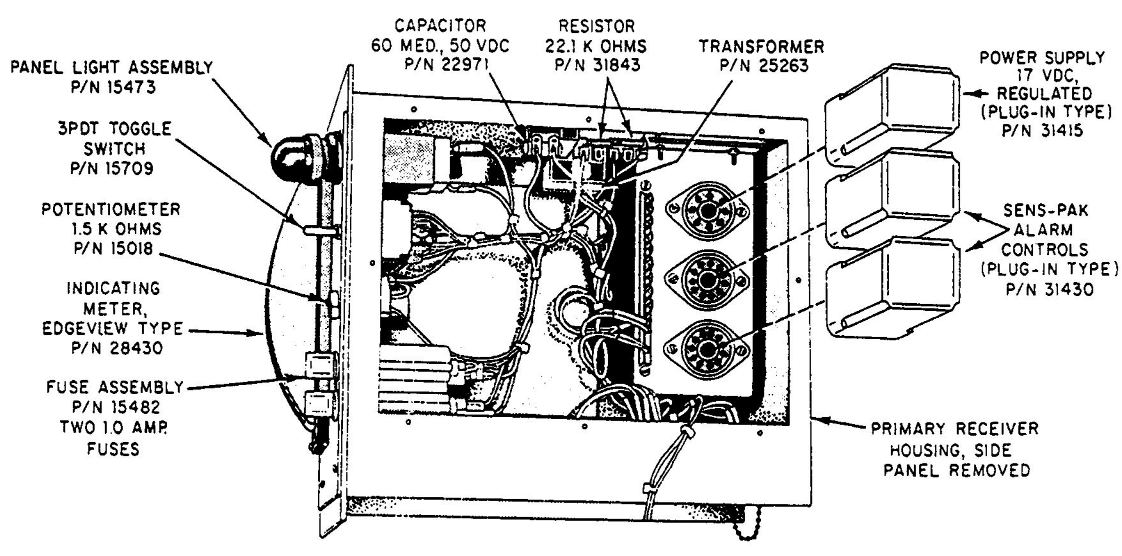


Figure 4-47.—Primary receiver interior.

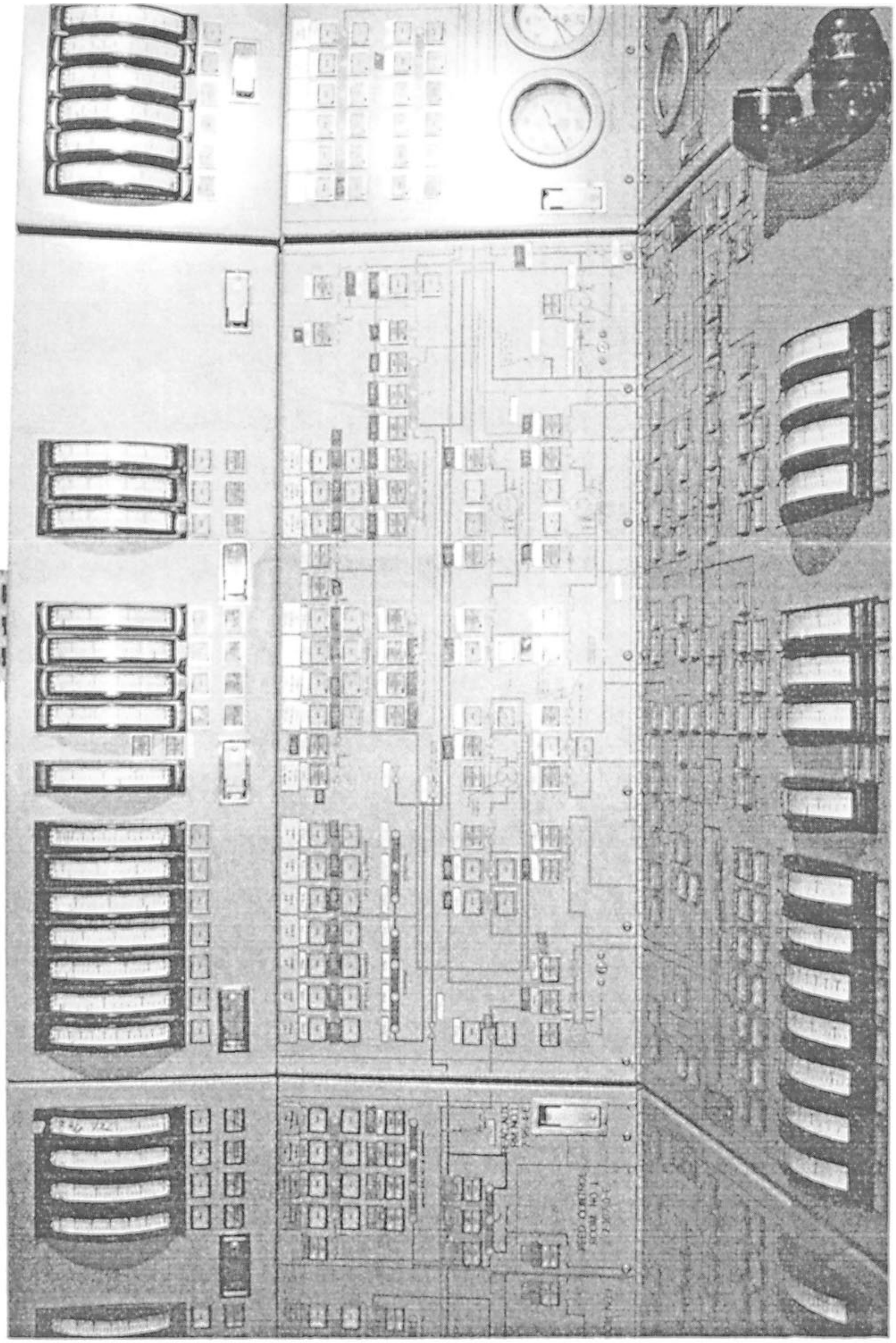


Figure 4-48.—Control Console.

switches, alarms and indicators. Specifically each console contains the following:

1. A **mimic diagram** colored to indicate JP-5 (purple), drainage (green), stripping (red), and miscellaneous (black) systems operated and/or monitored from the control console. The mimic also indicates the outline of the ship and shows components in their relative locations. Monitoring and control devices appear near or in the symbol served. The mimic on each console shows only the system served by the adjacent pump room except the filling and transfer mains; the filling system on 2nd and main deck are shown on both consoles. The drainage and ballast system shown is the part that serves the JP-5 or ballast and JP-5 over-flow or ballast tanks.

2. **Liquid-level indicators** for the JP-5, JP-5 or ballast, JP-5 overflow or ballast, JP-5 service, JP-5 defueling and contaminated-JP-5 settling tanks.

3. **"Full"-indieator (red) lights** for each tank. These lights are located adjacent the level indicator and are on when the tank reaches its operating capacity.

4. **Seawater-detector (green) lights** for JP-5 or ballast and JP-5 overflow or ballast tanks. These lights are located adjacent the level indicator and are on when seawater is present within the tank. These tanks also have white lights, which indicate the presence of JP-5 within the tank.

5. **Control switches** for starting and stopping the JP-5 service pumps.

6. **Indicator lights for valve positions** (open/-**shut)** for all motor operated valves and other valves (manually operated) whose position must be monitored at the console.

7. **Power indicator lights** for JP-5 purifiers and pumps (except auxiliary JP-5, jet engine test facility, JP-5 defuel pumps).

8. **Audible and visible overflow alarms** that warn when any tank having an independent overflow that overflows overboard reaches the 98 percent full level. A control switch is provided to silence the audible alarm.

9. **Seawater cleavage indicator lights** for contaminated-JP-5 settling tanks. The lights come on successively when seawater in the tanks reaches the 6-inch, 2-foot, 4-foot and 6-foot levels.

10. **Control switches** (open/shut) for positioning the selected electric motor operated valves.

11. **Override switches** that reenergize the circuit that closes tank cutout valves when the tank reaches operating capacity. This allows complete tank filling when desired. One switch controls a specific zone.

12. **Pressure gages** for firemain water to eductors and eductor suctions. These are the eductors used to deballast JP-5 or ballast and JP-5 overflow or ballast tanks.

Circuit Description

You might ask why an ABF needs to know the control circuits of a JP-5 console. We are operators of the console, not electrical repair personnel. In one respect, you are right, we do no repair work on the consoles. But you need to know how the circuits are interconnected to prevent specific things from happening, such as a storage tank valve that will not open because a saltwater level light is on for that tank.

Each console includes circuit operations as follows:

1. Circuit for JP-5 or ballast tank and JP-5 overflow or ballast manifold valve interlocked with manifold root valve. This circuit actuates the manifold valve either open or shut by a switch on the control console. Additional features of this circuit are:

a. Circuit automatically shuts manifold by high level detector circuit.

b. Circuit interlocks the root valve operation with the manifold valve. The root valve opens when any manifold valve is opened. The root valve closes when all manifold valves are closed.

c. Circuit does not allow manifold valve to open if sea water detector circuit indicates water in the tank.

d. Circuit monitors valve positions by open and shut lights on control console.

2. Circuit for JP-5 service tank suction and recirculating valves. This circuit actuates the suction valve either open or shut by a switch on the control console. The circuit interlocks the recirculating valve with the tank suction valve for the same tank so both valves open and shut simultaneously, circuit monitors valve position by open and shut lights on control console.

3. Circuit for JP-5 tank and JP-5 service tank fill manifold and gate valves. This circuit actuates the valves either open or shut by a switch on the control console. Circuit automatically shuts the valve by a high

level detector circuit and monitors the valve position by open and shut lights on the control console.

4. Circuit for drainage eductor actuating and overboard discharge valves. This circuit actuates the valves either open or shut by switches on the control console. Additional features of this circuit are:

a. The circuit stops the actuating valve in any intermediate position to allow throttling of eductors actuating supply.

b. Actuating valve is interlocked with the overboard discharge valve to prevent opening until the overboard discharge valve is opened.

c. The overboard discharge valve is interlocked with the actuating valve to prevent closing until the actuating valve is closed.

d. Circuit monitors valve position by open and shut lights on the control console.

5. Circuit for stripping, ballast, and drainage valves in the drainage system three-valve interlocked manifold. These circuits actuate the valves either open or shut by switches on the control console. Additional features of the circuits are as follows:

a. The three circuits are interlocked together to permit opening only one valve at a time. If any one of the three valves are open the other two are held closed by the circuits.

b. Stripping valve circuit bypasses the saltwater detector circuit to allow the JP-5 or ballast storage tank drainage manifold valves to be opened.

c. Circuit monitors valve positions via open and shut lights on control console.

6. Circuit for JP-5 and JP-5 service tank electric motor operated stripping manifold valve. This circuit actuates the valve either open or shut by a switch on the control console. Circuit monitors valve positions by open and shut lights on control console.

7. Circuit for JP-5 or ballast and JP-5 overflow or ballast tank drainage electric motor-operated manifold valves. This circuit actuates the valves either open or shut by a toggle switch on the control console. This circuit is interlocked with the seawater detector in the tank to prevent opening the valve if JP-5 is in the storage tank. The seawater detector interlock is bypassed when the stripping valve in the three valve interlocked drainage manifold is opened. Circuit monitors valve positions by open and shut lights on control console.

8. Circuit for selected JP-5 and drainage cutout valves. This circuit actuates the valves either open or shut by a switch on the console. Circuit monitors valve positions by open and shut lights on console.

9. Circuit for monitoring valve positions for valves that are manually operated and have limit switches at open and shut positions to actuate "open" and "shut" lights. Circuit actuates "open" and "shut" lights when in intermediate positions and shut off "open" light when valve is closed and shut off "shut" light when valve is open.

10. Circuit for starting and stopping JP-5 service pump. This circuit actuates the pumps to start and stop by a switch on the control console. Circuit monitors pump operation via "on" and "off" lights on control console.

11. Circuit for monitoring selected pump and purifier positions. The circuit actuates "on" lights when equipment is running and actuate "off" lights when equipment is not running.

12. Circuit for high level detector override. This circuit overrides the high level circuit of the tank level gage system to allow transferring fluid out of the tank or topping off the tanks to 100 per cent full.

13. Circuit for the electric motor operated JP-5 gate valves in shaft alleys No. 1 and 4. This circuit actuates the valves either open or shut by a switch on the forward console. Circuit monitors valve positions on both the forward and aft console by open and shut lights.

JP-5 FUELING SYSTEM OPERATIONS

LEARNING OBJECTIVE: Identify various JP-5 fuel system operations. Explain proper procedures for each operation.

Underway replenishment, transfer of fuel from one tank to another, and pumping fuel to the flight and hangar decks are everyday facts of life for the ABF. If proper procedures are followed, they are smooth and safe operations. If proper procedures are not followed, the operations become outright dangerous.

AVIATION FUELS OPERATIONAL SEQUENCING SYSTEM (AFOSS)

As stated before, though much of the equipment and operating procedures are similar from ship to ship, the fact is no two ships are alike. For this reason, the Aviation Fuels Operational Sequencing System (AFOSS) was developed to provide each ship with tailor made correct written technical operating procedures for the equipment installed on that specific ship. Every fueling evolution performed by the ABF will have an AFOSS procedure and that procedure MUST be followed.

AFOSS is developed into three operational stages. These stages are actually three copies of AFOSS designed around the purpose of each copy's use. They are as follows:

1. The Division Officer's copy
2. The Work center copy
3. The Work station copy

The Division Officer's copy contains the following:

1. An index page.
   a. Assigns each fueling evolution a title and number.
2. Step by step operating procedures for all evolutions concerning the fuels system.
3. A liquid level status diagram.
   a. Lists all tanks by tank number.
   b. Shows relative location.
   c. Indicates each tank's designation.
   d. Gives the capacity of each tank.
   e. Provides a space to show the current amount of fuel in each tank.
4. Training diagrams and charts.
   a. Shows each system.
   b. Indicates component locations.
   c. Gives the piping layout.
   d. Shows how different subsystems interrelate.

The Division Officer's copy is the master AFOSS for the division. It is used for training, scheduling and coordinating fueling evolutions, and insuring operations are properly conducted.

The work center copy is located in and applies only to a specific work center (flight or below decks) and contains the above information applicable to that work center only.

The work station copy is located in and applies only to a specific work station (JP-5 filter, JP-5 pump room, lube oil pump room) and contains the above information applicable to that work station only.

AFOSS operating procedures are prepared in a logical, detailed manner. They cover each fueling evolution and specific equipment used. They are also be used as a troubleshooting guide and as a reference for fuels casualty drills.

The operations discussed on the following pages are for training purposes and are based on typical procedures used during those operations. The specific procedures for operations aboard a particular ship will be in that ship's AFOSS. USE IT!

SOUNDING TANKS

While the tank level indicating equipment in use today is extremely reliable, the only 100% positive way to know how much and exactly what is in a tank is by sounding the tank. Sounding tanks is a simple procedure that has been used for as long as ships have sailed the sea. In the following paragraphs, we will discuss sounding equipment and procedures.

Sounding Equipment

Sounding tapes (fig. 4-49) are 50-foot steel tapes graduated in feet and inches (with the inches graduated to 1/8 's). The bitter end is fitted with a snaphook for attaching a plumb bob or thief sampler. The first 9 inches of the tape consists of the plumb bob and snaphook. These tapes are usually plain, but can be ordered in color, such as black on white or white on black.

Water-indicating and fuel-indicating pastes are available to assist in identifying positive "wet" marks on the tapes. Water-indicating paste will change color where the fuel/water interface occurs. Fuel-indicating paste will change color where the fuel/air interface occurs.

There are two types of thief samplers (shown in fig. 4-50). These samplers may be made up locally or obtained from a naval repair activity. Both can be used in a standard 1 1/2-inch diameter sounding tube. Type A is used where it is not necessary to obtain a sample from the very bottom. Type B can be used (if rigged properly) for any level or bottom sampling.

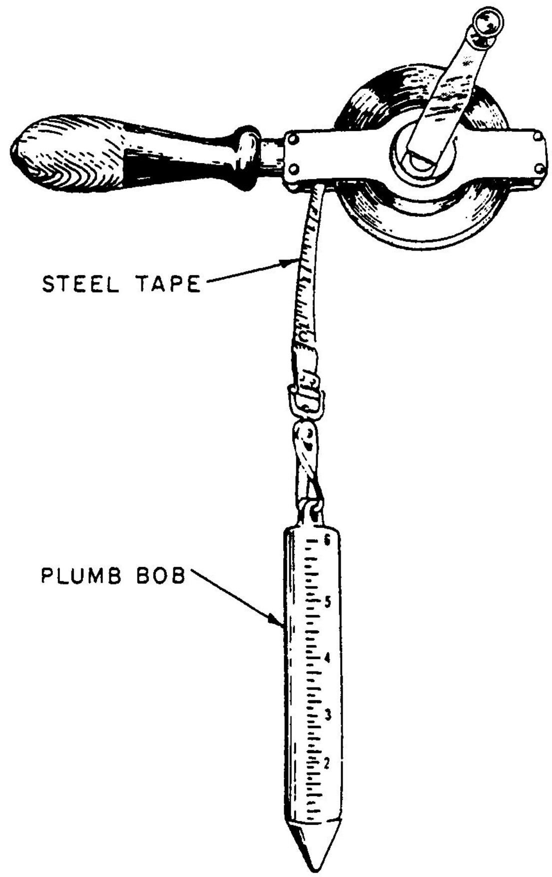


Figure 4-49.—Sounding tape.

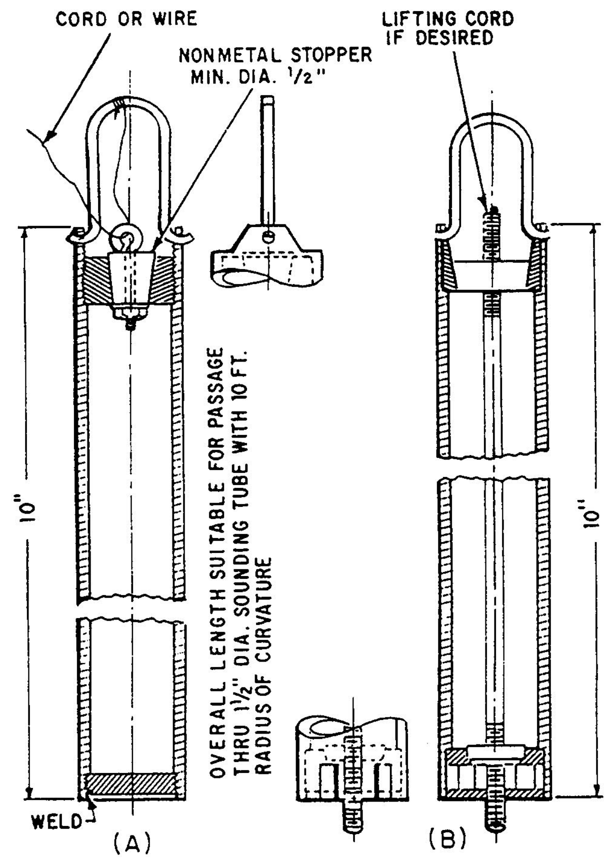


Figure 4-50.—Thief samplers.

Sounding Procedure

Spread a thin coating of water-indicating paste from the tip of the plumb bob to about the 2-foot mark on the tape. Lower the plumb bob through the sounding tube until, it touches the striker plate. The tape must be kept taut because slack would cause an inaccurate reading. Slowly withdraw the tape. The highest level where the JP-5 "wets" the tape is read in feet and inches. If the "wet" mark is difficult to see, use fuel-indicating paste. Dry the tape and spread a thin coating of the fuel-indicating paste in the approximate area of the first "wet" mark. When the tape is removed, note the line of color change on the fuel-indicating paste. This reading is then converted to gallons by use of a tank capacity chart. When the plumb bob is removed, note the line of color change of the water-indicating paste. The normal color, when applied, is gray. This level, in feet and inches, is converted to gallons and subtracted from the JP-5 reading to determine the quantity of JP-5 in the tank.

NOTE

The water-indicating and fuel-indicating pastes are different colors. They also change into different colors. They are NOT interchangeable.

To obtain a sample from the very bottom of the tank, remove the plumb bob and attach the type-B sampler shown in figure 4-50. Lower the sampler into the sounding tube. (The distance from the sounding tube cap to the striker plate will have been determined during sounding operations.) As the tip of the valve disk guide touches the striker plate, it will be depressed by the weight of the sampler, raising both upper and lower disks off their seat. After retaining this position momentarily, retract the sampler and dump the contents into a clean jar.

If water droplets or discoloration are noted on the sounding tape during the sounding and bottom sampling procedure, it is an indication of entrained or free water in the tank. Should this occur, it will be necessary to take a composite sample.

A composite sample is one in which samples are taken from different levels in the tank and mixed to form one sample. This type sample is more representative than one taken from only top and bottom. The same type sampler used to take the bottom sample can be used to take a composite sample, simply by attaching a string to the upper part of the disk guide stem. The sampler can then be opened at various levels by giving a smart jerk on the string. Tanks found to be contaminated with entrained water must be allowed more settling time before transferring.

RECEIVING JP-5 ABOARD

The first significant replenishing operation ever performed at sea by the U.S. Navy was in 1899, when the U.S. Navy collier *Marcellus,* while towing USS *Massachusetts,* transferred coal to her. Since that time, many methods and procedures have been tried and abandoned. Those described in this section are the typical procedures currently used in the fleet. The actual rigging of the replenishing hose between ships is the responsibility of the deck department and is not discussed. The ABF is concerned with only the filling connection hookup and the procedures for receiving JP-5 aboard.

The receipt of aviation fuel aboard carriers is a continuing problem in the fleet. This is due, in most part, to the hazardous nature of the fuel involved, and the ever increasing quantity required for our modern-day aircraft. Other factors of equal importance that also must be considered are the type and location of the operation, the time allotted, and the large number of personnel involved.

Time is an ever important aspect in any refueling operation, but more so at sea. The entire Task Force is scheduled to be replenished on a given date, and each ship is allotted a maximum time for this purpose. Not only are ships in constant jeopardy of a fire or collision during the replenishing operation, but they are also easy targets in the event of an attack.

JP-5 fuel is comparatively safe (having a minimum flashpoint of 140 F) when in its stored state. But, this same fuel handled under high pressure is extremely dangerous when released into the atmosphere in a fine mist or spray. Therefore, it should be treated accordingly, and every precaution should be taken to prevent the possibility of a fire or explosion when pumping this fuel.

A replenishing operation from a tanker was chosen to be described here since it covers all phases of any refueling operation.

The procedure for receiving JP-5 fuel aboard is basically the same for all class carriers. This section deals with the general procedures, equipment used, and the criteria for the acceptance or rejection of JP-5 fuel without reference to any particular ship.

The rate of fuel received is increased by using a double-hose rig. Two hoses are suspended, one below the other, from a single span wire. With this rig, two kinds of fuel maybe received simultaneously at a single station, or one kind may be pumped through both hoses.

Before receiving the tanker alongside, certain preparations are necessary to safely and efficiently expedite the replenishing operation.

Deballasting and Stripping

Any ballasted JP-5 tanks should be deballasted and stripped as soon as possible after the date and time of the replenishing operation have been confirmed. This requirement will be rare but must be covered in this section. Obtain assistance from personnel in the engineering department. They will align the main drainage system as required and operate the main drainage eductors.

The pump room or manifold operators align the tank stripping system as follows:

1. Unlock and open the main drainage cutout valve on the flood and drain manifold. (Relock manifold.)

2. Open the valves on the single-valved stripping manifold to the tanks to be deballasted.

NOTE

All tanks interconnected with one flood and drain manifold can be deballasted simultaneously. Each eductor can deballast an average of 1,000 gpm when supplied with fire main pressure of about 150 psi.

Because of the tremendous suction taken by the main drainage eductors, loss of suction on the tanks is most likely to occur before the tanks are completely emptied. When this occurs, realign the tank manifolds to use the tank stripping system as follows:

1. Close all valves in the single-valved stripping manifold.

valve and opening the stripping main suction cutout valve (relock the manifold valves).

3. Align the piping from the flood and drain manifold to the suction side of the motor-driven stripping pumps.

4. Align the motor-driven stripping pump discharge piping to pump into the contaminated settling tank or overboard (with the commanding officer's permission).

5. Open required valve on the single-valved stripping manifold.

6. Start the stripping pumps, and strip each tank one at a time until they are completely empty of all ballast water.

7. Secure the flood and drain manifold and close all valves in the single-valved manifold.

By use of the motor-driven stripping system, strip all storage tanks that are to be used in both the receiving operation and the internal transfer operation before receiving JP-5 aboard. Verify all stripping operations were successful by sounding the tanks, using water-indicating paste.

Strip the slack (partially filled) service tanks, using the hand-operated stripping system.

NOTE

Ships planning to replenish in port MUST deballast tanks before entering port.

Internal Transfer

Top off all slack service tanks. This will allow a longer settling time for the JP-5 being received. Consolidate the fuel load by transferring from slack storage tanks to completely fill as many tanks as possible. This will reduce the number of tanks to be filled and will minimize the number of tanks affected if contaminated fuel is received.

CAUTION

When fuel is to be transferred internally or received aboard, the overflow tank for every nest of tanks scheduled to receive fuel must be empty before fuel can be introduced into any tank in that nest.

Filling Sequence

Before receiving fuel, the JP-5 below decks supervisor should have soundings or readings taken on all storage and service tanks. A statement showing the amount and location of all JP-5 on board must be submitted to the V-4 division officer. It is the responsibility of the JP-5 below decks supervisor to know how much fuel is on board, where it is located, how much more can be received, the order in which the tanks should be filled, and the approximate duration of the receiving operation.

To determine the amount of JP-5 to be received, add the total capacity in gallons of each empty storage tank plus the amount required to top off any slack tanks. In determining the filling sequence, allow for a minimum of six tanks (three port and three starboard) on the line at all times. Knowing in advance the order in which the tanks will be filled will assist in the assignment of sounding teams, manifold operators, and the overboard discharge observers.

Three factors are involved in determining the duration of the receiving operation: the amount to be received (previously determined), the maximum receiving rate of the particular ship, and the normal pumping rate of the tanker. The latter two can be gained through experience and information recorded in the receiving log. But, if this is the first experience with the tanker, the pumping rate can be obtained in advance via radio messages to the tanker.

Personnel Preparations

A fueling watch list should be posted at least 24 hours before the refueling operation. In addition to the posted list, each man should be informed of his station and instructed in his duties. During the instruction period, emphasis should be placed on safety, emergency breakaway procedures, and other possible hazards. Assign only experienced and capable personnel to actually perform the duties. Limit the number of trainees, especially at the filling connections. Too many people at this station are not helpful and may confuse the operation by getting in the way. Whenever possible, rotate experienced personnel to other stations. This not only will give the individual the broadest training possible, but also will produce a more flexible division.

As a rule, fueling stations should be manned 1 hour before fueling time. The refueling stations to be manned and their locations are as follows:

1. Below decks office. This is where the below decks supervisor will coordinate the onload of fuel.

WARNING

Personnel working as overboard discharge watches and at the filling connections must wear a life jacket (kapok only), construction-type (safety) helmet or battle helmet, whistle, and pin-on marker light.

2. Overboard discharge watch. Located where required on catwalks, sponsons, or weather decks to observe and report the overflow from the overflow tanks.

3. Filling connection personnel (Repair personnel). Located at the filling connections on the sponsons.

4. Anticontamination sentry. Located in the AvFuels lab. Runners will be supplied to the sponsons to transport samples to the lab.

5. Sounding teams. Stationed where required. Sounding teams should be equipped with a sounding kit that contains the following:

a. Sounding tape (plumb bob safety-wired to tape).

b. Water-indicating paste.

c. Rags.

d. Pencils.

e. Tank sounding cards.

f. Flashlight (explosion-proof).

g. Sound-powered telephone headset.

h. T wrench (for sounding caps).

i. Spare gaskets (for sounding caps).

6. Manifold operators. Located in pump rooms or manifold spaces.

Preparations to be made on the refueling sponson by V-4 division personnel are not as numerous and time consuming as those below decks, since the actual rigging for receiving the tanker is the responsibility of the deck division. But, there are certain pieces of equipment that must be assembled by repair team personnel at or near the refueling sponson to safely and efficiently expedite the operation.

Repair team personnel should make sure the filling connection has a pressure gage, sampling connection. low-pressure air connection, and a flushing valve.

The equipment to be assembled at or near each refueling sponson by repair personnel includes the following:

- Proper handtools
- Drip pan
- Rags
- Swabs
- Buckets
- Five-gallon safety can
- Sound-powered phones
- Clean sampling bottles

The type and number of pieces of fire-fighting equipment to be laid out near the refueling station must be in accordance with the ship's fuel-handling bill.

Telephone talkers are stationed at the following locations on the 4JG circuit:

1. Below decks office
2. Filling connections
3. Flight deck control
4. Sounding tube locations
5. Overboard discharge watch
6. Pump rooms
7. Manifold spaces
8. Damage control central

All telephone headsets should be tested well in advance of the receiving operation.

Receiving Operation

Communications should be established immediately upon manning of a station. When all stations have reported manned and ready, the JP-5 filling and transfer system should be lined up for receiving JP-5. Open the following valves:

1. Below decks at the base of the downcomers to be used for the refueling operation.

2. All transfer-main bulkhead cutout valves.

3. Transfer-main branch header valves leading to the manifold of the tanks to be filled.

4. The transfer mainside manifold valves of selected tanks to be filled.

5. Tankside manifold valves of selected tanks to be filled.

NOTE

Deep centerline and double-bottom tanks are typically filled first during a refueling operation.

The below-deck piping and valves are now aligned for receiving JP-5 aboard.

Just before the tanker is received alongside, specific action must be taken by certain departments to ensure maximum safety and security during the replenishing operation.

The officer of the deck controls the smoking lamp. The operations watch officer makes sure certain high-frequency transmitters, radars, and other electronic equipment in the vicinity of the fueling stations are secured. The damage control watch officer ensures that additional firemain pumps are put on the line and that AFFF pumping stations are manned. The aviation fuels officer makes sure no mobile equipment or electrical winches (not required in the replenishing operation) are operated within 50 feet of the fueling station.

As the ship makes its final approach and steadies alongside, shot lines are sent over from each station. By these first lines, the telephone cables, distance line, and hose messenger are sent back. As soon as communication is established between stations, the JP-5 below decks supervisor clarifies with the tanker final information, such as the tanker's maximum pumping rate and discharge pressure and the earner's maximum receiving rate and pressure.

NOTE

The actual hookup of the fueling hoses is accomplished by personnel from the deck department.

The initial flow of JP-5 is received through the flushing valve and directed into the contaminated settling tanks. Before receiving JP-5 into the storage tanks, samples should be taken at the main deck fill connection in containers that permit visual inspection. If acceptable fuel is being received, open the downcomer and close the flushing valve. Start replenishment of aviation fuels at a slow rate.

When JP-5 enters the tanks, as indicated by the tank level indicators or sounding teams, order the tanker to start pumping at a normal rate. Log the starting time and continue taking samples to ensure the receipt of clean bright, water-free JP-5. Log the quality of the samples taken and pressure of the JP-5 being received at the filling connection.

The receiving pressure at the filling connection should be about 40 psi to obtain the designed maximum filling rate. CV/CVNs can typically receive JP-5 at a rate of 360,000 gallons per hour when using two stations.

As the storage tanks are being filled, you should check the volume of fuel in each tank by observing the tank level indicators and by sounding the tanks. In general, the tanks nearest the downcomer will fill first.

Begin sounding at the initial flow. Sounding should be taken periodically until the tanks reach 80 percent capacity. From this point on, soundings should be continuous.

When 80 percent capacity is reached in the first nest of tanks opened, open the tankside valve to another nest (minimum of six tanks-three port and three starboard) at the same time; throttle the TANKSIDE valves to the first nest of tanks; and top them off to at least 95 percent capacity. All storage tanks, except overflow tanks, can be filled to almost 100 percent to increase the amount of fuel carried on board.

All storage tanks in one nest, both port and starboard, can be opened for simultaneous filling, but care must be exercised when topping off to prevent overtaxing the overflow line.

CAUTION

Overflow mains for overflow tanks are typically designed for an overflow rate of 1,500 gpm, and each storage tank has an overflow rate of 500 gpm.

After the amount of JP-5 being received per minute has been determined, the tanker can be given an estimated “stop pumping” time.

All ships fitted with two or more downcomers can use any or all to expedite the refueling operation. The number of tanks that can be opened and the method of receiving will vary on the individual ships, depending on the number of personnel available as manifold operators, sounding teams, etc., and the experience gained after several refueling operations.

NOTE

An adequate number of contamination tanks must remain empty to receive the recirculated fuel from Cla-Val stations.

When the last port and starboard tanks to be filled reach 80 percent capacity, notify the tanker to reduce pumping. Top off the last tanks. When the overflow tanks reach 95 percent capacity, order the tanker to stop pumping.

After the tanker has ceased pumping, close the filling connection gate valve on the sponson.

At the completion of the replenishing operation, notify the officer of the deck of the start and stop pumping time and record the total gallons received. This information is entered in the ship's log.

Secure and restow all equipment. Close all valves in the filling and transfer system. The tanks should be sounded to obtain an accurate account of all JP-5 on board. During the final soundings, compare readings with the tank level indicators and adjust as necessary.

CRITERIA FOR ACCEPTANCE OR REJECTION OF JP-5.—The standards of fuel cleanness (table 4-4) are established as maximum limits for transfer of aviation fuels between shore activities and ships. Normally, contamination levels are maintained substantially below these levels.

Samples are taken continuously from the filling connection at the initial start of pumping until a clear sample is obtained. Thereafter, samples are taken every 15 minutes during the refueling operation. Any time a sample exceeds the contamination limits listed in table 4-4, the pumping operation must cease. The final decision of acceptance or rejection of the fuel rests on the commanding officer.

EMERGENCY BREAKAWAY.—During a refueling at-sea operation, any number of unforeseen circumstances could occur, making an emergency

Table 4-4.—Standards of Fuel Cleanness

From	To	Maximum sediment[1]	Maximum water[2]
Shore Tankage	Barges, Tankers, Fleet Oilers, Carriers	8.0 mg/liter	No visible
Fleet Oilers, Barges, Tankers	Carriers	10.0 mg/liter	No visible
Carriers, Fleet Oilers, Barges, Tankers	Shore Tankage	10.0 mg/liter	No visible

[1]Sediment levels are to be determined by laboratory analysis, or by the AEL Mk III Contaminated Fuel Detector.

[2]The free water content is determined by the AEL Mk I Free Water Detector Kit, and by laboratory analyses.

breakaway necessary. The order for an emergency breakaway may be given by the commanding officer of either the receiving ship or the delivery ship. Paramount in ordering an emergency breakaway is the allowance of sufficient time for the ships to disconnect the rigs in an orderly manner. Fueling rigs are subject to severe damage if not properly released at the breakaway signal, and serious injury to personnel could occur.

All emergency breakaway may be accomplished smoothly, rapidly, and safely if personnel at the station know how and what to do first. V-4 personnel on the refueling sponson should do the following:

1. After the tanker has stopped pumping, close the filling connection gate valve.

2. Clear the area.

Below decks personnel will secure the system as normal.

SETTLING AND STRIPPING

The storage period between receipt of JP-5 on board and delivery to an embarked aircraft is a vital link in the cleaning process required. This settling period, in addition to proper stripping, also will take the load off the other cleaning processes in the system. Therefore, it is extremely important for fuel handlers to be familiar with the settling and stripping procedures aboard aircraft carriers.

Settling Period

Use settling to the maximum degree possible to separate solids and water from fuel. The settling time for JP-5 is 3 hours per foot of product height. To obtain the maximum settling time for JP-5 tanks, the following operating procedures should be followed:

1. NEVER purify JP-5 into an IN USE service tank.

2. Completely empty the in use service tank before taking suction on another service tank.

3. Avoid agitating settled tanks by minimizing the transfer of JP-5 to consolidate the fuel load or to correct the list or trim of the ship. This can be prevented by following the proper emptying sequence and by taking suction from an equal number of port and starboard tanks simultaneously when transferring during normal operations.

4. Coordinate the replenishment date so there is always enough JP-5 on board to top off all service tanks before receiving JP-5 aboard.

5. When transferring JP-5 from storage to service tanks, the tank emptying sequence for any nest of tanks should be scheduled to empty the overflow tanks first, the slack tanks (if any) next, and the tanks that have had the longest settling time last.

Rotate the tank-emptying sequence between the different nests of tanks so all tanks are used and not just those that are most convenient to the pump-room operator.

Stripping Schedule

Serious contamination of JP-5 has occurred on several aircraft carriers, resulting in the loss of aircraft worth millions of dollars and, in some instances, loss of human life. All of this could have been avoided if WATER and SOLIDS in the fuel had not been allowed to reach the aircraft fuel cells.

This useless waste was caused mostly by improper use of the equipment, a lack of understanding of the need for stripping, and in some cases a complete disregard of the stripping equipment and procedure. Therefore, it is imperative that the following stripping schedule and procedure be complied with.

Strip the storage tanks with the motor-driven stripping pumps at the following times:

1. Before receipt

2. The day after receiving JP-5 aboard.

3. Weekly thereafter, as applicable

4. The day before purifying into service tanks

5. Immediately before purifying into service tanks

Strip the service tanks with the hand-operated stripping pumps at the following times:

1. Daily

2. Just before use

3. Weekly (in port)

Stripping Procedure

Before any transfer operation, the JP-5 storage tanks concerned must be stripped of all water and sludge by using the motor-driven stripping system.

The stripping system is aligned in basically the same manner as described for stripping ballast tanks. Proceed as follows:

1. Open the valve on the single-valved stripping manifold to the tank to be stripped.

2. Open the valve on the flood and drain manifold leading to the stripping main.

NOTE

Step 2 is necessary only for tanks that are designated JP-5 or ballast.

3. Open the necessary valves in the stripping main leading to the suction header of the stripping pump.

4. Open the stripping pump inlet valve.

5. Open the stripping pump discharge valve.

6. Open the cutout valve from the discharge header leading to the contaminated-JP-5 settling tank.

7. Start the motor-driven stripping pump.

Take frequent samples of the JP-5 being discharged. When a sample of clean, bright, water-free JP-5 is obtained, the tank is stripped. Close the valve on the single-valved stripping manifold, and open the valve to the next tank to be stripped. Strip all tanks in the same manner.

NOTE

The clean JP-5 remaining in the system between the single-valved stripping manifold and the stripping pump from the previously stripped tank MUST be discharged past the test connection before a conclusive sample can be obtained from the next tank to be stripped. This can be accomplished by having a general knowledge of the capacity of the stripping system piping between the two points and the capacity of the stripping pump. Run the pump accordingly. Allow extra running time for a safety factor. An example is, if the pipe capacity is 160 gallons and the pumps rated capacity is 50 gpm, then the pump should be operated for 4 minutes before a sample of the next tank is taken.

When all storage tanks have been stripped, stop the pumps and close all valves in the system.

The service tanks can be stripped in basically the same manner as the storage tanks by using the motor-driven stripping pumps. But, this should rarely, if ever, be necessary except when completely emptying the service tanks (the last 24 inches of fuel) before maintenance, cleaning, etc., and to remove the wash water after a cleaning operation.

If the storage tanks are allowed adequate settling time and are properly stripped, and if the centrifugal purifiers are maintained and operated properly, there should NEVER be enough water in a service-tank to require using the motor-driven stripping system for normal stripping purposes.

Service tanks are normally stripped by use of the hand-operated stripping pump. The procedure used is as follows:

1. Open the valve on the suction side of the stripping pump leading to the service tank to be stripped.

2. Open the valve on the discharge side of the stripping pump.

3. Operate the pump handle until clean fuel is observed in the discharge line (as indicated by the bull's-eye sight glass).

4. Open the test connection and take frequent samples. Pump until a sample of clean, bright, water-free JP-5 is obtained.

TRANSFER SYSTEM OPERATIONS

Transferring JP-5 internally is accomplished by the three individual transfer pumps in each of the forward and after pump rooms.

Transferring From Storage to Service

When transferring from storage to service tanks, use the following procedure:

1. Strip all tanks concerned, both storage and service.

2. Empty the purifier sump drain box.

3. Arrange the tank emptying sequence, Empty the overflow tank first, the slack tanks second, and the tanks that have had the longest settling time last.

4. Open the following valves:

a. Selected tankside manifold valves.

b. Selected transfer mainside manifold valves.

NOTE

Ensure that the telltale valves are closed.

c. All valves in the transfer main branch header between the manifolds and pump suction header.

d. Valves in the suction header.

e. The pump inlet and discharge valves to a designated transfer pump.

f. All valves from the pump discharge header to the designated purifier.

g. The service tank cutout valve to the tank to be filled.

h. The designated purifier discharge valve.

5. Start the purifier.

6. When the purifier attains 4100 rpm (146 to 150 bumps per minute), open the seal water plug valve on the purifier.

NOTE

To minimize vibration when starting with a dirty bowl, admit seal water immediately after pressing the stint button.

7. Open the main water-discharge observation port on the cover assembly. When water discharges past this port, close the seal water inlet plug valve on the purifier and at the supply end.

8. Start the designated transfer pump.

9. When the pump discharge pressure builds up, SLOWLY open the purifier inlet globe valve and throttle to maintain 9 psi inlet pressure. Then throttle the purifier discharge globe valve to maintain 30 psi back pressure (+or–5 psi).

10. Log the time the transfer pump and purifier were started.

11. While the system is in operation, make the following additional log entries:

a. Transfer pump inlet and discharge pressure.

b. Purifier inlet and discharge pressure.

12. Take inlet and discharge samples.

a. Send to the AvFuels lab to analyze with the AEL Contaminated Fuel Detector Mk III and the AEL Water Detector Kit Mk I.

b. Log the results of the analysis.

NOTE

It is advisable to take a visual sample of the contents of the storage tank from which suction is being taken at the initial opening of the manifold valves. This sample can be drawn through the telltale valve.

13. If the transfer pumps lose suction before the service tank is full, take the following action:

a. Close the purifier inlet valve.

b. Close the manifold valves to the empty tanks.

c. Place additional tanks on the line.

d. When the transfer pump discharge pressure is again attained, repeat step 10.

14. When the service tank is 95 percent full, secure the system The procedure for stopping the purifier is as follows:

a. Close the purifier inlet valve.

b. Stop the transfer pump.

c. Stop the purifier.

d. DO NOT engage the brake; the purifier will coast to a stop in about 45 minutes.

e. As the purifier slows down, centrifugal force diminishes, and inlet and discharge pressure will drop to zero.

f. When the flapper in the discharge sight glass stops, close the purifier discharge valve.

g. Close all valves in the falling and transfer system.

h. Make the following log entries:

(1) Time transfer pump stopped.

(2) Time purifier stopped.

(3) Gross gallons removed from storage tank.

(4) Net gallons received in service tanks.

During the transfer operation, samples for visual examination must be taken from the purifier outlet at regular intervals in accordance with local instructions. Samples must be clean and bright and contain NO free water. A cloud, haze, specks of sediment, or entrained water indicates the fuel is probably unsuitable and points to a breakdown in the purification process. Should this occur, the transfer operation must be secured until storage tanks concerned have been restripped; a clean, bright, water-free sample is received on the discharge side of the stripping pump; and the centrifugal purifier is inspected and discrepancies are corrected.

Transferring From Storage to Storage

This operation should rarely be necessary if an emptying sequence was properly established and followed (except when consolidating the fuel load before receiving). If and when this operation is called for, it will, in most instances, require transferring JP-5 from port to starboard, or vise versa, to correct the list on the ship; or transferring JP-S from forward to aft, or vice versa, to correct the trim on the ship.

The operating procedure for this operation is the same as transferring from storage to service with the following exceptions:

1. Purification and sampling procedures are not required.

2. The transfer piping from the discharge header of the transfer pumps is aligned to discharge into the opposite transfer main branch header, from which suction is being taken (when transferring from port to starboard, or vice versa), or to the transfer main (when transferring from forward to aft, or vice versa).

CAUTION

The overflow tank for any nest of tanks scheduled to receive fuel must be empty before JP-5 can be transferred into any tank in that nest.

Consolidating Fuel

When any transfer operation has been completed, consolidate to the greatest extent possible the last 24 inches of JP-5 remaining in the storage tanks. (As much as 5,000 gallons remain in some of the larger tanks after the transfer pumps lose suction.) This consolidation must be accomplished by the motor-driven stripping pump.

The procedure for consolidating the last 24-inches of JP-5 is the same as that outlined for stripping, except that the stripping pump discharge header is aligned to direct the discharged fuel into the transfer main instead of the contaminated-JP-5 settling tank.

From the transfer main, the JP-5 is directed into preselected storage tanks. Consolidated fuel should be allowed maximum settling time before it is stripped before use.

Ballasting Operation

The empty ballast storage tanks are ballasted (filled with sea water) to preserve the underwater protection system of the ship. Ballasting must be accomplished in accordance with current ship's ballasting instruction for each ship.

Tanks on CV/CVNs are ballasted by gravity through the sea chest valve on the flood and drain manifold and the single-valved stripping manifold. On LPHs and LPDs this water is supplied from the ship's fire main system.

Ballasting procedure is as follows:

1. Follow the tank falling sequence as scheduled by damage control central to maintain the proper list and trim of the ship.

2. Open the valves on the single-valved stripping manifold to the tanks to be filled.

CAUTION

Open an equal number of tanks on the opposite side of the ship.

NOTE

ALL tanks that are served by one flood and drain manifold can be filled simultaneously.

3. Align the valves on the flood and drain manifold for ballasting.

a. Unlock the sliding lock bar by loosening the two bolts over the oblong slots.

b. Position the lock bar so the circular hole in the keyhole slot is directly above the raised collar on the sea chest valve stem.

c. Rebolt the lock bar in position.

4. Open the sea chest valve.

5. Sound the tanks to determine the instant they are full.

6. As each tank becomes full, as indicated by the tank sounding teams, close the valve on the single-valved stripping manifold.

7. When all tanks are ballasted, close the sea chest valve and reposition the lock bar.

8. Lock the tankside valve (on the double-valved filling and suction manifold) in the CLOSED position.

9. Open the telltale valves on the double-valved manifold and drain the contents, then close these valves.

CAUTION

Thereafter, while the tanks are ballasted with seawater, periodically open the telltale valves to determine the condition of the tank-side valves and transfer mainside valves.

NOTE

Most ballast tanks will not fill completely. Some will only half fill due to tank height and draft of ship. Ballast liquid will seek its own level.

OFF-LOADING JP-5

When it is necessary to offload JP-5, the service pumps are used as transfer pumps due to their increased capacity. JP-5 is discharged off the ship via the transfer main, downcomer, filling connection, and then to a barge, tanker, or fuel farm. Since the service pumps are used as transfer pumps for off-loading JP-5, the piping and valves in the filling and transfer system and the service system must be aligned to enable the service pumps to take suction from, and discharge into, the same piping as the transfer pumps.

Assume, in this operation, that the entire fuel load is to be offloaded, including the JP-5 in the service tanks. This being the case, empty the service tanks first, since no special preparations are required to take suction from these tanks with the service pumps.

Off-Loading JP-5 From Service Tanks

Align the piping and valves as follows:

1. Open the service tank suction cutout valve between the service tank and the service pump suction header.

2. Open the service pump inlet valve.

3. Unbolt and rotate the spectacle flange (or line blind) to the OPEN position in the cross-connecting piping between the service pump discharge header and the transfer pump discharge header. Unlock and open the gate valve in this same line.

4. Open the valve between the transfer pump discharge header and the transfer main.

5. Open the transfer main bulkhead cutout valves leading to the downcomer.

6. Open the gate valve at the base of the downcomer.

7. Open the gate valve at the filling connection.

When topside preparations have been made for off-loading fuel, start the service pumps.

When pump discharge pressure reaches 80 psi, SLOWLY open the globe valve on the discharge side of the pump. Throttle pumps to avoid cavitating and maintain a minimum of 35 psi back pressure for automatic operation of pump motor controllers.

The service pumps are now taking suction from a service tank and discharging overboard via the service pump discharge header, transfer pump discharge header, and transfer main, up through the downcomer, and out the filling connection.

Continue the pumping operation as outlined above until all service tanks have been emptied. Then secure the pumps and align the system for emptying the storage tanks.

NOTE

The remaining 24 inches of JP-5 in the service tank are consolidated into preselected storage tanks by the motordriven stripping pump.

Off-Loading JP-5 From Storage Tanks

The piping arrangement from the service pump discharge header to the filling connection at the refueling station remains the same.

Align the piping from the suction header of the service pump to the storage tanks as follows:

1. Unbolt and rotate the spectacle flange or open the line blind valve in the cross-connecting piping between the service pump suction header and the transfer

pump suction header. Unlock and open the gate valve in this same line.

2. Open selected transfer mainside manifold valves.

3. Open selected tankside manifold valves.

NOTE

The suction headers for the service pumps are 8-inch to 10-inch lines, and all filling and suction lines to storage tanks are 5-inch lines. Therefore, an adequate number of tanks must be open at all times, or the service pumps will lose suction.

4. Open all valves in the transfer main branch headers leading to the suction header of the transfer pumps.

5. Start the service pump with the discharge globe valve closed. When the pump discharge pressure reaches 80 psi, SLOWLY open the discharge globe valve.

Continue pumping until all fuel has been off-floaded. Just as on-loading, when off-loading fuel, a tank emptying sequence must be followed to maintain the proper list and trim on the ship.

JP-5 SERVICE SYSTEM OPERATIONS

The operations described here for the service system include (1) flushing the service system, (2) fueling aircraft, and (3) defueling aircraft.

Before fueling any aircraft, the entire JP-5 service system must be thoroughly flushed after any one of the following occurrences:

1. After a shipyard overhaul (includes newly constructed or reconverted carriers).

2. After any major repair work has been accomplished on the JP-5 service system.

3. After drain back for maintenance.

The flushing operation is performed to rid the piping of the large quantity of solids and condensation that accumulate during the installation of and/or repairs to the system during a shipyard overhaul. Flushing also removes loose deposits of microbiological growth that can grow anywhere in the system where pockets of water exist.

Operation of the service system requires pumping large quantities of fuel at high pressure, therefore, every safety precaution must be adhered to.

The flushing operation is performed by pumping clean JP-5 through the service system piping from service tanks, via the service filter, through the distribution piping to every service station, and back into the contaminated settling tanks. The entire flushing operation can be accomplished with virtually no loss to the JP-5 fuel involved.

The piping arrangement and operating procedure between the pump room and the service stations for the flushing operation are practically identical as for fueling aircraft, which is to follow. To minimize repetition, the operation described here between the two points is for both operations.

The piping arrangement for one quadrant only is described here. Other quadrants can be aligned in the same manner.

Set up the pump room as follows:

1. Strip the in-use service tank.

2. Open the cutout valves in the suction line between the service pump and in-use service tank.

3. Aline the recirculating header to the service tank from which suction is to be taken.

4. Open the service pump recirculating line.

CAUTION

Ensure that the service pump discharge valve is closed.

5. Align distribution piping in the pump room.

6. Align the distribution piping in the filter room to activate the main fuel filter as follows:

a. Open the filter inlet and discharge valves.

b. Open the falter vent line.

c. Align the automatic water drain system.

d. Open both cutout valves leading to the forward and after legs of the outboard distribution main.

e. Open the port and starboard crossover cutout valve.

7. Align the first service station to be flushed as follows:

a. Open the service station riser valve and the cutout valve between the service station and hose reel.

b. Unreel all fueling hoses and attach the pressure fueling nozzle from one hose to the defueling main.

NOTE

The defueling main will have been opened to the contaminated settling tanks.

8. Start one service pump. When a discharge pressure of 80 psi is obtained, SLOWLY open the pump discharge globe valve. Observe the bull's eye sight glass in the filter vent. When a solid stream of JP-5 is discharging through this line, close the vent valves.

9. When the filter vent valve has been closed, start the service station defuel pump.

10. Close the nozzle toggle switch on the pressure fueling nozzle to place the service station in the fueling position.

Flush until a clean bright, water-free sample is obtained at the test connection on the pressure fueling nozzle. Analyze the sample using AEL detectors. Continue this operation on a station-by-station basis until each hose reel has been thoroughly flushed.

Fueling of aircraft is accomplished in the same manner as flushing the hoses, except that the nozzle is attached to the aircraft. **Specific flight deck procedures for flushing, fueling, and defueling are covered in chapter 5.**

AUXILIARY SYSTEM OPERATIONS

The auxiliary JP-5 system provides for the delivery of JP-5 to emergency diesel generators, small boat filling connections, and yellow gear fill stations. The procedure for transferring JP-5 to the auxiliary main is as follows:

1. Strip the selected service tank.

2. Open the tank top valve from the selected service tank and the cutout valve to the auxiliary pump suction.

3. Ensure all service tank valves not involved with the transfer operation are closed.

4. Open the valves in the discharge line from the auxiliary pump to the auxiliary main.

5. Open branch valves in the auxiliary system to the stations to be serviced, and check to ensure all branch valves for those stations not requiring servicing are closed.

6. Establish communications between the pump room and the stations to be serviced.

7. Start the JP-5 auxiliary pump.

8. When the transfer operation is complete, secure the JP-5 auxiliary pump and close all valves in its suction and discharge lines. Then close all open valves in the remainder of the system.

POLLUTION CONTROL

The Navy's ability to accomplish its mission requires daily operations on land, at sea, in the air—in other words, in the environment. The Navy is committed to operating its ships and shore facilities in a manner compatible with the environment. National defense and environmental protection are, and must be, compatible goals. The chain of command must provide leadership and personal commitment to ensure that all Navy personnel develop and exhibit an environmental protection ethic. Thus, an important part of the Navy's mission is to prevent pollution, to protect the environment, and to conserve natural, historic, and cultural resources.

Oil pollution is the Navy's largest single pollution problem. As ABFs, we have millions of gallons of petroleum products under our control at all times. **We are responsible for the safe storage and handling of every single gallon.**

OPNAVINST 5090.1A is the Navy's Environmental and Natural Resources Program Manual. In it, the Chief of Naval Operations provides specific guidelines and policies, assigns responsibility, and sets standards for the Navy to follow pertaining to environmental protection policies.

Some of the specific policies that concern the ABF are:

1. Oil or oily waste shall not be discharged from any naval activity or ship within 50 nautical miles of any shoreline in such quantities that will leave a sheen of the water.

2. Personnel will prevent or contain any accidental discharge to prevent pollution.

3. Provides procedures for the disposition of waste petroleum products.

4. Explains specific responsibilities of the chain of command for pollution abatement.

As an ABF, it is your responsibility to know and follow the Navy's pollution prevention policies.

SUMMARY

In this chapter, you have learned about the equipment and subsystems that make up the various below decks systems. You have learned typical operating procedures and minor troubleshooting.

The JP-5 Afloat Below Decks System is a vast, complex system that can be difficult to learn. A good training program will produce excellent results here. A key point to remember: If you follow the operating procedures in the equipment technical manuals and your ship's AFOSS, you can't go wrong. Supervisors should stress this point with junior personnel.

CHAPTER 5

JP-5 AFLOAT FLIGHT DECK SYSTEMS AND OPERATIONS

Working the flight deck of an aircraft carrier is one of the most exciting and dangerous jobs you can have. Additionally, the ABF works with highly flammable fuels. Though the below decks system is more complex, the ABF working on the flight deck must be equally knowledgeable in the flight deck system, its components, and correct operating procedures.

This chapter will identify the components used for flight and hangar deck operations and explain the correct operating procedures. As with below decks, the arrangement of the flight deck system will vary from ship to ship. The information in this chapter is based on typical arrangements.

JP-5 FLIGHT DECK SYSTEM COMPONENTS

LEARNING OBJECTIVES: Identify the components that make up the JP-5 flight and hangar deck fueling system. Describe their function and principles of operation.

The flight and hangar deck fueling system is built around the Cla-Val fueling unit. The number and location of these units depend on the individual ship. Typically, each refueling station contains three or four hose reels, each having its own Cla-Val.

In this section, we will identify and describe the components in the flight and hangar deck JP-5 system.

CLA-VAL FUEL/DEFUEL VALVE

The CLA-VAL fueling unit (fig. 5-1) is the core of the JP-5 fueling station. It is a three-port, two-way, fuel/defuel valve, of modified globe valve design that is intended for use as an integral part of the JP-5 dispensing system for shipboard use. This valve performs four distinct functions:

1. It functions as a pressure-reducing valve to maintain a constant discharge pressure not to exceed 55 psi.

2. It functions as a solenoid-operated emergency shutoff valve.

3. It functions as a pressure-relief valve when discharge pressure rises above a predetermined setting.

4. It functions as a defueling valve to evacuate the piping and hose beyond the valve discharge.

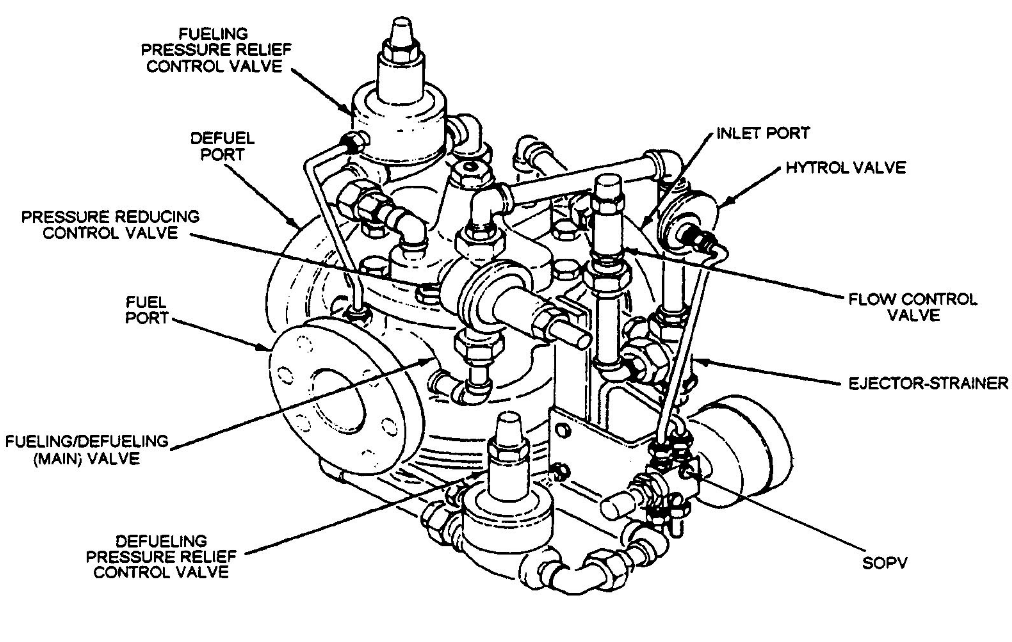


Figure 5-1.—Cla-Val fuel/defuel valve assembly.

Main Fuel/Defuel Valve

The main valve (fig. 5-2) is actually two single-seated globe valves built into a common body. Each of the valves performs a separate and distinct function, one is the fueling valve and the other is the defueling valve.

Each valve employs a well-supported and reinforced diaphragm as its operating means. The fueling valve is spring-loaded to close; therefore, it is normally closed. The defuel valve is inverted (upside down) and held open by its own weight.

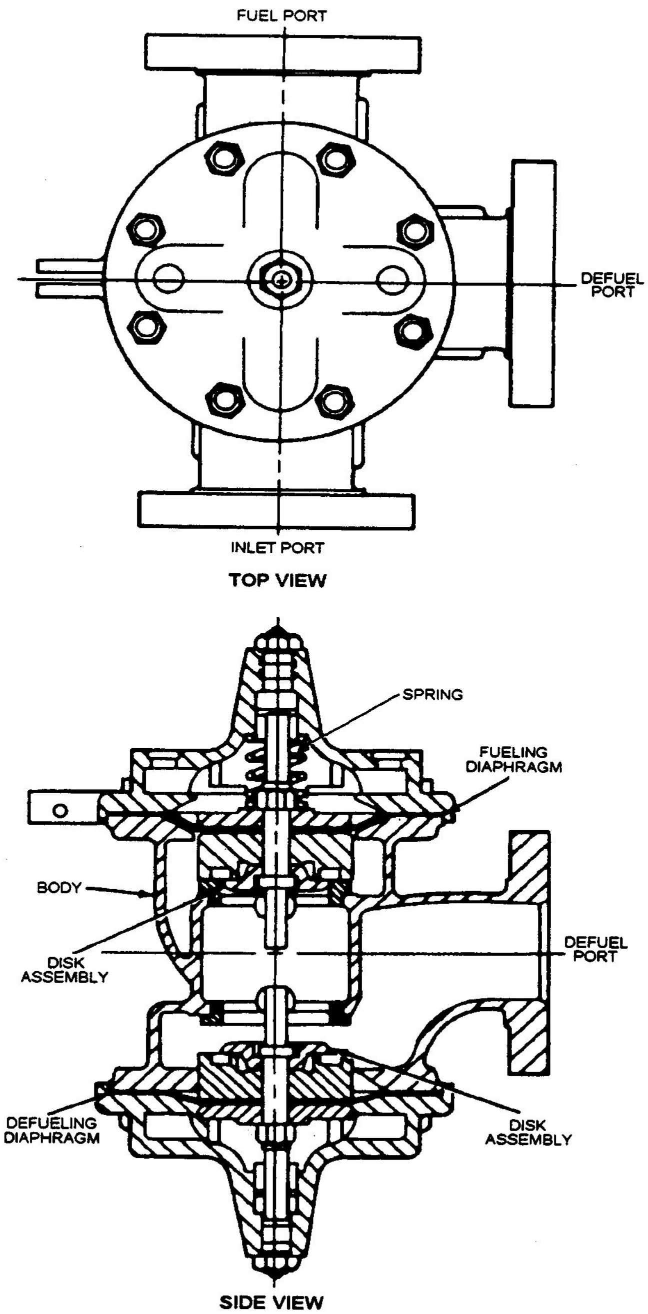


Figure 5-2.—Main valve.

The main valve directs fuel flow from the inlet port to the fuel port when fueling, and fuel flow from the fuel port to the defuel port when defueling. The fuel and defuel valves are controlled by pressure acting on a diaphragm. The change from the fuel to defuel mode is accomplished by energizing or deenergizing the solenoid-operated pilot valve (SOPV), or by excessive delivery pressure.

When pressure above the fueling valve diaphragm is vented off, inlet pressure on the diaphragm lifts its disk assembly, opening the fuel valve. Simultaneously, pressure is applied to the bottom of the defueling valve diaphragm, seating its disk assembly and closing the defuel valve.

When pressure underneath the defueling valve diaphragm is vented off, its disk assembly falls, and the defuel valve opens. Simultaneously, pressure is applied to the top of the fuel valve diaphragm (both line and spring). When this pressure overcomes the inlet pressure, its disk assembly seats, closing the fuel valve.

The main valve is controlled by a set of smaller valves using line pressure, thus providing fully automatic operations. The SOPV shifts the Cla-Val assembly from defueling to fueling, and from fueling to defueling. The flow control valve regulates the opening speed of the fueling side of the main valve. The hytrol valve either isolates inlet pressure from the pressure-reducing control valve, or vents inlet pressure to the pressure-reducing control valve and the fuel port of the main valve. The pressure-reducing control valve regulates delivery pressure. The ejector-strainer aids in relieving pressure above the diaphragm of the fueling valve and prevents foreign particles from entering the pressure-reducing control valve. The pressure relief control valves open to shift to the defueling mode if the delivery pressure exceeds the preset limit.

Pressure Relief Control Valves

The pressure relief control valves (fig. 5-3) open to shift the main valve to the defueling mode when delivery pressure exceeds the preset adjustment. There are two pressure-relief control valves for each Cla-Val fueling unit. One valve acts as a pressure

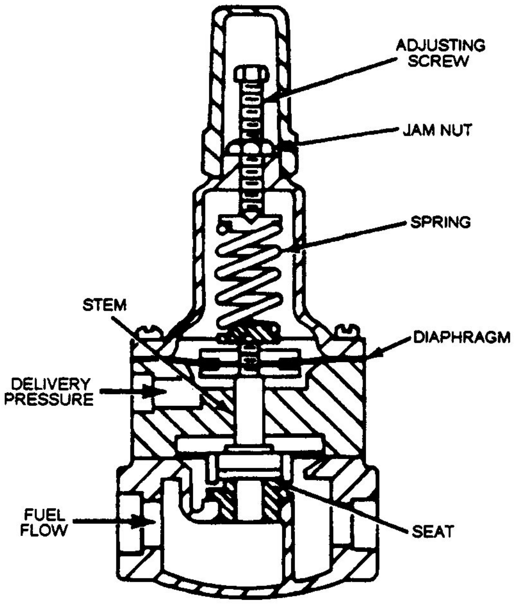


Figure 5-3.—Pressure-relief control valve.

relief for the fuel valve, and the other for the defuel valve.

Each pressure-relief control valve contains a stem, a diaphragm, a spring, and an adjusting screw. Each valve is a direct acting, spring-loaded valve, designed with a large diaphragm working area in relation to the valve area seat, to ensure positive operation. It is held closed by the force of the compression spring. Pressure adjustment is made by rotating the adjusting screw to vary spring compression on the diaphragm. Compressing this spring increases the pressure at which the valve opens. The spring can be adjusted to provide a relief setting from 20 to 70 psi. The adjusting screw is covered by a protective housing.

When the controlling pressure under the diaphragm exceeds the set spring force, the disk is lifted off the seat, permitting flow.

The pressure relief for the defuel valve is set about 7 1/2 psi above delivery pressure. The pressure relief for the fuel valve is set approximately 2 1/2 psi above delivery pressure. The opening of the pressure relief control valve for the fueling valve increases the closing speed of the fueling valve. The opening of the pressure relief control valve for the defueling valve vents pressure from the bottom of the defuel valve diaphragm, opening it.

Pressure-Reducing Control Valve

The pressure-reducing control valve (fig. 5-4) steadily reduces a higher initial pressure to a lower pressure and regulates the delivery pressure when the main valve is in the fueling mode.

The pressure-reducing control valve is a direct acting, spring-loaded valve designed with a large diaphragm working area in relation to the valve seat to ensure sensitive control and accurate regulation of the delivery pressure. Pressure adjustment is made by rotating the adjusting screw to vary spring compression on the diaphragm. Compressing this spring in-creases the delivery pressure setting. The spring can be adjusted to provide delivery from 15 to 100 psi. The adjusting screw is also covered by a protective housing.

The pressure-reducing control valve normally is held open by the force of the compression spring. When the delivery pressure acting upon the lower side of the diaphragm exceeds the force of the compression spring, the valve closes.

Conversely, when the delivery pressure reduces below the spring setting, the valve opens. Thus, a constant delivery pressure is maintained by balancing delivery pressure against spring pressure. The valve can be easily regulated by turning the adjusting screw, which provides a simple means of pressure adjustment.

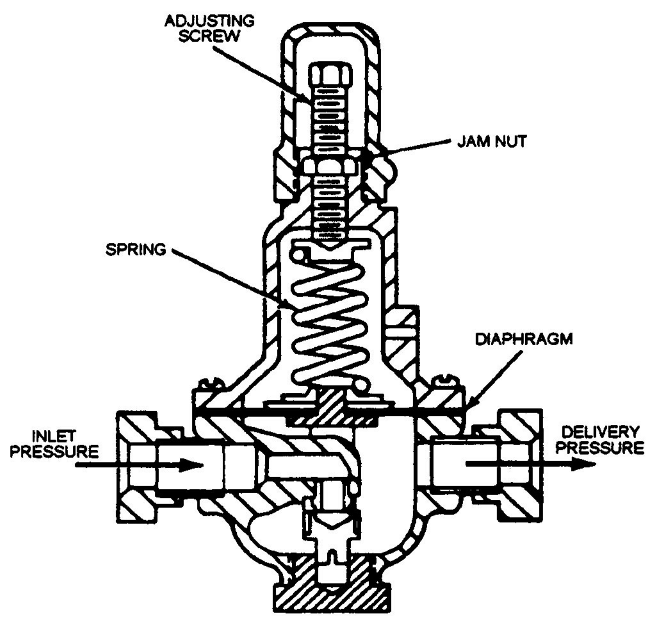


Figure 5-4.—Pressure-reducing control valve.

Hytrol Valve

The hytrol valve (fig. 5-5) either isolates inlet pressure from the pressure-reducing control valve, or vents inlet pressure to the pressure-reducing control valve and the fuel port of the main valve. Pressure directed from the SOPV to the top of the diaphragm holds the hytrol valve closed. When this pressure is vented (also through the SOPV), the inlet pressure opens the hytrol valve allowing fuel flow. No adjustments are made to the hytrol valve. It is either open or closed.

Ejector-Strainer

The ejector-strainer (fig. 5-6) reduces inlet pressure to the pressure-reducing control valve, and filters fuel. It consists of an orifice plug and a 60-mesh monel screen located between the inlet port and three discharge ports. The orifice plug creates reduced pressure by increasing fuel velocity (like an eductor). This aids in vacating the cover chamber of the fuel valve. The monel screen traps foreign particles and contaminating substances. The three discharge ports direct filtered fuel to the pressure-reducing control valve, the flow control valve, and the SOPV.

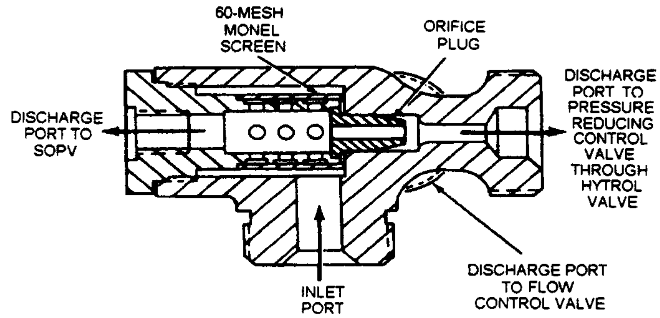


Figure 5-6.—Ejector strainer.

Solenoid-Operated Pilot Valve (SOPV)

The SOPV (fig. 5-7) shifts the Cla-Val assembly from the defuel to the fuel mode of operation, and vice versa. The SOPV is a direct acting, solenoid-actuated valve. It is a four-way valve with a grooved stem that moves back and forth in a machined bore inside the body. When the solenoid is energized in the fueling mode, the stem is drawn against spring compression by the magnetic pull of the solenoid. When the solenoid is deenergized in the defueling mode, the stem is returned by the extension of the core spring. Movement of the valve piston directs full flow in one direction or full flow in the opposite direction. There is no closed-port position. The valve is also equipped with a manual operator. Manual operation is done by pushing upward on the button at the lower end of the control. A quarter-turn clockwise locks the manual operator in place.

The solenoid is housed in an explosion-proof case and meets the requirements for use in hazardous locations.

Flow Control Valve (Needle Valve)

The flow control valve (fig. 5-8) consists of a needle valve with a spring and disk assembly within a housing. The housing cover can he removed to allow for needle valve adjustment. The flow control valve is installed in the line between the ejector-strainer and the fuel valve cover chamber.

The flow control valve, by virtue of its construction, controls the flow from the fuel valve cover chamber,

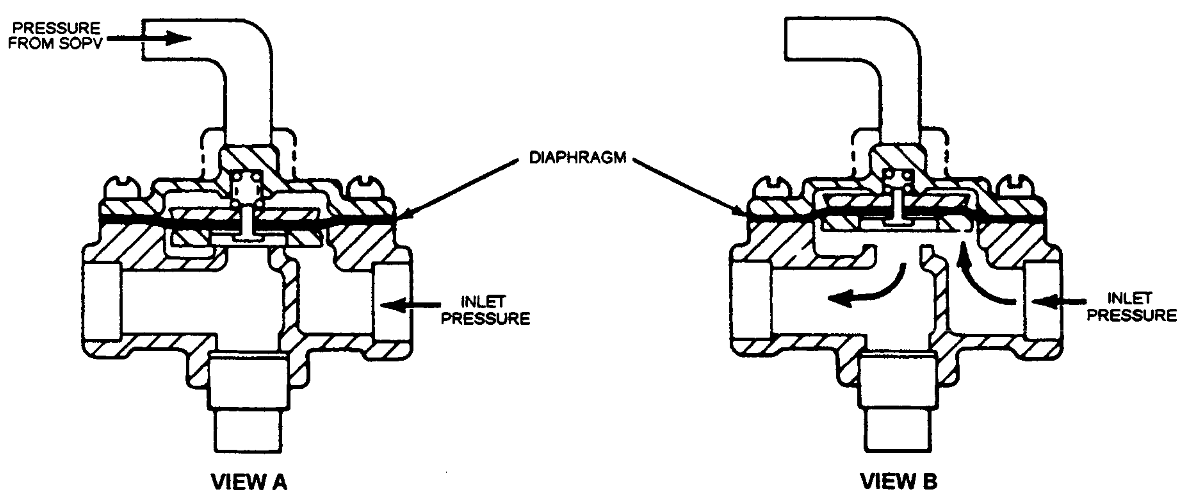


Figure 5-5.—Hytrol valve.

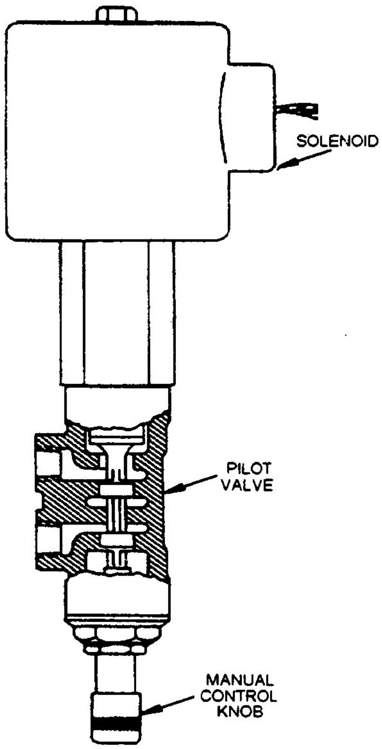


Figure 5-7.-Solenoid-operated pilot valve (SOPV).

which controls the reaction time of the fuel valve. This is done by restricting fuel flow through the needle valve and disk assembly. Flow in the opposite direction lifts the disk up off the seat, permitting free flow.

Operation of the Cla-Val

A step-by-step analysis of the valve's operation is as follows. Figure 5-9 shows the valve in the fueling position.

1. The solenoid is energized.

2. The SOPV directs pressure from the main valve inlet into the cover chamber of the defueling valve, holding it closed.

3. The SOPV also vents the cover chamber of the hytrol valve to the defueling line. This permits the pressure-reducing control valve to take over control of the fueling valve.

4. When the pressure-reducing control valve goes into operation, high pressure fuel enters the fueling valve and bypasses through the ejector-strainer to the pressure-reducing control valve, which is held open by its compression spring. With pressure at the pressure-reducing control valve below the adjusted setting, a maximum flow is permitted through the ejector-strainer. This creates a reduced pressure in the main valve cover chamber, which allows the fueling valve to open to build up pressure in the downstream system. The increasing downstream pressure is transmitted through the pressure reducing control valve line to the under side of the pressure reducing control valve diaphragm.

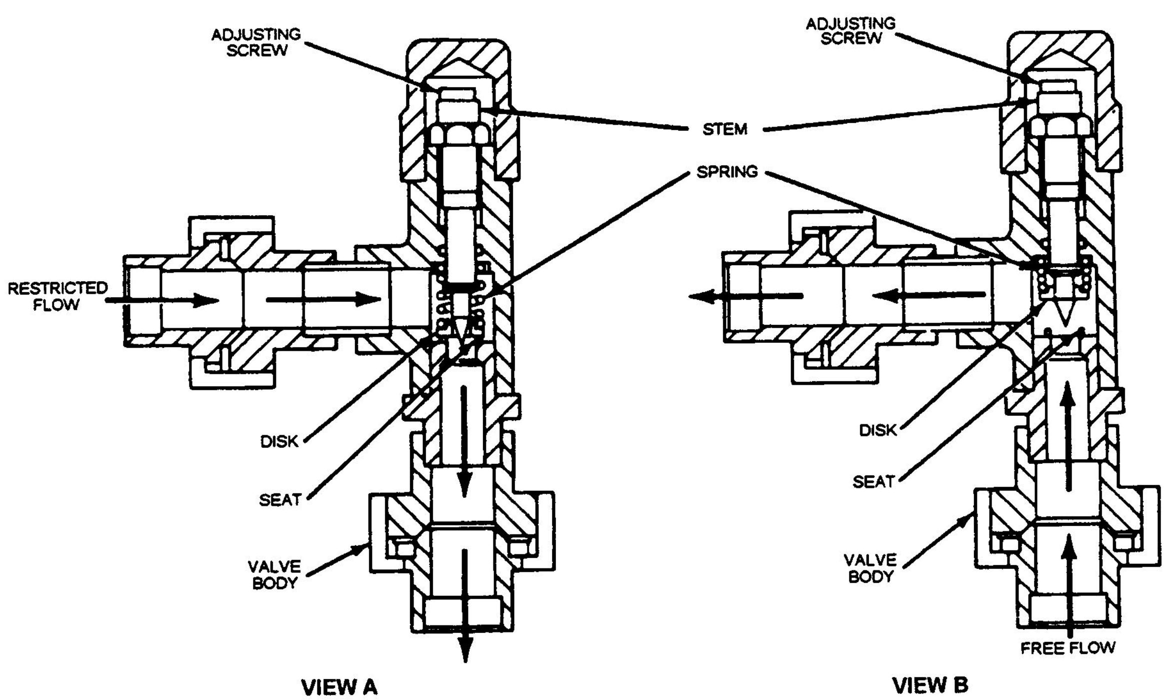


Figure 5-8.—Flow control valve (needle valve).

NOTE

The flow control valve controls the rate in which fuel is evacuated from the cover chamber of the fueling valve and the speed the fueling hose charges. It should be adjusted so the fuel hose charges gradually. If the hose charges too hard, the possibility of equipment damage and injury is increased.

5. When the pressure under the pressure-reducing control valve diaphragm reaches a point where it balances the loading of its compression spring, the pressure-reducing control valve begins to close, thus restricting the flow through the ejector-strainer sufficiently to increase the pressure in the main valve cover chamber. The resulting increase in pressure in the cover chamber forces the disk toward the seat until the main valve is passing just enough fuel to maintain a down-stream pressure that balances the loading of the pressure-reducing control valve compression spring. Any subsequent change in fuel demand tends to cause a slight change in downstream pressure, which results in the pressure-reducing control and main valves assuming new positions to supply the new demand.

6. As long as normal fueling operation is in process and the flow rate is not changing rapidly, the fueling

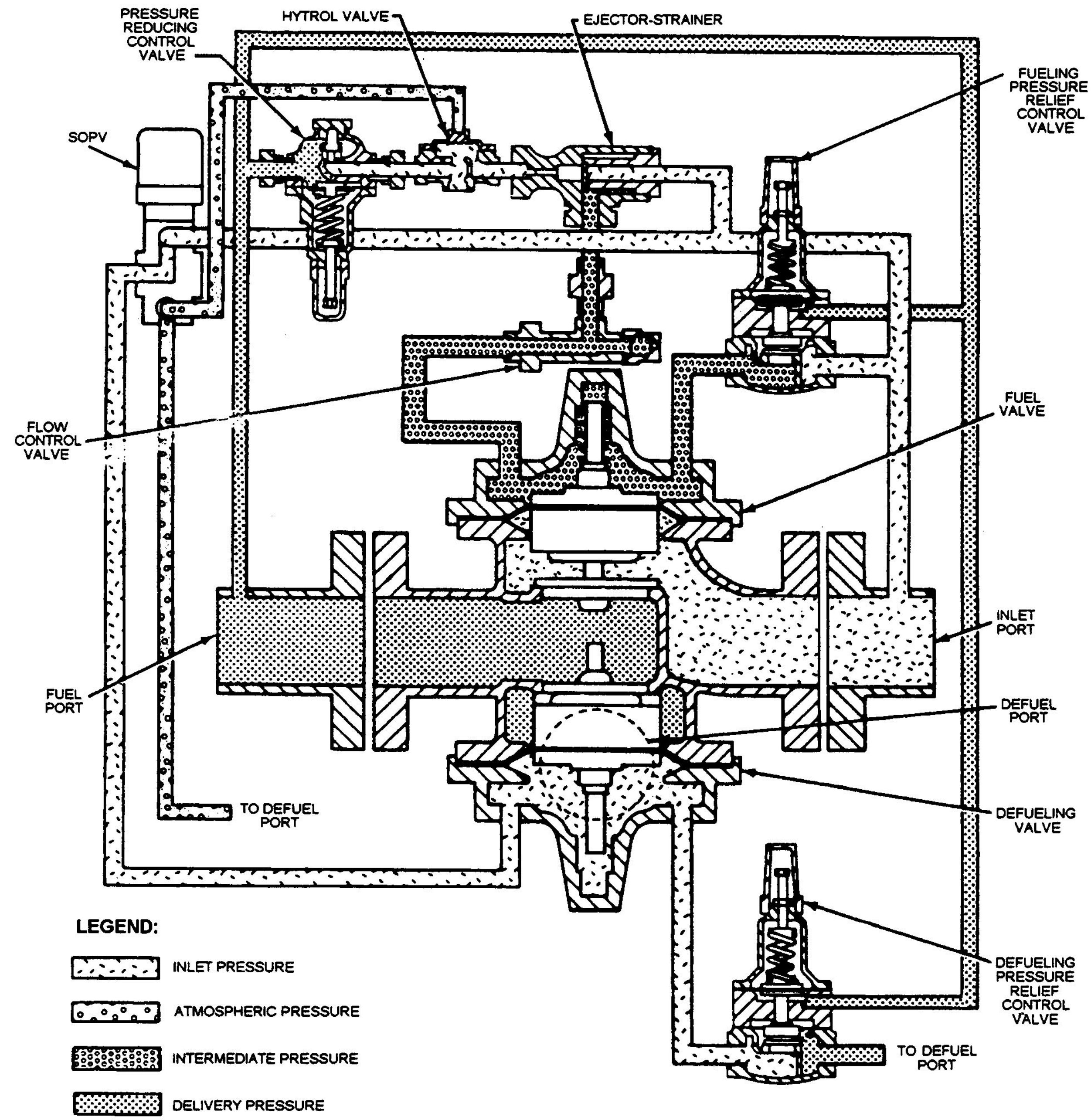


Figure 5-9.—Cla-Val fueling operation.

valve functions as outlined above. If the flow rate suddenly decreases, two things occur:

a. Any pressure rise is offset by the opening of the defueling valve.

b. The fueling valve closes rapidly.

7. Figure 5-9 shows that delivery pressure is reflected under the diaphragm of both pressure-relief control valves, opposing the force applied by the spring. When a downstream pressure rise occurs that is sufficiently high to overcome the force of the spring, the defueling valve pressure-relief control valve opens to relieve pressure from the cover of the defueling valve. This allows the defueling valve to open, thereby relieving excess pressure into the defueling line.

8. When pressure and flow conditions return to normal, all valves resume their normal functions.

Defueling Operation of the Cla-Val

The defueling operation of the Cla-Val follows. Figure 5-10 shows the valve in the defueling position.

1. The solenoid is deenergized.

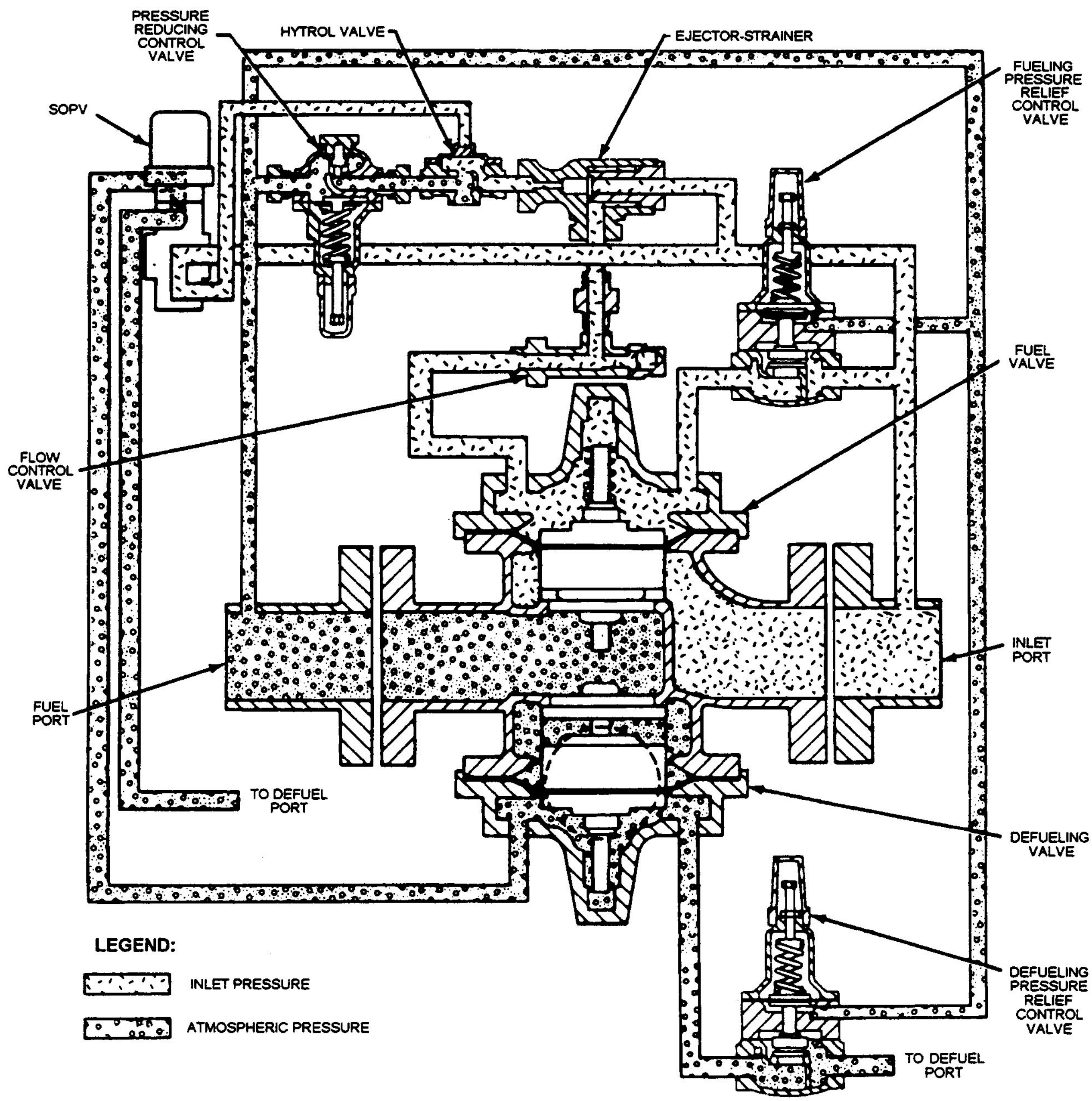


Figure 5-10.—Cla-Val defueling operation.

2. The SOPV directs pressure from the main valve inlet into the cover chamber of the hytrol valve, holding it closed. This diverts high pressure through the ejector-strainer into the cover chamber of the fueling valve, holding it closed.

3. The SOPV also vents the cover chamber of the defueling valve to the defueling line. With pressure released from the cover chamber, the defueling valve opens by virtue of its own weight and inverted design. The defueling valve will have a controlled opening rate produced by a restriction tube elbow located in the line from the cover chamber.

Cla-Val Fuel/Defuel Pressure-Setting Procedures

Procedures are the same for all pressure settings; only the pressure will vary. This example is for a final delivery pressure of 50 psi. The pressure-setting procedures are the following:

1. A pressure gauge must be installed in the line between the fuel/defuel valve and the hose.

2. Remove adjusting screw housings for both pressure-relief control valves and the pressure-reducing control valve.

CAUTION

Do not turn these screws beyond the point at which they become tight. Damage to the internal parts of the valve may result.

3. Loosen all three jam nuts and gently screw the adjusting screw on both pressure-relief control valves all the way in.

4. Line up and pressurize the service system.

5. Unreel the hose and connect the nozzle to the defuel main. (Use proper grounding procedures.)

6. Start the defuel pump.

7. Place the toggle switch to the ON position.

8. Slowly turn the adjusting screw on the pressure-reducing control valve until the gauge in the delivery line reads 10 psi higher than the desired pressure (60 psi in this example).

9. Tighten the jam nut to lock the adjusting screw.

10. Slowly turn the adjusting screw of the defuel valve's pressure-relief control valve until the delivery pressure gauge dips downward approximately 2 1/2 psi (57 1/2 psi in this example).

NOTE

The defuel valve's pressure-relief control valve will be set 7 1/2 psi higher than delivery pressure.

11. Tighten the jam nut to lock the adjusting screw.

12. Loosen the jam nut and slowly turn the adjusting screw of the pressure-reducing control valve until the delivery pressure drops to a point 5 psi above the desired delivery pressure (55 psi).

13. Tighten the jam nut.

14. Slowly turn the adjusting screw of the fuel valve's pressure-relief control valve until the delivery pressure gauge begins to dip downward approximately 2 1/2 psi (52 1/2 psi).

NOTE

The fuel valve's pressure-relief control valve will be set 2 1/2 psi higher than delivery pressure.

15. Tighten the jam nut to lock the adjusting screw.

16. Loosen the jam nut and slowly turn the adjusting screw of the pressure-reducing control valve until the delivery pressure has dropped to the desired delivery pressure (50 psi).

17. Tighten the jam nut to lock the adjusting screw.

18. Replace all adjusting screw housings.

19. Secure station.

Trouble-shooting Procedures

To do troubleshooting, you must completely understand the function of the Cla-Val. Before you actually make any mechanical adjustments, carry out the following steps:

1. Be sure that the SOPV is operating when the fueling switch is turned to the ON position and that it is being deenergized when the switch is turned to the OFF position. (This is commonly called a "click" test.)

2. Be sure the inlet pressure is high enough to maintain the required delivery pressure. Inlet pressure should be at least 10 pounds higher than desired delivery pressure.

3. Check to see if the protective housings are missing or damaged. If they are, this may indicate improper adjustment of the control valves.

4. Be sure that no part of the control valve system has been removed, disturbed, or damaged.

The above checks may indicate the probable source of trouble. If not, the step-by-step procedures outlined in the following paragraphs should be followed. As always, when actually troubleshooting equipment, refer to the applicable technical manual.

FUELING VALVE FAILS TO OPEN.— If the SOPV is not operating properly, proceed as follows:

1. Energize SOPV and apply pressure at the main valve inlet.

2. Loosen the tube fitting at the cover of the hytrol valve.

3. If fuel under pressure is present, the SOPV is probably stuck in the deenergized position.

4. Operate the SOPV manually as outlined in operating instructions.

5. If fuel under pressure at the loosened fitting is shut off when the SOPV is actuated manually, the SOPV must be repaired or replaced.

If the hytrol valve fails to open, proceed as follows:

1. Loosen the tube nut at the cover of the valve. No pressure should be present at this point.

2. Make sure there is no pressure in the downstream fueling line. Break the union between the fueling pressure-relief control valve and the hytrol valve.

3. If no pressure is present at the disconnected union, failure of the diaphragm in the hytrol valve is indicated.

4. Remove the cover screws and the cover of the hytrol valve.

5. Remove the diaphragm assembly and replace the diaphragm if ruptured.

6. Reassemble the hytrol valve. Reconnect the union and tubing fittings.

FUELING VALVE FAILS TO CLOSE.— If the SOPV is not operating properly with the solenoid de-energized and pressure at the main valve inlet, proceed as follows:

1. Loosen the tube nut at the cover of the hytrol valve to determine whether or not fuel is under pressure at the loosened connection.

2. If there is no flow under pressure, SOPV failure is indicated.

3. Operate the SOPV manually as outlined in the operating instructions.

4. If pressure is received at the loosened tube connection when the SOPV is actuated manually, this indicates the SOPV must be replaced or repaired.

The ejector-strainer may be clogged. Carry out the following procedure:

1. With no pressure at the valve inlet, remove the large box nut on the end of ejector-strainer.

2. Inspect the screen and clean it if it appears to be clogged.

3. Inspect the secondary jet to make sure it is not plugged.

FUELING VALVE FAILS TO MAINTAIN DESIGNED DELIVERY PRESSURE.— If the pressure-reducing control valve is not operating properly, carry out the following procedures:

1. Remove the adjusting screw housing.

2. Loosen the jam nut and turn the adjusting screw clockwise.

3. If the fueling valve opens during this procedure and delivers fuel at art increased and constant pressure, it is an indication the pressure adjustment of the pressure-reducing control valve is incorrect.

4. To remedy, follow the entire "Pressure Setting Procedure" outlined in the operating instructions.

Fueling pressure-relief control valve may be held open.

—The correct setting of this valve is 2 1/2 psi higher than the pressure setting of the pressure-reducing control valve.

—If the fueling pressure-relief control valve is adjusted to a pressure equal to or lower than the desired delivery pressure, the fueling pressure-relief control valve will be held open. If it is open, inlet pressure will flow into the cover chamber of the fueling valve and hold it closed.

—If this appears to be the trouble, remove the adjusting screw housing, loosen the jam nut, and turn the adjusting screw clockwise until it bottoms. This should close the pressure-relief control valve. If this was the trouble, the pressure settings should be re-adjusted as outlined in the operating instructions.

The fueling valve diaphragm may be ruptured. This occurrence is very unlikely. However, if all other steps have been followed and indications are that the main valve is faulty, follow these steps:

1. Remove all fittings from the cover of the fueling valve.

2. Remove the nuts holding the cover in place and lift off the cover.

3. Lift the diaphragm assembly out of the valve and examine the diaphragm for any holes.

4. Replace the diaphragm with a new one if necessary.

5. While the diaphragm assembly is out of the valve, the disk should be checked to see that it is in good condition. Replace if necessary.

6. When reassembling the valve, make sure the internal spring fits into its recess in the cover.

7. When the valve is returned to service, follow the procedure outlined in the operating instructions.

HOSE REELS

Each hose reel assembly (fig. 5-11) stores 150 feet of 2 1/2-inch collapsible hose or 1 1/2-inch non-collapsible hose. Each hose reel assembly consists of a drum, swing joint and elbow assembly, a support frame, and a manual brake. The drum holds, reels, and unreels the hose. The swing joint and elbow assembly permits rotation around the central axis of the drum, and also houses a spider assembly for the continuity circuit. The support frame provides permanent mounting for each drum. The manual brake prevents the drum from rotating when not in use.

The swing joint (fig. 5-12) is made of brass, to resist corrosion. The continuity wire enters the top of the flange on the fuel inlet side of the swing joint. It is connected to an amphonel stud that is insulated from the brass to prevent grounding out. Both ends of the stud have very small O-rings that are held in place by flat washers. The washers are, in turn, held in place by nuts that are threaded on to the amphonel stud.

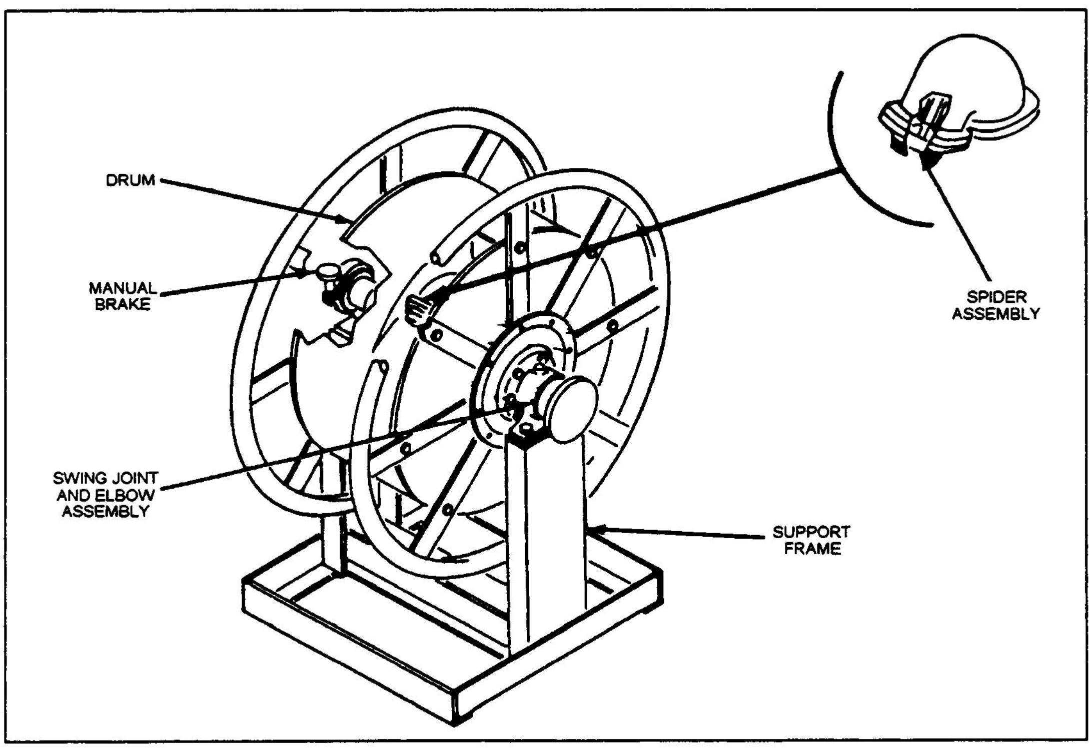


Figure 5-11.—Hose reel assembly.

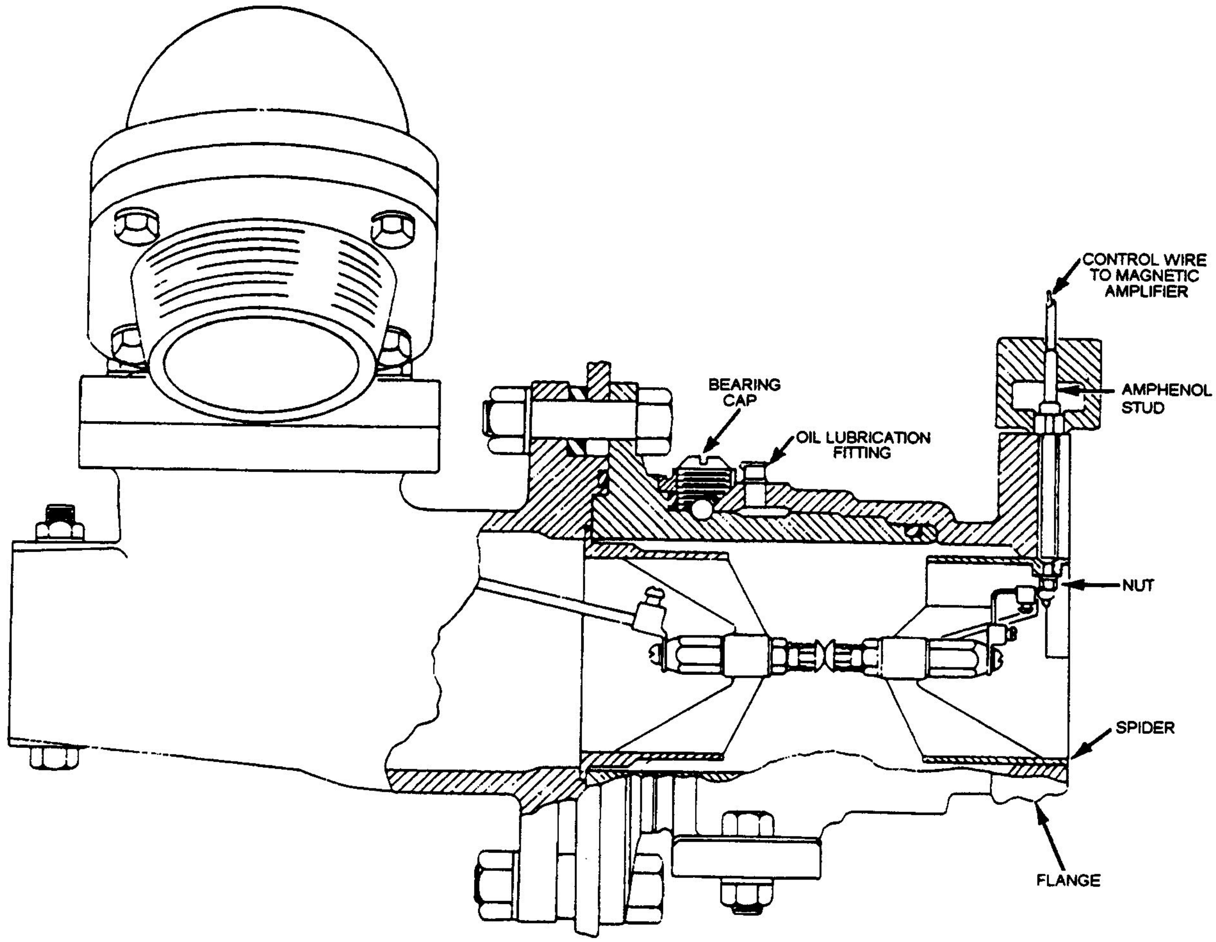


Figure 5-12.—Swing joint.

NOTE

The purpose of the O-ring is to prevent leakage of fuel around the amphonel stud. Sometimes, due to vibration, the nuts become loose, and leakage around the stud will occur. If you use a lock washer and double nut on the stud, you will lessen the chance that the nuts will back off because of vibration.

The amphonel stud is connected inside the swing joint to a spider assembly. The spiders inside the hose reel are connected from the swing joint by direct contact of spider to spider. The other spiders inside the drum area are connected by a hard wire.

The spider assembly in the male end of the hose reel (where the hose attaches) connects directly with the spider assembly in the female end of the fuel hose. Each end of the fuel hose has a spider assembly installed.

FUEL HOSE

Aviation fuel hoses are designed to pressure refuel aircraft quickly and safely. There are three types and sizes the ABF will typically use:

- 2 1/2-inch collapsible, used for refueling aircraft
- 2 1/2-inch non-collapsible, used for defueling aircraft
- 1 1/2-inch non-collapsible, used for defueling aircraft, boat fill, tractor fill, etc.

NOTE

Hoses on fueling stations that are used for defueling may be also used for fueling providing they are properly flushed.

All hoses come in standard 50-foot lengths or 100-foot bulk lengths. The 50-foot lengths come as a complete assembly. The 100-foot lengths are hose only and require installation of the couplings and continuity wire.

One end has a male coupling and the other end has a swivel-type female coupling (fig. 5-13). Leakage between the couplings is prevented by an O-ring in the female coupling. Both couplings are machined to receive the nylon spiders that act as non-conducting supports for connecting the continuity wire. The continuity wire runs through the hose and is slightly longer than the hose, to allow for hose stretching.

New hoses and hoses that were out of service for a long time must be cured (pickled) before being placed in service. Use the following procedure:

NOTE

Some new hoses manufactured according to Mil-H-17902 do not require pickling. How-ever, they must still be flushed and tested prior to use.

1. Flush the hose with 100 gallons of fuel.

2. Cap one end and elevate the hose.

3. Fill the hose, cap it and let it stand for at least 1 week.

4. Drain the hose and observe drainage for discoloration. (If discoloration is observed, repeat steps 1 through 3.

5. Test the fuel with the CFD. (Should be less than 10 mg/1.)

6. Install the hose and flush until acceptable fuel is sampled. (Less than 2 mg/1.)

Because of their environment, fuel hoses are subjected to severe wear and tear. They should be inspected during each use for superficial cuts, worn areas or bubbles in the hose, deep cuts that expose the wire reinforcement or inner layer wrapping, and leaky couplings.

If any of the above is observed, notify the flight deck supervisor, flight deck control, and flight deck repair immediately.

You can prolong the useful life of fuel hoses by not twisting or kinking a hose, not rolling a twisted or kinked hose up on its reel, and not allowing aircraft, tractors. or other rolling stock to run over the hoses. New fuel hoses are hydrostatically tested before being placed in-service, and in-service hoses are hydrostatically tested annually. In accordance with PMS requirements, fuel hoses are tested at 1 1/2 times their system operating pressure.

If a hose is found to be damaged near an end coupling but otherwise usable, it may be salvaged by cutting the damaged area off. This is known as “cutting back” a hose. To cut back a fuel hose, do the following:

1. Disconnect and remove the spiders and continuity wire from the hose.

2. Remove the coupling from the damaged end.

a. Unscrew the external taper sleeve from the coupling end and slide it down past the damaged area.

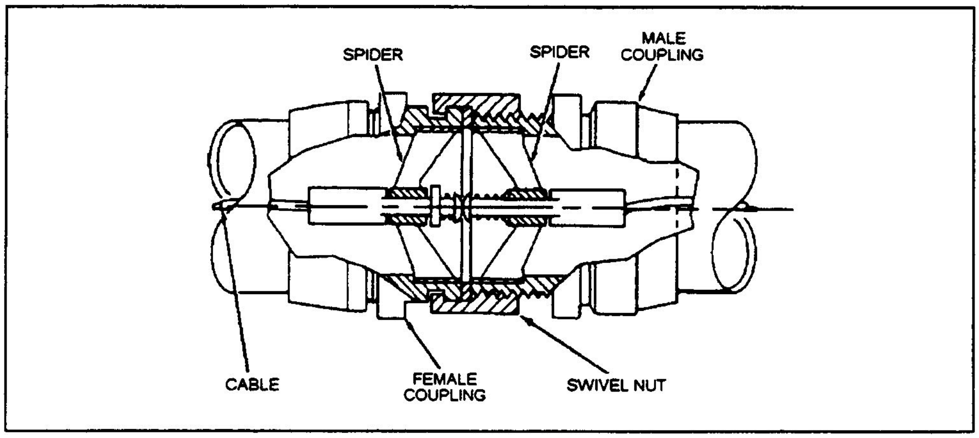


Figure 5-13.—Fuel hose couplings.

b. Work the wire helix (spiral) down and off the coupling end.

c. Remove the coupling end.

d. Remove the wire helix.

3. Make sure the hose is squared up, and mark the hose for cutting, using the taper sleeve as a guide. After marking, remove the taper sleeve.

4. Cut fabric-reinforced hose with a sharp knife wetted with fresh water. Cut wire-reinforced hose with a new or sharp hacksaw with fine teeth. Insert a round wood plug into the hose to eliminate the danger of loosening the inner liner or damaging the wire reinforcement while cutting.
coat of barrier.

5. Paint the freshly cut hose end lip with a light coat of zinc chromate primer to provide a moisture barrier.

6. Slide the external taper sleeve back on the hose.

7. Slide the wire helix on and position it about 6 inches down from the end of the hose.

8. Insert the coupling end into the hose, ensuring the hose is bottomed at the lip of the coupling end.

9. Work the wire helix up and into position over the inserted part of the coupling end. Be careful not to overexpand the wire helix.

10. Slide the taper sleeve into position and screw it tightly to the coupling end.

11. Hydrostatically test the hose as instructed in the appropriate MRC.

12. Cut the continuity wire 10 to 12 inches longer than the hose, to compensate for hose stretch.

13. Reinstall the continuity wire and spiders. Check for electrical contact between the contact buttons at the hose ends, using an ohmmeter. Maximum allow-able reading is 40 ohm.

14. Upon reinstallation on a station, flush the hose until an acceptable sample is obtained.

QUICK-DISCONNECT COUPLING (QDC)

The quick-disconnect coupling (fig. 5-14) is designed to provide the means of attaching the fuel nozzle to the hose. It also contains the switch to energize or de-energize the SOPV. When operating the quick-disconnect coupling, don't jam the switch, and don't drop the coupling on the deck.

The quick-disconnect coupling has a female thread on one side to fit the male threads of the hose. The other end has a female ball bearing quick-release that receives the male end of the nozzle adapter.

NOZZLE ADAPTER

The flange side of the nozzle adapter is bolted to the nozzle. The male end opening provides a means of installing a 100-mesh strainer inside the nozzle assembly. The strainer is held in place by a snap ring that fits into a recessed groove inside the male end.

PRESSURE FUELING NOZZLE

The pressure fueling nozzle connects to all NATO military aircraft and is designed to provide a leak-proof seal between the nozzle and the aircraft for high-capacity fueling operations. This includes sup-plying fuel under pressure to aircraft, and removing fuel by suction from aircraft.

The pressure fueling nozzle is attached to the hose by the nozzle adapter and quick-disconnect coupling. The nozzle outlet attaches solidly to the aircraft refueling adapter. The nozzle is secured to the aircraft by aligning the slots in the nozzle with the lugs on the aircraft adapter, pressing the nozzle firmly against the aircraft adapter, and rotating the collar clockwise until the internal stops are contacted.

The JC Carter D-1 and MD-1 are the pressure fueling nozzles most widely used in the Navy.

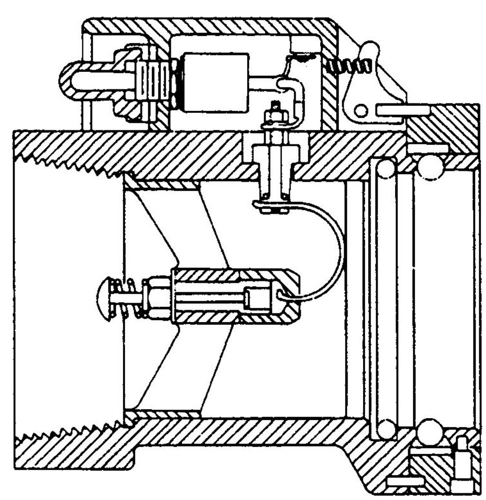


Figure 5-14.—Quick disconnect coupling with toggle switch.

The MD-1 (fig. 5-15) is the newer nozzle and will eventually replace all D-1 nozzles. Although physically similar, they differ internally, as the collar on the MD-1 nozzle swivels independently of the body. On the D-1 nozzle, the body and collar are one unit. Because the MD-1 is scheduled to become the standard pressure nozzle used in the fleet, it is the only one discussed here.

The MD-1 pressure fueling nozzle consists of four major components. They are the collar assembly, the nose seal assembly, the body, and the valve operating linkage.

Collar Assembly

The collar assembly holds the dust cover and the bumper. The dust cover is used to keep dust, dirt, and moisture out of the nozzle. The bumper is to provide additional protection to prevent accidental damage to the nozzle. The collar is attached to the body by 49 ball bearings.

Nose Seal Assembly

The nose seal assembly acts like a modified O-ring to seal the nozzle to the aircraft refueling connection and prevent leakage at the connection. It is made of metal and an O-ring type material. It also provides a housing for the poppet.

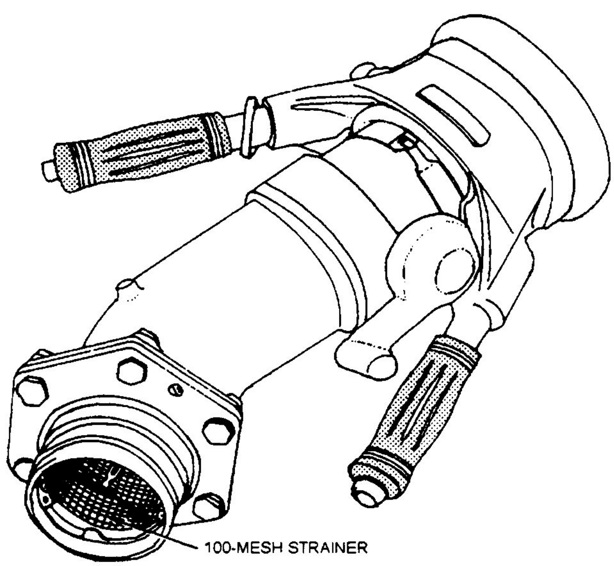


Figure 5-15.—MD-1 Pressure fueling nozzle with nozzle adapter and strainer.

Body

The body houses the actuating linkage, indexing pins, collar lock pin, and the collar lock pin spring. It also has an opening to connect the sample connection and another opening to connect the actuating lever. The bottom of the body is attached to the inlet elbow by 39 bearings. Leakage between the body and other attached parts of the nozzle is prevented by O-rings.

Valve Operating Linkage

The valve operating linkage connects the actuating lever to the poppet. When the actuating lever is rotated up and forward, the linkage pushes out the poppet and opens the nozzle. When the actuating lever is rotated backward and down, the linkage pulls the poppet back into the nose seal assembly and closes the nozzle.

The poppet is made of Teflon®-coated cast aluminum. A shroud on the bottom of the poppet eliminates turbulence while fueling. The nozzle poppet pushes on the aircraft fueling adapter poppet when opening, thereby opening the aircraft fueling adapter.

GRAVITY (OVERWING) FUELING NOZZLE

The gravity fueling nozzle (fig. 5-16) is manually controlled. Like the pressure refueling nozzle, it is attached to the end of a fuel hose by a nozzle adapter and quick-disconnect coupling. The nozzle outlet is inserted directly into the fuel tank. The nozzle is actually a valve for controlling the rate of fuel flow, and it closes automatically when hand pressure is released.

When you move the control lever toward the nozzle handle, fuel is allowed to flow through the nozzle. A dual valve in the nozzle allows a gradual opening or closing of the nozzle.

The control lever presses against the valve stem and lifts a small valve disk that is held against its seat by a compression spring. When you open the smaller valve, you avoid a sudden flow of fuel (known as cracking the valve). After cracking, the continued action of squeezing the handle depresses the valve stem farther, and a shoulder on the stem meets the large disk assembly, opening the valve fully. In closing the nozzle, the operation is reversed, and the larger valve disk closes first. The small stream still coming through the valve relieves the stress on the hose, which results if the complete flow is suddenly stopped. Fully releasing the control lever closes the

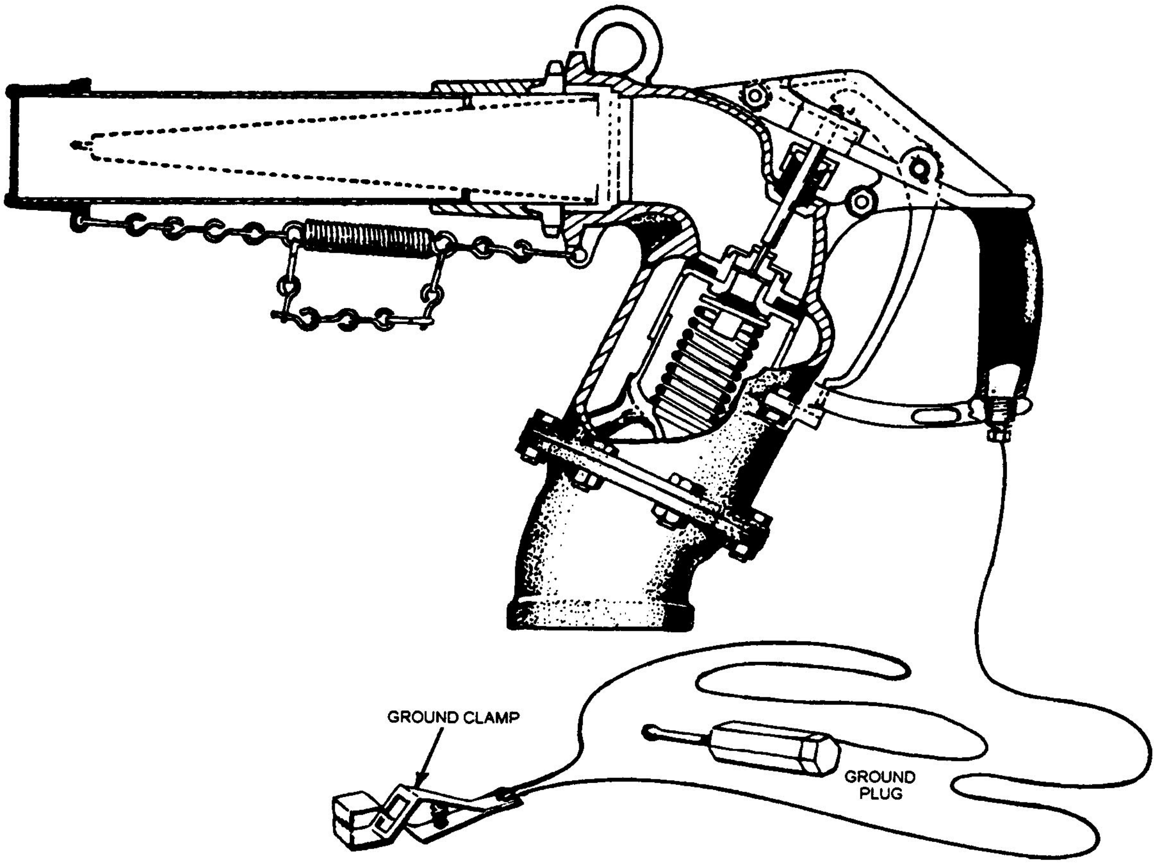


Figure 5-16.—Gravity fueling nozzle.

smaller valve, and the nozzle is then completely closed.

Never block the gravity fueling nozzle in an open position. Ratcheted handles that allow the operator to lock the handle in the open position are prohibited. The nozzle must always be controlled by hand, so that the flow of fuel may be instantly stopped when necessary. A strainer or screen installed in the nozzle provides a last means of stopping any dirt or foreign matter from entering the aircraft fuel tanks. This strainer should never be left out of the nozzle if it is to be used for fueling aircraft.

DEFUEL PUMP

The defuel pump used in Cla-Val fueling stations is the Blackmer rotary vane, positive displacement pump. It is described in detail in chapter 4 of this manual.

Flight and hangar deck station defuel pumps are normally set to pump 100 gpm at 15 psi.

PORTABLE DEFUEL PUMPS

The portable defueling pumps are either an air-motor-driven internal gear pump or an air twin-diaphragm pump mounted on a mobile cart. Both pumps are operated off the ship's low-pressure air system.

Three hoses are used with the defueling unit: an air hose, which has a 1/2- or 3/4-inch inside diameter, and two defueling hoses, which have 1 1/2 or 2 1/2-inch inside diameter. One defueling hose is used as a suction hose. It should be as long as necessary to reach from the aircraft to the defueling unit. The longer the hose, the less effective the defueling unit is. The other defueling hose is used for the defueling unit discharge hose. The length of this hose has little effect on the defueling unit operation as long as it does not become kinked.

The defueling suction hose is connected to the aircraft in several different ways. For jet aircraft having single-point fueling/defueling capability, the hose is connected to the aircraft through a pressure fueling nozzle. For aircraft drop tanks, the hose without a fitting is inserted into the tank fill opening or pushed up over a drain fitting on the bottom of the tank. When defueling drop tanks only, the method normally used is to insert the defueling suction hose into the tank through the tank fill opening. For total defueling, defuel through the aircraft pressure fueling adapter. The discharge hose from the defueling unit is connected to the fill connection through a special fitting.

CONTINUITY

Electrical continuity is a firm requirement for all aircraft refueling stations. Electrical continuity must be present and maintained to ensure personnel safety, equipment protection, and efficient fueling operations.

With electrical continuity present, the nozzleman fueling the aircraft has immediate control of fuel flow. This is essential to prevent fuel spills and possible accidents during aircraft refueling. Electrical continuity is present when wires are provided and switches are set to allow an electrical current to flow away from the controller and back to it through a solid metallic path.

Now, let's follow the continuity circuit (fig. 5-17). Starting the defuel pump applies power to the solid state relay, but nothing happens, because the circuit is broken. Make sure your ground wire to the deck is grounded to metal. Then hook it to the aircraft. Remove the dust cover and connect the nozzle. Flip the switch in the quick-disconnect housing to ON, which closes the circuit. The ground then goes back through the spiders in the quick-disconnect coupling to the wire in the hose. From there, it goes back to the

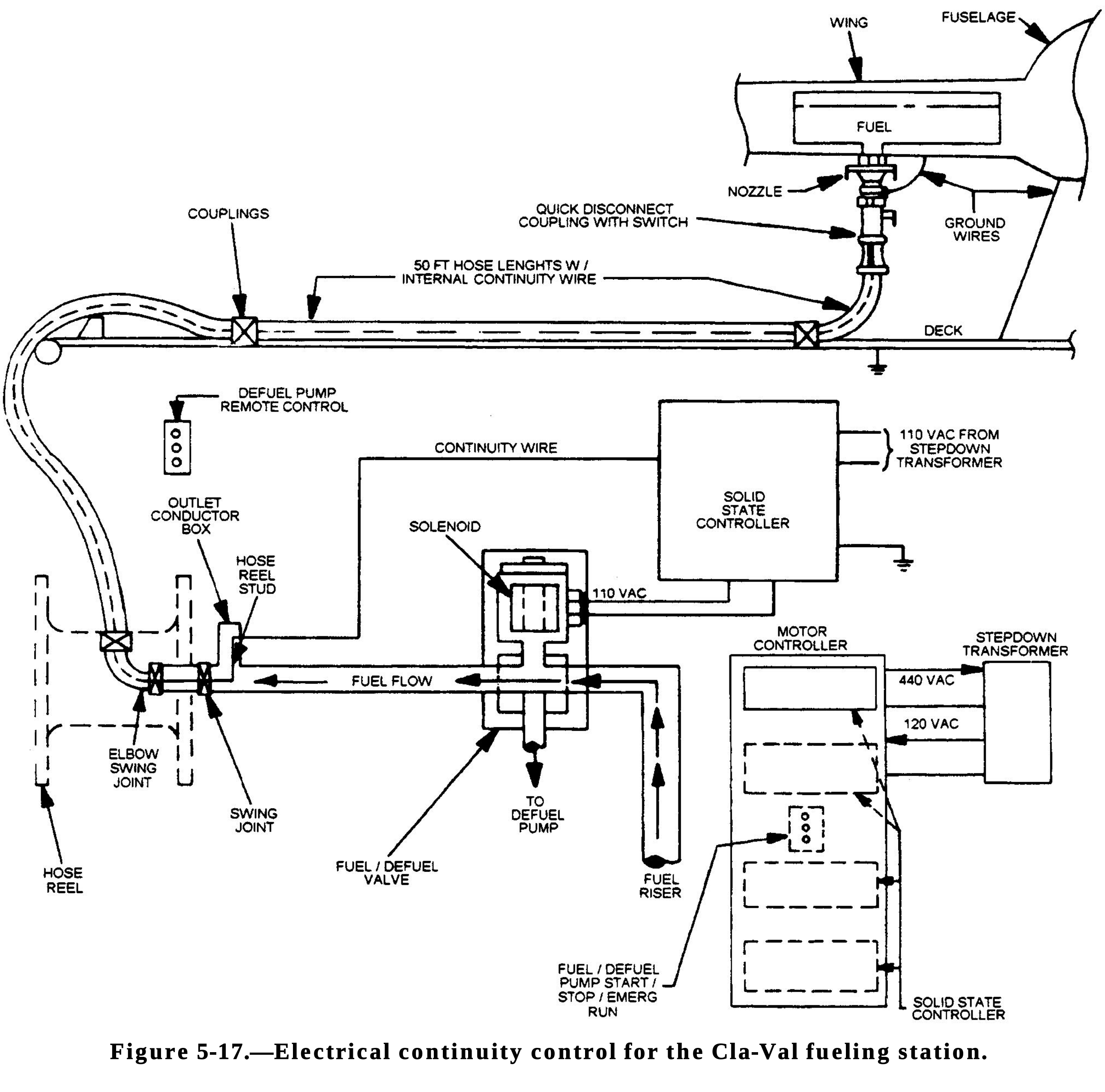


Figure 5-17.—Electrical continuity control for the Cla-Val fueling station.

hose reel hub, to the swing joint, through the amphonel stud to the junction box, to the solid state relay (which is also grounded to the ship), and from the solid state relay back to the electric solenoid, which goes to the fuel position.

If the continuity circuit is broken at any place, the solenoid will immediately de-energize, and the Cla-Val will go into the defuel mode.

NOTE

More often than not, if a hose does not charge when the fueling switch is flipped on, the cause is a bad ground. Double-check all grounding connections to ensure metal-to-metal contact is made.

CAUTION

If a hose should rupture while fueling, and the continuity circuit is not broken, FUEL WILL CONTINUE TO BE PUMPED THROUGH THE HOSE AND OUT THE RUPTURE. Immediate action by the nozzleman to flip the QD housing switch to OFF is required to de-energize the SOPV so the Cla-Val will go into the defuel mode. If the nozzleman is unable to do this, the station operator should turn the defuel pump off (this will also break the continuity circuit) and close the station riser valve.

SHIPBOARD AIRCRAFT REFUELING PROCEDURES

LEARNING OBJECTIVES: Identify various flight and hangar deck fueling and defueling operations. Explain proper procedures for each operation.

The actual fueling or defueling operation is the end result of several actions. Unlike below-decks operations, flight-deck operations are rarely routine.

Fueling assignments on the flight and hangar deck are made by the Aviation Fuels Flight Deck Control Talker. The Control Talker works closely with the Handler and CAG Maintenance Chief to ensure aircraft and support equipment are fueled quickly and safely.

The following shipboard operating procedures cover only those activities directly involved with the refueling of aircraft. They do not cover the below-deck operations that must be performed in conjunction with the aircraft refueling operation. The procedures presented here are the typical ones used aboard ship.

Specific shipboard operating procedures, including below-deck activities as well as aircraft refueling, are contained in the *Aviation Fuels Operational Sequencing System* (AFOSS). As in all fueling evolutions, use the specific procedures published in your ship's AFOSS.

Skill, experience, and good judgment are the keys to running a successful flight deck.

HAND REFUELING SIGNALS

In the upcoming pages, we will discuss operations. All successful operations depend on how well you can communicate with the person with whom you want to communicate. Since the flight deck is often very noisy, you cannot talk directly with the pilot or even members of your fueling crew; you must use hand signals. A clear understanding of hand signals is required. See figure 5-18 for an easy-to-follow diagram of refueling signals. It is very important that you, the ABF, know the correct hand signals for refueling.

Study the figure carefully. As an ABF, you will constantly use hand signals. When an aircraft lands on deck, one of the first questions asked is, "What is your fuel load?" The question and answer are communicated with hand signals.

AIRCRAFT PRESSURE REFUELING WITH ENGINES OFF (COLD REFUELING).

A minimum of three people are needed for refueling an aircraft: refueling crewman, refueling station operator, and a plane captain. A crewleader (safety person) is also recommended, but it is possible for the safety person to supervise more than one fueling operation.

Aircraft refueling tasks are to be performed in the following sequence:

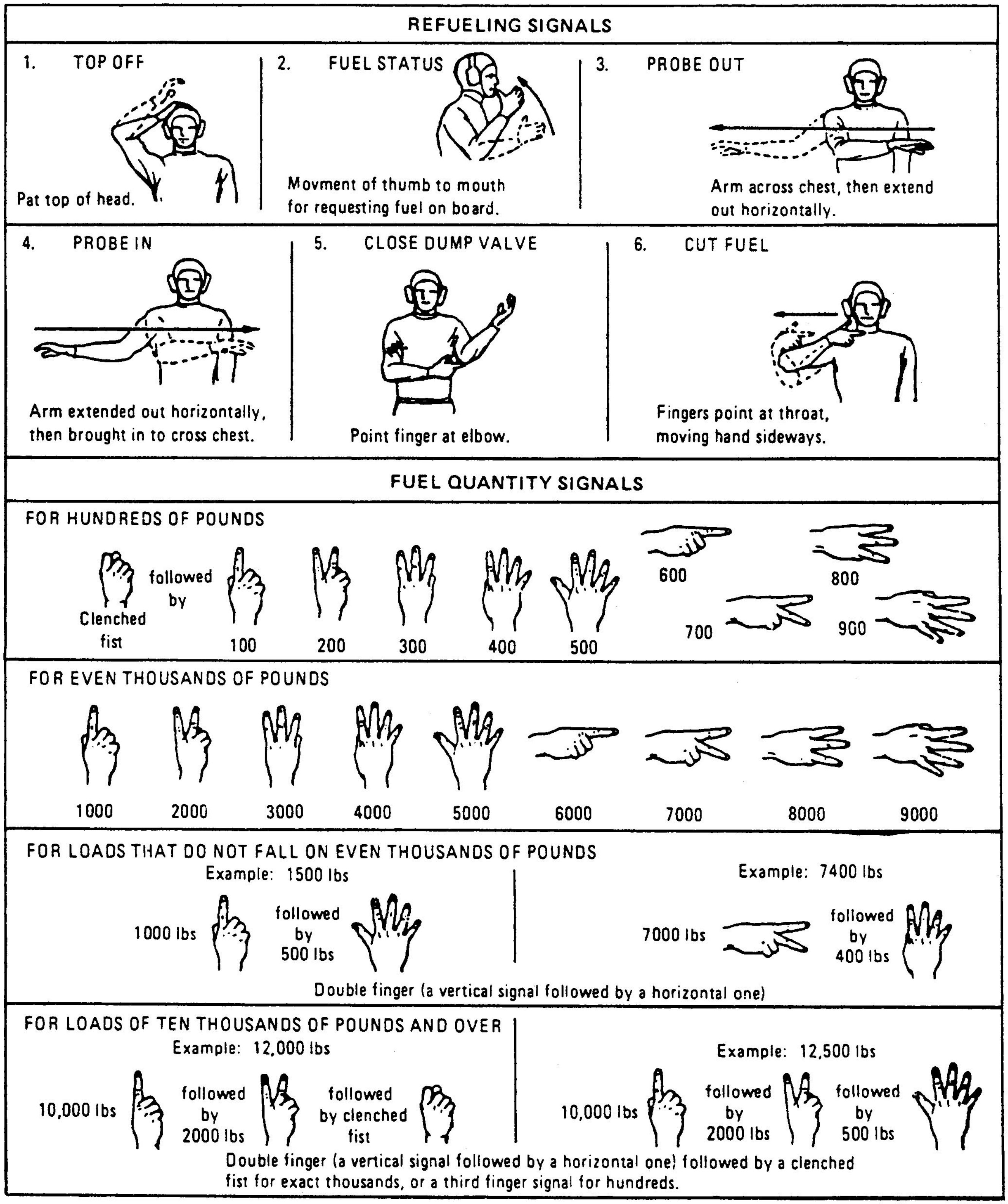


Figure 5-18.—Refueling hand Signals.

1. Secure all electronic and electrical switches on the aircraft not required for fueling. Once a fueling evolution has commenced, the aircraft's electrical power status and connections are NOT to be changed until the evolution is completed. This means the following:

a. NO aircraft engines or auxiliary power units will be started or stopped.

b. External power will NOT be connected, disconnected, or switched on or off.

c. Changing the aircraft's electrical power status can create significant ignition sources.

2. Verify that manned fire-fighting equipment is in the area. The flight deck P-16 is manned by crash and salvage personnel when aircraft are aboard, and satisfies this requirement for fueling on the flight deck. On the hangar deck, if no roving fire-fighting equipment is manned, the fuel crew must have a portable fire extinguisher manned nearby.

3. Take a sample if needed for quality surveillance checks. The hose (not the entire station) is considered ready for use if an acceptable fuel sample was taken under normal flow conditions within the preceding 24 hours. If this has not occurred, the hose MUST be flushed through the flushing connection into the selected contamination tank, and a sample taken and tested for contamination prior to refueling the first aircraft. Fueling must NOT begin until acceptable sample results are obtained. The Maximum allowable limits for sediment and water contamination are 2 milligrams per liter (2mg/1) for sediment, and 5 parts per million (5ppm) for free water.

4. Check for "hot brake" condition (plane captain).

5. Ensure that the aircraft has initial tiedowns. Aircraft tiedowns will not be removed or altered during the aircraft refueling evolution.

6 . Attach the grounding wire from the deck to the aircraft. Grounding connections must be made to bare metal.

7 . Position the fuel hose.

8 . Remove refueling adapter cap from the aircraft and the dust cover from the pressure nozzle. Inspect the face of "the nozzle and make sure it is clean. Inspect index pin area for excessive wear. Verify that the flow control handle is in the fully closed and locked position.

9. Visually inspect the aircraft's adapter (receptacle) for any damage or significant wear. If there is any doubt about the integrity of the adapter, notify the squadron representative.

NOTE

Refueling will not be performed unless qualified squadron personnel are present.

CAUTION

A worn or broken adapter can defeat the safety interlocks of the refueling nozzle, permitting the poppet valve to open and fuel to spray or spill.

10. Confirm that the switch on the nozzle quick-disconnect coupling (QDC) is in the OFF position.

11. Lift the nozzle by lifting the handles; align the lugs on the nozzle with the slots on the aircraft adapter; and connect the nozzle to the aircraft by pressing it firmly onto the adapter and rotating it clockwise to a positive stop. The nozzle must seat firmly on the adapter and not be cocked.

12. Upon receiving signals from the nozzle operator that hook-up is complete and from the plane captain that he is ready to begin the fueling operation, the station operator opens the defueling pump discharge valve, the Cla-Val cutout valve, and the hose reel cutout valve. After checking the gauge for the station supply riser to ensure fuel pressure is available, the station operator starts the defuel pump. The station operator must remain in position at the station controls throughout the fueling operation.

13. Place the quick-disconnect switch in the ON (fuel) position. This energizes the solenoid-operated pilot valve (SOPV) for the Cla-Val and places it in the fueling position.

CAUTION

The flow control handle of the pressure nozzle must be placed in either of two locked positions: fully open or fully closed. The handle is NOT to be used as a flag to indicate fuel flow. Excessive wear on the aircraft adapter and the fuel nozzle poppet will result if the handle is allowed to "float" in the unlocked position.

14. When the hose is fully charged, rotate the nozzle flow control handle to the FULL OPEN position. The handle must rotate 180 degrees to insure that the poppet valve is fully open and locked.

15. Once fuel flow has been established, squadron personnel will exercise the aircraft's pre-check system.

NOTE

The pre-check system simulates the completion of refueling by closing all the tank shut-off valves within the aircraft. All fuel flow into the aircraft should stop within a few seconds to 1 minute of actuating the pre-check system. The primary means of detecting successful pre-check is by observing the flow indicator on the aircraft. If the aircraft is not configured with the indicator, an alternate method is to observe the jerk and stiffening of the refueling hose and/or the pressure spike that occurs at the refueling station. If an aircraft fails pre-check, it can be cold refueled only if procedures are called out in that specific aircraft's NATOPS.

16. Fuel the aircraft as directed by the flight plan. The plane captain will monitor aircraft vents, tank pressure gauge(s) and/or warning lights as necessary. The plane caption is also responsible for ensuring that the aircraft is fueled to the correct fuel load.

17. When directed by the plane captain, rotate the nozzle flow control handle to the OFF and fully locked position.

18. Place the quick-disconnect switch in the OFF position. This deenergizes the solenoid-operated pilot valve (SOPV) and places the Cla-Val in the defueling position.

19. When the hose is evacuated, disconnect the nozzle from the aircraft adapter, replace the adapter cap, and remove the ground wire from the aircraft, then the deck.

20. Move to next aircraft to be fueled. After all aircraft have been fueled, secure the refueling station.

21. Restow the hose.

Aircraft Pressure Refueling With Engines Operating (Hot Refueling)

Hot refueling procedures are the same as the Cold Refueling procedures listed above except for the following additions and precautions:

1. The aircraft pilot will select fuel loading, ensure that the cockpit switches are in the proper positions, and maintain UHF radio contact with Primary (Air Boss).

2. The pilot will secure all electronic and electrical equipment not required for refueling.

3. The pilot will place all armament switches in the SAFE position.

4. The aircraft must NOT be hot refueled if it fails pre-check. Failure of the pre-check indicates a malfunction in the aircraft's fuel system, which can result in a fuel spill and fire.

5. The aircraft canopy and helicopter side doors will remain closed during the entire fueling evolution.

6. Be extra cautious around intakes and exhausts. Assume both engines on a dual-engine aircraft are operating. Although some aircraft can and do shut down the engine on the side where the refueling adapter is located (F-14), most aircraft currently do not (F-18, A-6).

7. Pilot-in-command changes are not permitted during refueling operations.

8. No static samples are to be taken during hot refueling.

NOTE

Hot refueling is performed with the pressure nozzle only.

Overwing Refueling

Overwing (gravity) refueling can be performed only with the engines off. Overwing refueling procedures are the same as cold refueling procedures, except for the following additions:

CAUTION

Fueling with an overwing nozzle requires skill and patience because of the increased chance for a spill. ALWAYS use extreme caution when fueling this way and NEVER block the overwing nozzle in the open position.

1. Overwing nozzles must be grounded to the aircraft (or support equipment) prior to inserting the nozzle.

2. After inserting the nozzle in the fueling receptacle, make sure metal-to-metal contact between the nozzle and the fueling port is maintained throughout the fueling operation.

REFUELING AIRCRAFT WITH AUXILIARY POWER UNIT (APU) RUNNING

The aircraft APU maybe used to supply electrical power for pressure refueling on military aircraft so equipped. Refueling with the APU running is not conducted in the hangar deck. Although this operation is not considered "hot refueling," the following precautions must be observed, in addition to the normal refueling procedures:

1. One person will be at the APU controls in the cockpit.

2. Hand signals/signal wands must be established between cockpit and personnel performing refueling to ensure immediate shutdown in an emergency.

DEFUELING AIRCRAFT

Defueling is one of the most technically demanding and potentially dangerous operations performed by fuels personnel. Most aircraft defueling equipment can defuel an aircraft faster than the aircraft cart release it. The pump's discharge is throttled down to balance its inlet (fuel from the aircraft) to prevent pump cavitation and/or the loss of suction, which would necessitate reflooding of the pump. Once the proper balance is achieved, it is maintained by manipulation of the valve on the downstream side of the pump throughout the defueling operation.

Defuelings normally have lower priority than refueling. Unless otherwise directed and if they are not of an emergency nature, defuelings will be by written request approved by the Aircraft Handling Officer (ACHO). A defuel request for an aircraft leaking fuel is considered an emergency and handled promptly.

The following rules apply to every defueling operation:

- Aircraft defueling must be requested by an authorized representative of the squadron by completing and submitting an Aircraft Defueling Certificate to the ACHO.

- During defueling operations, no other maintenance not directly required to aid the defueling operation is to be performed.

CAUTION

Fuel with a flash point below 140°F SHALL NOT be defueled into the ship's JP-5 system. These systems are not designed to handle fuel with a lower flash point. The risk of explosion and/or fire will significantly increase if fuel with a low flash point is placed in these systems.

- All fuel removed from turbine engine aircraft is assumed to be low-flash-point fuel. Defueled jet fuel will NOT be returned to the ship's JP-5 system without first confirming the flash point of the fuel to be 140°F or higher.

- Prior to any defuel, fuel will be tested for particulates, free water, and flash point. Ultimate disposition will depend on the results of subsequent laboratory tests.

Additionally, JP-5 containing leak-detection dye cannot be returned to a ship's system.

- If during the defuel operation the pump starts to lose prime or cavitate, the operation will be discontinued until the problem is resolved.

- A special log of each defueling operation will be maintained. The following minimum information is contained in the log:

  - All abnormal happenings.
  - Aircraft Buno number.
  - Station/portable defuel.
  - Visual/flashpoint.
  - Scheduled amount to be removed and amount that was actually removed.
  - Disposition of product.
  - Time/date when the defuel operation was started and completed.
  - Name of defuel operator and squadron personnel present during the defuel operation.

- Defueling crews must wear proper safety clothing and goggles.

- Plane captains will be at their aircraft, and aircraft engines stopped. All electronic and electrical switches not required for defueling must be secured.

Ž A fire-fighting unit must& stationed upwind of the aircraft to be defueled.

Defueling With Pressure Nozzle

Perform the defuel operation as follows:

1. Verify that the aircraft has been grounded. If it hasn't, connect the ground wire to the deck and then to the aircraft. Ground connections must be made to bare metal.

2. Unreel the hard hose and lead to the aircraft to be defueled.

3. Ensure the quick disconnect continuity switch is in the OFF (defuel) position.

4. Remove the pressure nozzle receptacle cap from the aircraft.

5. Remove the dust cover from the pressure nozzle.

6. Lift the nozzle by the lifting handles; align the lugs on the nozzle with the slots on the aircraft adapter; and hook up the nozzle to the aircraft by pressing it firmly onto the adapter and rotating it clockwise to a positive stop. The nozzle must seat firmly on the adapter and not be cocked.

7. Open the station defuel valve.

8. Start the defuel pump.

9. Defuel the aircraft as directed.

10. Rotate the nozzle flow control handle to the full open position. (The handle must rotate 180 degrees to ensure the poppet valve is fully open and locked by toggle action.)

11. When defueling is complete, shut the nozzle valve by rotating the nozzle flow control handle 180 degrees to shut and locked position.

12. Stop the defuel pump and shut the defuel valve.

13. Disconnect the nozzle from the aircraft.

14. Replace the nozzle receptacle (adapter) cap on aircraft.

15. Replace the dust cover on the pressure nozzle.

16. Remove the ground wire from the aircraft, then the metal deck.

17. Restow the hose.

Defueling With Overwing Nozzle

If an overwing nozzle is to be used to defuel a drop tank or other similar vessel, the nozzle must first be outfitted with a short length of hose. The bottom of this hose must have notches so suction is not impeded.

Defueling procedures using the overwing nozzle are the same as the defueling procedures for the pressure nozzle, with the following additions:

1. The overwing nozzles must be grounded to the aircraft (or droptank or other vessel) before the nozzle is inserted.

2. The nozzle must remain in metal-to-metal contact with the object being defueled.

3. The nozzle must be physically held open during the defueling evolution. Do NOT block the overwing nozzle in the open position.

HANDLING OF AIRCRAFT CONTAINING FUEL OTHER THAN JP-5

Aircraft that have been either land-based or aerial refueled by USAF, USA, commercial airport, or other equipment/facilities must be assumed to contain fuel other than JP-5 in their tanks. The following precautions apply:

1. Aircraft recovering aboard the ship with mixed fuels shall notify the first available ship's controlling authority (strike, marshal, Pri-Fly) prior to recovery.

2. On deck, the aircraft will be marked with a large *X* across the port and starboard side of the nose. The *X* will be of ordnance-type tape and will remain on the aircraft until it has been certified that the flash point is 140°F or above. Aircraft will be refueled with JP-5 as soon as possible.

3. Every effort should be made not to park aircraft with low-flash-point fuels on hot catapult tracks. Catapult slot seals will be installed before any refueling evolutions commence.

4. Prior to any defuel operation, the aviation fuels officer will ensure the fuel being removed is of satisfactory flash point for shipboard storage.

CAUTION

Fuel with a flash point below 140°F must NOT be defueled into the ship's system. Shipboard aviation fuel systems are not designed to handle fuel with a lower flash point. The risk of explosion and/or fire will significantly increase if fuel with a low flash point is placed in these systems.

If an aircraft containing fuel with a low flash point must be lowered to the hangar deck, fuel samples must be taken from all low point drains of the aircraft and their flash point measured. If the flash point tests results are all above 120°F, the aircraft can be lowered to the hangar deck with the following minimum special precautions:

1. All hangar bay sprinkler groups located in the hangar bay in which the aircraft are parked will be operable.

2. A manned MFFU/TAU will be positioned at a location that will provide coverage of the affected aircraft.

3. The CONFLAG station located in the hangar bay with the affected aircraft will be manned.

4. Hot work will not be conducted in the hangar bay or close to the hangar bay containing the affected aircraft.

SAFETY PRECAUTIONS

Before fueling or defueling is started, the OOD should be notified, permission received to commence, and the smoking lamp put out. At the end of the operation, the OOD should be notified and the smoking lamp lighted. During planned flight quarters, fueling and defueling are expected, and requesting permission from the OOD to fuel and defuel is not necessary, but the OOD should be notified about the recommended condition of the smoking lamp.

Care should be exercised to prevent sparks from striking in locations where fuel is being handled. The supervision of fueling and defueling operations should always be done by a qualified petty officer to ensure that all safety precautions are earned out and that the operation is done properly.

All personnel involved in handling aviation fuels must be fully aware of the constant danger of fire and thoroughly trained in firefighting. They also must know and follow all precautions and proper procedures.

The petty officer in charge of the fueling crew checks with the plane captain or other authorized representative of the aircraft crew to ensure that, unless it is required in the fueling (or defueling) operation or in the quantity gauging system check, no electrical equipment in the aircraft is energized or being worked on. In addition, NO electrical apparatus supplied by outside power (electrical cords, droplights, floodlights) is permitted in or near the aircraft. For night refueling or defueling, only approved flashlights are used.

The fueling or defueling of aircraft is handled by the aviation fuels crew under the direction of the officer who is responsible for this procedure. Fueling or defueling of aircraft is done only by members of an aviation fuels crew.

All personnel directly involved in fueling or defueling evolutions must wear the proper safety gear, even when the ship is not at flight quarters. Cranial, goggles, gloves, jersey, and life vest must be worn during fueling/defueling operations.

No aircraft will be fueled while on jacks.

Simultaneous fueling, loading/downloading of weapons is authorized only as specified in CV and Aircraft Refueling NATOPS Manuals.

JP-5 becomes highly flammable if spraying (such as a ruptured hose or gasket) or wicking (such as a fuel-soaked rag or clothing). Extreme caution should be observed if these conditions occur.

Leaks in aircraft, hose, and connections, or trouble with fueling equipment should be reported immediately to the aviation fuels flight deck supervisor.

CHECKING AND RECORDING FUEL LOADS

On flight decks, the fuels checker will go to all incoming aircraft and check fuel loads and record on checker cards the amount of fuel in the aircraft before fueling and after fueling. The figures that are received and logged on the checker cards are in pounds, not gallons. Pilots and aircrew talk about pounds of fuel because they are concerned with the weight of the fuel.

We, the ABFs, will take the figure in pounds and convert it to gallons by dividing the difference from the start weight to the finish weight by 6.8 (which is how much a gallon of JP-5 weighs). For example, a starting figure from the aircraft is 2,800 pounds and the finish fuel weight is 9,700 pounds; the difference is 6,900 pounds. When you divide 6,900 pounds by 6.8 you will get gallons of fuel. At the end of a preset time, the squadrons will get a bill for the number of gallons of fuel received.

SUMMARY

In this chapter, you have learned about the equipment and procedures used in flight deck fuels operations. As with below decks operations, following proper procedures is a must. The flight deck of an aircraft carrier is one of the most exciting and dangerous places to work. All flight deck supervisors should ensure new personnel receive in-depth training on flight deck hazards. Knowing your equipment, knowing the correct operating procedures, and always being aware of your surroundings will keep you alive!

CHAPTER 6

AFLOAT LUBE OIL AND MOGAS SYSTEMS AND OPERATIONS

The catapult cylinder lubricating system on board aircraft carriers is maintained by the Aviation Fuels Division (V-4). The MOGAS system is also maintained and operated by the ABF. Both are discussed in this chapter.

CATAPULT LUBRICATING OIL SYSTEM

LEARNING OBJECTIVES: Describe a typical afloat lube oil system. Explain correct lube oil system operating procedures.

Although lube oil systems vary from ship to ship, an ABF qualified in one system can qualify quickly in the operation and maintenance of other lube oil systems. Lube oil systems were intended for the storage and distribution of reciprocating engine oils and to supply oil to operate the ship's catapults. With the decline in use of piston engine aircraft, lube oil systems are now used solely to supply lubricating oil to the ship's catapults. Oil used in jet engines is provided in sealed cans and handled through the Supply Department.

The lube oil system (fig. 6-1) is a separate, independent system. It is composed of a storage tank, one or two pumps, valves, and piping. The piping is arranged to supply two (or four, based one which ship you are on) ready service tanks, located in the catapult spaces. The pumps take suction from the manifolds connected to the lube oil storage tank and discharge through a manifold to the riser going to the service tanks. It is a simple system that is simple to operate and maintain.

OPERATIONS

Operation of the lube oil system is done IAW the Aviation Lube Oil Operational Sequencing System (ALOSS). The piping is arranged in the pump room so that the following operating conditions may be obtained:

. Either or both pumps may simultaneously take suction from the storage tank, and discharge to any ready service tank.

NOTE

Some lube oil systems have only one pump.

- Either or both pumps may take suction from the fill line, and discharge to the storage tank during the filling operation.

- Either or both pumps may simultaneously take suction from the storage tank, and discharge for offloading of lube oil.

NOTE

In the lube oil spaces, a 4JG sound-powered phone is installed for constant communication between the pump room operator and catapult personnel during actual pumping operations to the service tanks.

Filling the Storage Tank

The storage tank may be filled by any of the following methods:

- POURING FROM DRUMS. Screw a large funnel into the filling connection; raise the drum above the filling connection by using a forklift or other means; and open the large cap. The large cap should be on the bottom, near and over the funnel. Next, open the small cap on top to allow air into the drum. The amount of oil leaving the drum can be controlled by opening and closing the top cap.

- SIPHONING FROM DRUMS. Rig a 1 1/4-inch gasoline nozzle with a brass nozzle long enough to reach to the bottom of the drum. Then rig a hose from the nozzle with a fitting into the filling connection. With this method, the vacuum from the lube oil pumps may be used for loading.

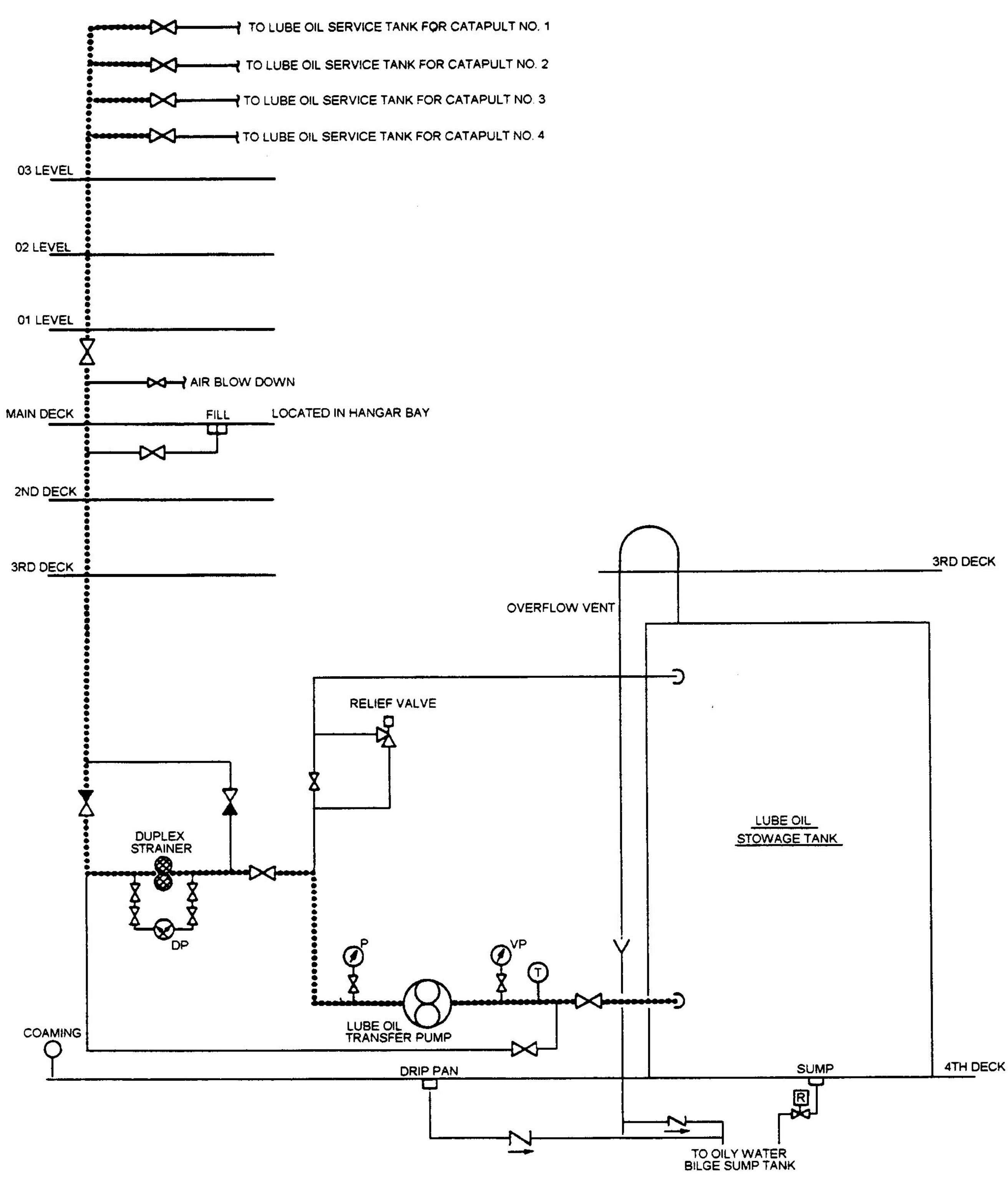


Figure 6-1.—Typical lube oil system.

• LOADING FROM A TRUCK ON THE DOCK. Rig a direct line from the truck to the filling connection. With this method, a pump on the truck is used to boost the oil from the truck to the filling connection.

CAUTION

When loading from struck on the dock, use caution to ensure that the pressure from the truck to the lube oil system is not enough to cause damage to hose, piping, or pumps.

When the system is taking on lube oil, a vent is not necessary, because the system is vented through the tank to the overflow tank. The valves from the tank to the overflow tank are locked open during this operation. To allow for expansion, tanks should not be filled beyond 90% capacity.

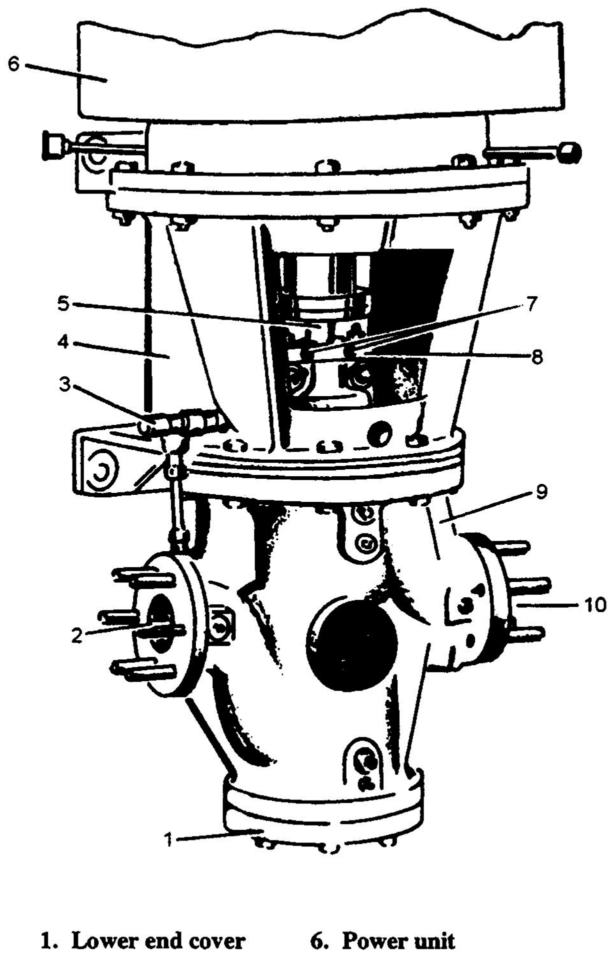


Figure 6-2.—Typical rotary-screw lube oil pump.

Lube Oil Pumps

Numerous lube oil pumps are installed on Navy ships, and it would be nearly impossible to cover each one. This manual will cover an older pump, the De Laval 31P156.

The De Laval 31P156 is a vertical, single-stage, positive displacement, rotary-screw pump (figs. 6-2 and 6-3). The pump consists of a power rotor (which moves the oil), two idler rotors (for sealing), the housing, thrust elements, shaft packing, and piping connections.

When the pump is started for the first time or after a long period of idleness, follow the instructions for initial starting, given below.

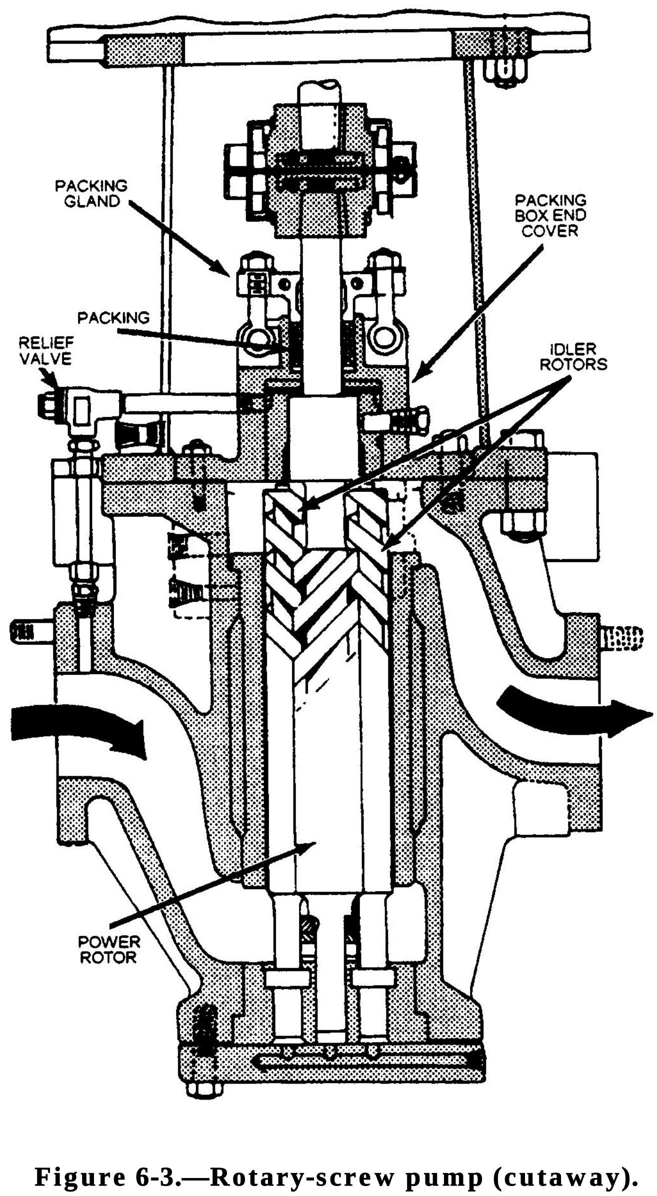


Figure 6-3.—Rotary-screw pump (cutaway).

INITIAL STARTING.— All external surfaces of the pump should be carefully cleaned before the pump is started. If the factory assembly has not been disturbed, it will not be necessary to dismantle the unit for cleaning. The interior of the pump was coated with a special rust-preventive compound after the factory test. The removal of this compound is effected completely without any harmful results in the normal operation of the unit.

Make sure that the shaft packing has been installed and that the gland nuts are only fingertight.

Before you start the pump, prime it by filling the pump case and as much of the suction line as possible with oil. If the air is not removed from the suction line, the performance of the unit will be erratic, or it will not pump at all. If no priming connection is provided, use the plug on the suction connection of the pump.

Open the suction, discharge, and vent valves and start the motor. If the pump is moving the oil satisfactorily, the vent valve may be closed after a few minutes of operation. Allow the shaft packing to leak freely for the first 15 minutes of operation; then, tighten the gland nuts with your fingers until there is only a slight leakage past the packing.

If the pump fails to discharge after starting, stop the motor, prime the pump again, and restart the pump. If it still does not pickup oil immediately, there may be a leak in the suction line, or the trouble may be traced to excessive suction from an obstruction, throttle valve, or other causes. Connecting a gage at several points along the suction line, while the pump is operating, helps locate the trouble. An obstruction in the suction line causes an observable drop in pressure at the point of obstruction, the lower pressure being on the pump side.

CAUTION

Operating the pump without oil causes rapid wear of the housing and bearings; therefore, checks for trouble must be made quickly and systematically.

ROUTINE STARTING.— Open the suction and discharge valves and start the motor. Ensure that oil is being pumped and that there is a slight leakage past the shaft packing. Read the gages that indicate the suction and discharge pressures for the pump, and make sure the pump is operating normally. If it is not pumping, follow the instructions for initial starting.

OPERATION.— After the pump is in service, it continues to operate satisfactorily with little or no need for maintenance except normal PMS. The suction and discharge pressures should be checked at least every 10 minutes to verify the performance of the pump. Once each day, the shaft packing should be inspected to see that it is properly adjusted. Any unusual conditions should be noted and investigated.

SECURING.— Stop the motor and close the suction and discharge valves.

Maintenance

De Laval pumps require very little attention in normal usage. Unless they are operated without oil or with oil containing abrasive particles, their operation without major overhaul is virtually unlimited.

The pump is equipped with a relief valve to prevent excessive oil-pressure buildup. The relief valve also seals the metallic packing against air leakage during suction lift conditions.

There is a set of packing located in the packing box end cover (fig. 6-3). The four flexible, metallic packing rings are installed with the joints of abutting rings staggered, and they are held in place by a packing gland. This packing gland is split to allow packing replacement without disturbing the other elements of the pump. The two sections of the packing gland are held together with two screws, and the gland pressure is adjusted with two gland nuts. This adjustment should be sufficient to allow a slight amount of leakage past the packing for lubrication of the packing.

Inspection

An inspection made while the pump is operating discloses any leakage between the end covers and case or in the piping connections. If leakage is observed, it may be due to foreign matter on the gaskets, defective gaskets, or loose nuts and bolts. Replace the gaskets or tighten the nuts and bolts as required.

Lubrication

The pump does not require any lubrication, since the oil being pumped lubricates all the moving parts. Driving-unit lubrication instructions are provided with each unit.

Operating Troubles

Some operating troubles may be evident from a low discharge pressure, excessive or unusual noise, or an overloaded driving unit. The following paragraphs discuss the most likely causes of operating troubles.

LOW DISCHARGE PRESSURE.— A low discharge pressure generally indicates that not enough oil is being pumped. This condition may exist because the pump needs priming or because of leakage. A gradual decrease in discharge pressure over a period of time is generally the result of pumping oil that contains abrasive particles, which causes the housing and rotors to wear.

NOISE.— Excessive or unusual noises may be caused by cold oil, dirty strainers, air in the oil, vaporization of the oil because of increased temperature, or misalignment of the coupling.

OVERLOADED DRIVING UNIT.— Excessive friction in the pump or in the driving unit can cause a driving unit to be overloaded. Misalignment of parts when the pump is reassembled increases friction. Overloading may also be caused by faulty operation of the system, heavy or cold oil, or from other causes that are not due to actual malfunctioning of the pump.

MOGAS SYSTEMS AFLOAT

LEARNING OBJECTIVES: Describe the typical afloat MOGAS system. Identify the protective systems for afloat MOGAS components. Explain the correct operating procedures for afloat MOGAS systems.

As an ABF assigned to LPD and LHA ships, you will be working with motor gasoline (MOGAS) systems. As with JP-5 systems, each ship is different, even ships within the same class. As older equipment is replaced with newer equipment, the uniformity among ships will increase until firm standardization evolves.

Most equipment used in a fixed MOGAS system, such as pumps, valves, and filters are identical to the same equipment used in the afloat JP-5 system only smaller. This chapter will cover the major areas within a typical fixed MOGAS system aboard an LHA and the equipment unique to this system. Other class ship's systems are slightly different. For specific system information and operation and maintenance procedures onboard your ship, refer to your ship's *Cargo Fuel Operational Sequencing System* (CFOSS) manuals.

The theories and laws of physics apply to all fuel systems, but you must understand them completely before you attempt to operate a fixed MOGAS system.

U-TUBE PRINCIPLE OF THE MOGAS SYSTEM

Hydraulics is the study of the behavior of fluids in their application to engineering problems. The fundamental law underlying the whole science of hydraulics was discovered by the French scientist Pascal, in the seventeenth century. Pascal's law states: "Any pressure or force applied to a confined liquid will be transmitted equally and undiminished in all directions, regardless of the size or shape of the container."

Liquid seeks its own level. The surface of the water in a teakettle is at the same level in the spout as it is in the body of the kettle. This rule also applies when a liquid is introduced to several differently shaped, openly connected tanks. The surface of the liquid would be at the same level in each connected tank.

The two liquids handled in the MOGAS system are seawater and gasoline. A cubic foot of seawater weighs 64.0 pounds, while a cubic foot of gasoline weighs 45.8 pounds. Since gasoline is lighter than seawater, it will float on top of the seawater and not mix with it.

A U-tube analogy to the MOGAS system, shown in figure 6-4, is based on two principles:

- The weight per unit volume of gasoline is less than that of seawater. Therefore, the gasoline will float on the surface of the seawater.

- A given head of seawater in a U-tube will hold in balance a greater head of gasoline because the gasoline is lighter than the seawater.

The MOGAS system on the ship is really a giant U-tube. The saddle storage tank containing seawater and gasoline forms the bottom of the tube. The seawater piping forms one side of the tube, and the gasoline piping forms the other side.

The installation is designed to keep the gasoline storage tanks entirely full at all times, either with gasoline on top of the seawater or completely with seawater. As gasoline is drawn off, water replaces it,

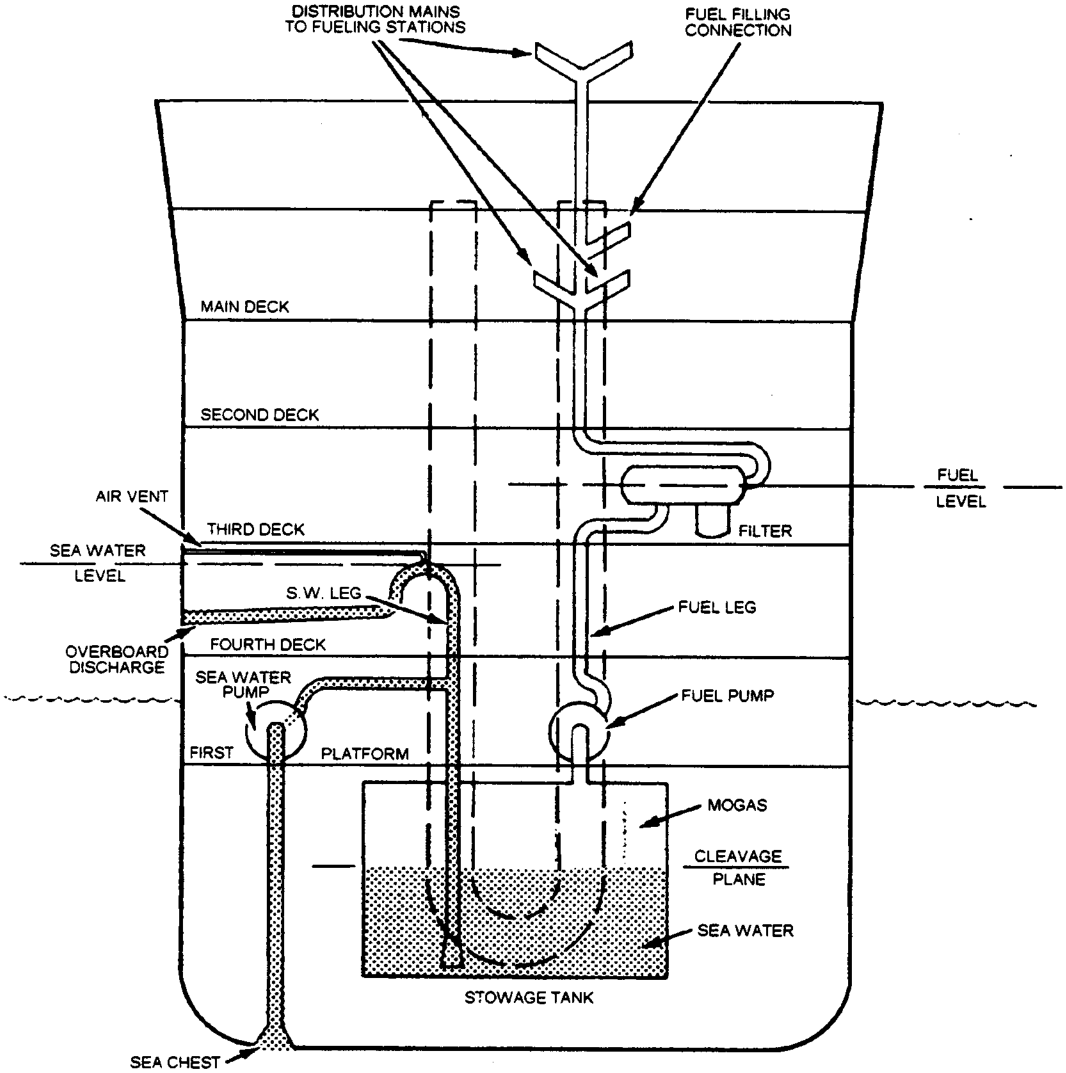


Figure 6-4.—U-tube analogy of the MOGAS system.

and no air pockets can form to hold explosive mixtures of gasoline vapor and air. The constant pressure applied by seawater is maintained by the elevated loop design in the seawater system.

STORAGE TANKS

The saddle-type storage tanks (fig. 6-5) of the MOGAS system are designed to provide the greatest possible safety for the storage of gasoline.

A storage tank actually consists of two tanks—an outer tank and a drawoff tank—and a cofferdam. The outer tank encloses the drawoff tank, and a cofferdam surrounds the outer tank. The cofferdam is part of the protective system and is filled with nitrogen (N2) or carbon dioxide (CO2) for protection against fire and explosion.

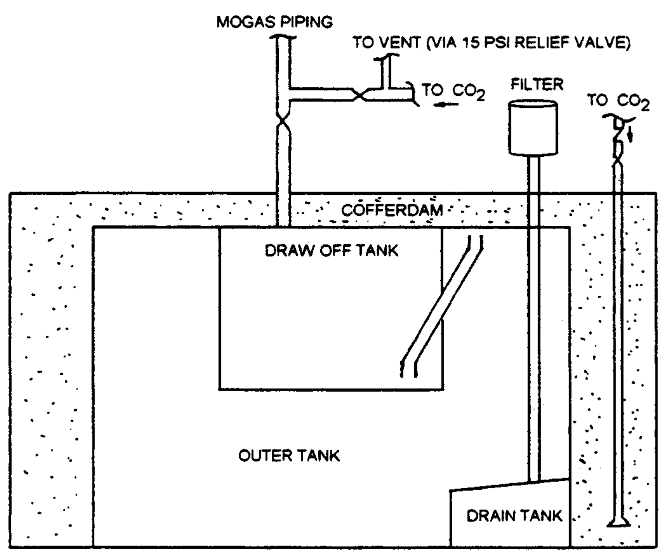


Figure 6-5.—MOGAS saddle-type storage tank.

A manhole cover is provided in the top of each tank to gain access for cleaning and maintenance. A Buns-N-Cork gasket is installed between the tank and manhole cover plate to prevent leakage. The outer tank manhole cover plate is fitted with a steam-out connection.

Outer Tank

The seawater supply riser enters the outer tank at the top and terminates in a diffuser near the bottom. The seawater required for pressurizing the tanks is discharged through this line.

A pressure gage line extends from the top of the outer tank to a pressure gage located in the pump room. The gage has a red pointer, indicating the maximum allowable tanktop pressure for that set of tanks. (Allowable pressures will vary for the different classes of ships.) A warning plate attached near each gage reads, "THE MAXIMUM ALLOWABLE TANK-TOP PRESSURE INDICATED BY THE FIXED RED POINTER SHALL NOT BE EXCEEDED WHEN THE SHIP IS FUELED."

Two in-tank reservoirs for water-filled, static-head gasoline gages are installed in the outer tank. One reservoir is installed at the top of the tank and the other at the bottom directly underneath the upper reservoir. Stuffing boxes are provided where the tubing for the gage passes up through the outer tank. The stuffing boxes prevent leakage of gasoline and seawater out of the tank. They also prevent nitrogen in the cofferdam from entering the tanks.

NOTE

LPDs have water filled, static-head gages but are scheduled to have them replaced with TLIs. LHAs already have TLIs.

The outer tank is interconnected with the drawoff tank by a sluice pipe. The sluice pipe extends from near the top of the outer tank and terminates in a diffuser at the bottom of the drawoff tank. The top of the sluice pipe is flared to reduce friction. The outer tank completely envelopes the drawoff tank.

The outer tank has a motor-driven stripping system installed for deballasting the tank. The independent hand-stripping system also ties into the outer tank to remove water and sludge from the bottom of the tank.

Draw-off Tank

The draw-off tank is the smaller of the two tanks. It is the tank from which gasoline is drawn when servicing or off-loading fuel. It is the first tank filled when MOGAS is being received and the last tank emptied when MOGAS is being off-loaded.

The gasoline supply riser extends from the extreme top of the drawoff tank to the common suction header of the gasoline pump. The recirculating header terminates in a diffuser at midpoint in the draw-off tank.

The draw-off tank is provided with an independent stripping system to remove water and sludge from the bottom of the tank. This system is the same hand-operated type used with the JP-5 service tanks. The suction line is fitted with a shutoff valve and extends from three-fourths of an inch off the bottom of the lowest part of the tank. The discharge line, fitted with a sight glass, test connection, one-way check valve, and a shutoff valve, terminates in two places: 24 inches off the bottom of the outer tank, and overboard.

The draw-off tank also has a water-filled, static-head gage, or a TLI.

Drain Tank

The drain tank is a small tank located inside the outer storage tank. The drain tank stores contaminated MOGAS/water that is filtered/separated out of the MOGAS.

Cofferdam

The cofferdam provides two-fold protection for the storage tanks. The cofferdam is normally kept charged with nitrogen (N_2) to 3 psi at 50% inertness or carbon dioxide (CO_2) at 35% inertness to reduce fire and explosion hazards. It also collects any leakage from the storage tanks.

The nitrogen supply line for purging and charging the cofferdam terminates in a loop, which completely encircles the outer tank. From this loop (located near the top of the cofferdam), pipes (legs) extend down to near the bottom. Each leg is fitted with a diffuser, which serves to spread the inert gas throughout the space. A stop valve for controlling the nitrogen entering the tank is located in the main supply line at the pump room level.

An air escape riser, fitted with a shutoff valve, extends from the top of the cofferdam and vents to atmosphere at the 02 level. A bypass line is installed around the shutoff valve. This line contains a sure-relief valve (set at 4 psi), a pressure gage, and a portable inertness analyzer connection.

A fixed eductor is installed in the cofferdam to remove any seawater or gasoline that might escape from the storage tanks. The eductor is fitted with two suctions: one near the centerline at the forward end of the cofferdam and the other near the centerline at the after end of the cofferdam.

The controls for the eductor are located in a watertight box on the pump room deck.

Two static-head liquid-level gages, or electronic sensors, are installed in each cofferdam to indicate the presence of leakage into the compartment. One is located on the centerline in the forward end of the cofferdam and the other on the centerline in the after end. This arrangement makes it possible to determine the presence of leakage, regardless of the trim of the ship.

Access to the cofferdam is gained through a bolted manhole cover in the pump room deck. Normally, the cofferdam manhole cover is located directly over the outer tank manhole cover.

Storage Tank Diffuser

The diffuser (fig. 6-6) reduces turbulence when gasoline or seawater enters the storage tanks. Diffusers are mounted on the bottom of the gasoline storage tanks around the end of each sluice pipe and seawater supply riser. They are bolted to clips or brackets that are welded to the bottom of the tank and to the bulkhead.

The diffuser is a perforated cylinder with an open bottom, and it has a top plate with an opening for the gasoline or seawater supply pipe. The opening in the top plate is larger than the outside diameter of the supply pipe, which permits the pipe to move with the movement of the ship's structure. The total area of the perforations in the diffuser is five times that of the area of the supply pipe. Gasoline or water enters the diffuser in a single stream and is broken into smaller streams as it passes through the holes in the cylinder. The distribution of flow over a large area reduces turbulence.

Gaging Equipment

Two different types of gages are currently used in the gasoline tanks to determine the amount of gasoline within the tanks. These gages are the water-filled, static-head type, and the TLI.

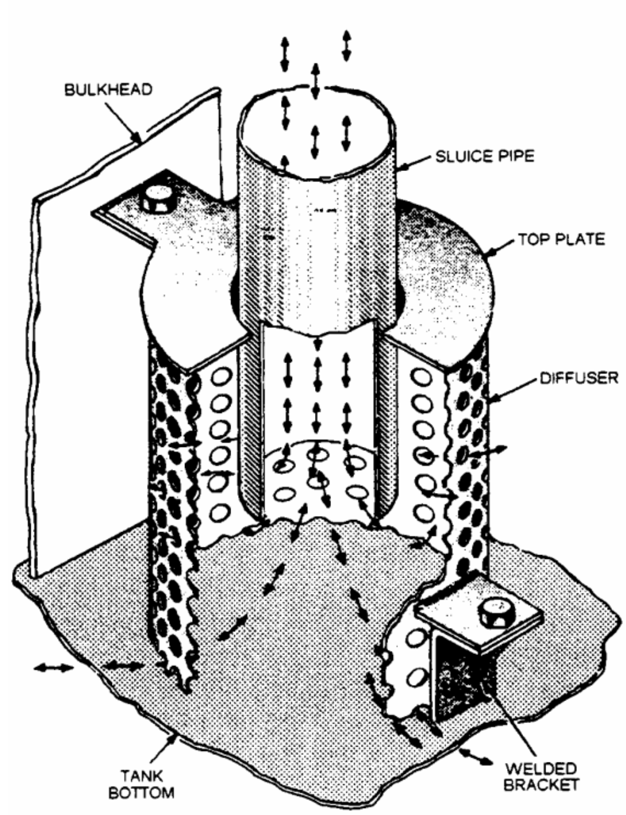


Figure 6-6.—MOGAS storage tank diffuser.

The water-filled, static-head gasoline gage (figs. 6-7 and 6-8) provides an accurate means of determining the amount of gasoline in the saddle-type storage tanks. It accomplishes this task by sensing the differential created, as the plane of cleavage between

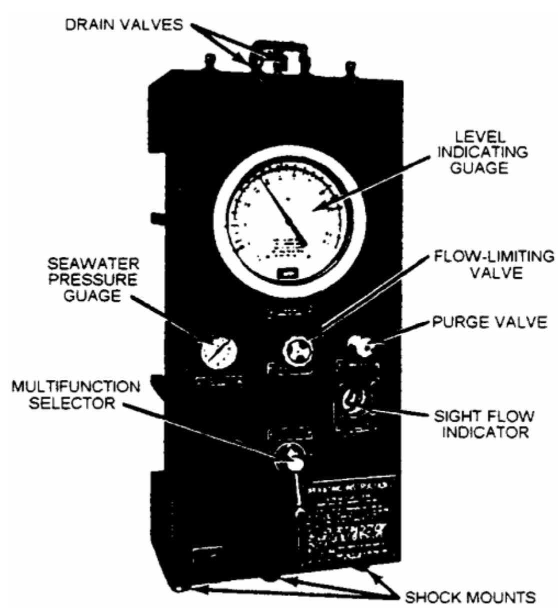


Figure 6-7.—Level indicating panel (front view).

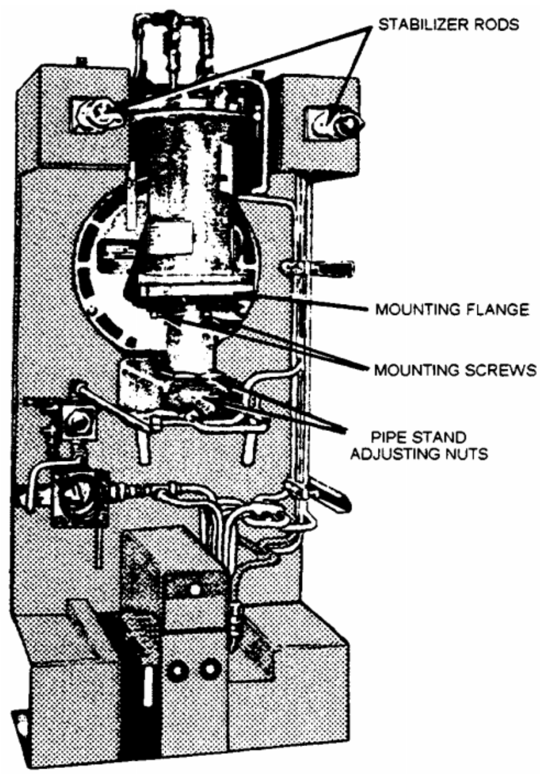


Figure 6-8.—Level indicating panel (rear view).

the two liquids (gasoline and seawater) varies and converts this differential to gallons of gasoline. There are four components to this gage:

• In-tank reservoir, an upper and lower reservoir for each of the inner and outer tanks (a total of four reservoirs)

• A panel in the pump room, which contains the following:

Differential pressure gage

Multifunction selector

Flow-limiting valve

Seawater pressure gage

Purge valve

Flow indicator

Operating instructions

• Water-filled connecting lines connect the in-tank reservoirs to the gage panel.

• Seawater supply for purging consists of the following:

Firemain cutout valve

Strainer

Pressure-reducing valve

Pressure gage

Bypass purge line

Bypass purge valve

Most of the components are installed to aid in purging the system. Only three items are necessary for the actual gaging of the tanks. These are the differential pressure gage, water-filled connecting lines, and the upper and lower in-tank reservoirs.

When the storage tanks are full (100%) of seawater, a constant differential pressure exists between the upper and lower in-tank reservoirs, and the differential pressure gage reads ZERO. As the storage tanks are filled with gasoline, a varying differential pressure is developed between the upper and lower in-tank reservoirs. This varying differential pressure, created by the difference in specific gravities of the two liquids (gasoline and seawater), is transmitted to the gage panel through the water-filled connecting lines. The differential pressure gage senses this varying differential pressure and converts it to gallons of gasoline present in the storage tank.

The differential pressure gage (fig. 6-9) measures the varying pressure differential from the tank and

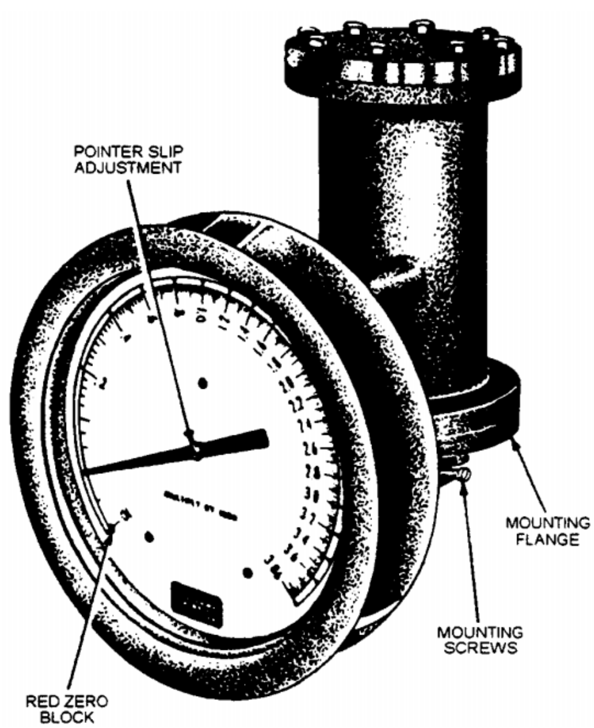


Figure 6-9.—Differential pressure gage.

indicates its findings on a dial that is calibrated in gallons. This gage consists of three basic units: the bellows, torque tube, and dial mechanism.

The flow indicator (fig. 6-10) provides visual identification of the flow of seawater through a pipeline. The indicator has a hinged flapper suspended from the body so it rests against the inlet passage at no flow. As liquid begins to flow, the flapper swings outward to a position generally proportional to the flow rate.

The in-tank reservoir connecting lines are gasoline-tight, cylindrical tanks with a nontight flanged cover. They are open to liquid pressure near the top by two holes directly opposite each other. The in-tank reservoirs are brazed to the ends of connecting lines. One is located near the top of the tank and the other located near the bottom of the same tank. Connecting lines terminate 1/2 inch off the bottom of the reservoir. The in-tank reservoirs are filled with seawater because of purging. The connecting lines are purged with seawater to prevent gasoline from entering the pump room through the lines.

The flow-limiter valve is a globe-type needle valve used to reduce seawater pressure to the desired pressure. It is located between the firemain supply and the purge valve.

The seawater pressure gage indicates the pressure of the seawater supply and is located between the flow-limiter valve and the purge valve.

With one exception, the TLI used in MOGAS tanks is just like the TLI used in JP-5 tanks. The float for the TLI used in MOGAS systems is constructed of Hycel. This material is designed to float on water and sink in fuel. That means the float will be at the cleavage line (interface) of the water and MOGAS. Refer to chapter 4 for information on TLI components and operations.

SEAWATER PIPING AND VALVE ARRANGEMENT

The seawater system supplies seawater (under pressure) to the outer tank to force gasoline up to the transfer (gasoline booster) pump. It also provides a means for flushing and draining the storage tank, and limits the amount of pressure that can be applied to the tanks at maximum pump capacity.

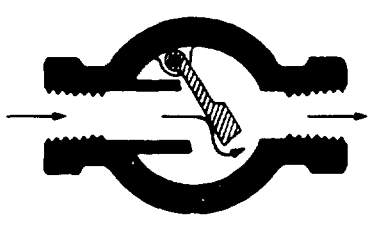


Figure 6-10.—Flow indicator.

Seawater is supplied directly from the sea, through a sea chest located in the cofferdam around the storage tanks. A steel grating installed in the opening of the ship's bottom prevents large objects from being drawn into the system. Steam is used for cleaning out the sea chest in the event of clogging. Steam has a two-fold effect for cleaning purposes. It can be supplied at an adequate pressure for blowing out any debris, and it also provides a "cooking effect" to remove remaining gasoline vapors as well. A shutoff valve is located between the sea chest and the sea chest supply riser. This valve is LOCKED OPEN.

The sea chest supply riser connects directly to the suction header of the seawater pump. An additional shutoff valve is installed in this line at the pump room level.

The motor-driven, centrifugal seawater pump is located in the MOGAS pump room, and the motor is in the adjacent pump motor room. The shaft connecting the pump to its motor passes through a watertight stuffing box in the bulkhead. The pump takes suction from the suction header and discharges into a discharge header. The pump suction line is fitted with a basket strainer, a one-way check valve, and a compound gage. The discharge line contains a pressure gage and a shutoff valve. On centrifugal pumps, the pump inlet is always larger than the discharge line.

NOTE

LPDs have a separate seawater pump room, located in the starboard shaft alley.

The discharge header is connected to the outer tank seawater supply riser and the seawater expansion tank fill line. Shut off valves installed in this line can be used to direct pump discharge pressure into the outer tank for pressurizing the system during normal operations or filling the expansion tank.

The expansion tank is a 500-gallon tank kept full of seawater. Its purpose is to keep the MOGAS tanks full at all times by compensating for contraction of the MOGAS.

The outer tank seawater supply riser terminates in a diffuser at the bottom of the outer tank. This line contains a spectacle flange (or pipe blind) and a steam-out connection. The spectacle flange is rotated to the closed position when steam is injected either here or at the outer tank manhole cover for steaming tanks.

The overboard discharge line is led upward in a loop from the expansion tank and then overboard just above the third deck level. The height and size of the overflow loop act as a relief device. It limits the pressure that can be exerted on the tanks (within the maximum allowable limits) when maximum pump capacity is discharged overboard. This would be the condition when the delivery of gasoline is stopped and the seawater pump continues to operate. However, the height of the loop and the expansion tank also maintains an adequate back pressure on the tanks to force gasoline to the suction side of the gasoline pumps. This ensures a positive pressure (0.5 to 1 psi) is maintained when maximum delivery of gasoline is being made. A one-way check valve and a shutoff valve are installed near the end of the overflow line. The shutoff valve is normally LOCKED OPEN. Steam-heating coils are installed around the overflow line at the shell connection to keep the line clear during icing conditions.

A vent line extends from the top of the loop to the atmosphere at the 02 level. The vent line is provided to break the syphoning effect of the overflow loop to prevent lowering the pressure at the gasoline pump suction header. This line also may be equipped with steam-heating coils.

OPERATION OF THE SEAWATER SYSTEM

The seawater system serves to force the gasoline through the tank and up to the gasoline pump suction. A pressure of about 0.5 to 1 psi is required at the gasoline pump suction to prevent the gasoline pumps from becoming vapor locked.

The seawater pump should be put into operation before starting up the gasoline pump. The seawater pump will discharge to the outer tank. As gasoline is drawn from the tank, it is automatically replaced with seawater, thus maintaining a positive pressure on the gasoline pump suctions. Excess seawater will automatically be discharged overboard through the over-flow line.

1. To line up the system to take suction from the sea and to discharge to the outer tank supply riser, take the following actions:

a. Open the shutoff valve between the sea chest supply riser and the pump suction header.

b. Open the shutoff valve between the pump discharge header and the outer tank supply riser.

2. To align the seawater pump, take the following actions:

a. Open the shutoff valve in the pump suction line.

b. Vent the pump through a petcock at the top of the pump casing. When seawater appears, close the petcock.

c. Start the pump with the discharge valve closed. When the pump discharge pressure builds up, open the discharge valve SLOWLY.

DOUBLE-WALLED GASOLINE PIPING

When MOGAS passes through spaces, it is carried in double-walled piping that consists of two concentric pipes (fig. 6-11). The inner pipe is copper

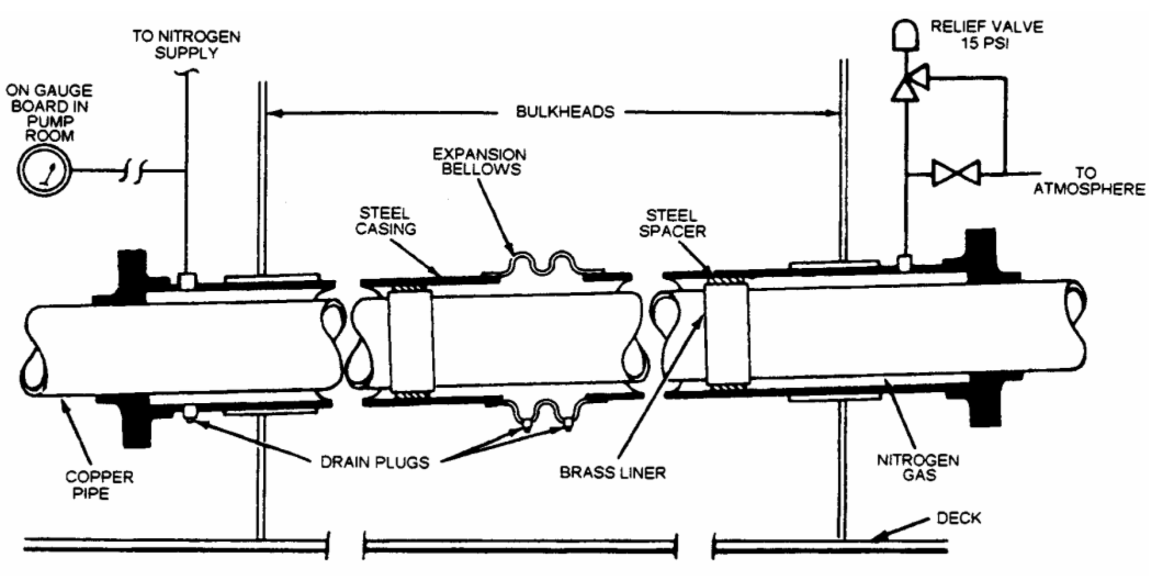


Figure 6-11.—Double-walled piping.

nickel and carries the fuel. The outer pipe is steel and serves as an armor casing. The outer pipe also serves to contain a protective jacket of inert nitrogen gas at 3 psi around the inner piping. A pressure gage for the double-walled piping is installed in the pump room to indicate the pressure in the piping. The gage has a range of zero to 15 psi.

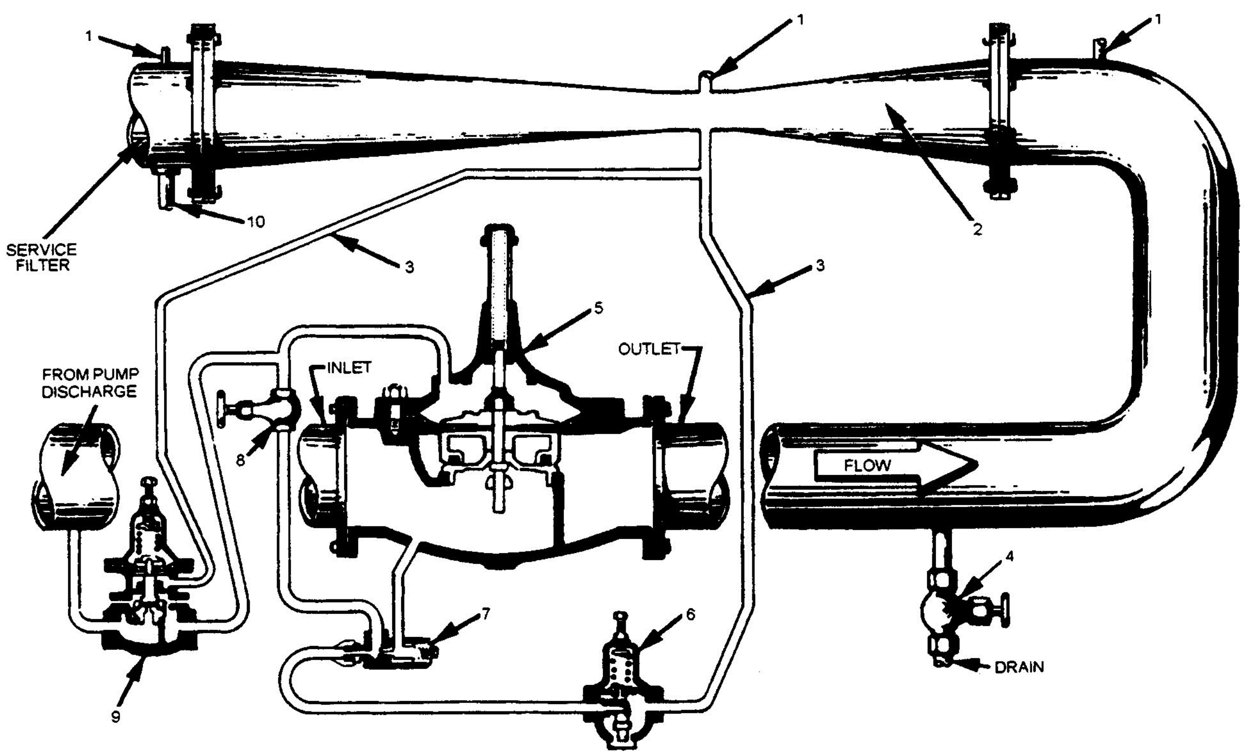
If the outer casing is pierced, the nitrogen gas will leak out. The resulting drop in pressure will be indicated on the gage. Also, if a rupture should occur in the fuel line inside the steel casing, the resulting increase in pressure will be indicated on the gage. Isolate the piping until the cause has been determined.

Expansion bellows are provided in the outer casing to avoid strains in the casing due to unequal expansion, which may result in leakage of the nitrogen gas. Drain plugs in the bellows can be used to determine whether any leaks have occurred in the inner piping. Brass liners soldered to the outside of the inner piping and steel spacers welded to the inside of the outer piping are placed at intervals of about 5 feet. These serve to hold the inner piping in the center of the outer piping and still allow for movement caused by expansion and contraction between the two pipes. The outside piping is about 2 inches larger than the inner piping.

An inert gas connection, for charging the outer piping, is provided at the lower or inboard end of the double-walled piping. The outer piping is also provided with a relief valve to avoid excess pressure. The released inert gas is vented to the atmosphere through separate piping. The relief valve is set at 15 psi.

AUTOMATIC PRESSURE-REGULATING SYSTEM

The pressure-regulating system (fig. 6-12) used in MOGAS risers is identical for all class ships except for size and pressure settings. This section deals with a typical regulating system without reference to size



1. Gage lines
2. Venturi
3. Actuating lines
4. Drain valve
5. Hytrol valve
6. Pilot valve
7. Ejector-strainer
8. Globe valve
9. Control valve
10. Recirculating line

Figure 6-12.—MOGAS pressure-regulating system.

or pressure. On LHAs, the pressure regulator is typically installed after the filter. On other class ships, it may be installed before the filter.

An automatic pressure-regulating system is provided in all MOGAS distribution risers.

The pressure regulator consists of an automatic pressure-regulating valve operated through changes of pressure in the throat of a venturi, located downstream of the valve. The main components of the system (fig. 6-12) are as follows:

- Main valve (pressure regulator) (5)
- Pilot valve (6)
- Ejector strainer assembly (7)
- Control valve (9)
- Venturi tube (2)

NOTE

Venturi Principle. If a fluid flowing through a tube reaches a constriction or narrowing of the tube, the speed of the fluid flowing through the constriction increases and its pressure decreases. If the fluid flows beyond the constriction into a tube the same size as that of the original, the speed of flow decreases and the pressure increases.

The pressure-regulating system is entirely hydraulic in operation, using line pressure to open and close the valve. Because of this, it can be installed either vertically or horizontally in the riser.

The main valve is of a modified globe design, employing a well-supported and reinforced diaphragm. When line pressure is admitted to the cover chamber, the valve tends to close. When pressure is reduced in the cover chamber, line pressure under the disk opens the valve.

The pilot valve is a direct-acting, spring-loaded valve designed with a large diaphragm and effective working area to ensure sensitive control and accurate regulation of the required delivery pressure. The pilot valve is located in the actuating line between the ejector strainer and the venturi throat. It is normally held open by a compression spring. When venturi throat pressure acting under the diaphragm increases, the valve tends to close. When venturi throat pressure decreases, the valve opens (wider). Thus, a constant pressure is maintained by balancing venturi throat pressure against spring tension.

The ejector strainer assembly is installed in the actuating line between the main valve and the pilot valve. It consists of an ejector nozzle with a 1/16-inch orifice protected by a 60-mesh monel strainer to prevent clogging of the nozzle. The assembly speeds up the operation of the main valve by speeding up the evacuation of fluid from the cover chamber. It prevents chatter of the main valve by reducing the violence with which pump discharge pressure is admitted to the main valve cover chamber.

The control valve is a direct-acting, spring-loaded valve designed with a large diaphragm and effective working area to ensure positive operation. The control valve, located in the ejector bypass line, is normally held closed by a compression spring. Its purpose is to close the main valve quickly when there is a sudden buildup in downstream pressure. It is opened by venturi throat pressure 10 psi in excess of the pilot valve setting.

Venturi tubes are installed in the distribution riser downstream of the regulating valve. The venturi tapers from a 2-inch inlet to a 3/8-inch throat to a 2-inch outlet. A recirculating line on the delivery side normally returns 5% of the capacity of the booster pump.

Operation of the Automatic Pressure Regulator

In the operation of the system, high-pressure fuel flows initially from the pump and enters the main valve body. This fuel bypasses the main valve seat and flows through the ejector strainer assembly to the pilot valve. The pilot valve is held open by its spring. From the pilot valve, this flow is directed into the throat of the venturi tube. At this point, the pressure at the throat of the venturi tube is practically nonexistent.

As long as the pilot valve stays open, maximum flow through the ejector strainer assembly is permitted. This flow through the ejector strainer assembly creates a reduced pressure in the main valve cover chamber. (Remember that the ejector strainer assembly works like an eductor.) Line pressure from the pump, working under the disk of the main valve, can now open the main valve, permitting flow into the distribution riser. This flow builds up pressure in the distribution riser.

The increasing pressure in the riser is transmitted from the throat of the venturi tube to the underside of the pilot valve diaphragm. When the pressure under the pilot valve diaphragm reaches a point where it is greater than the setting of the pilot valve spring, the pilot valve begins to close. This restricts the flow through the ejector strainer assembly. When this flow is restricted, the ejector strainer assembly loses its suction and the inlet pressure is diverted, by way of the suction line, to the main valve cover chamber.

The resultant increase in pressure in the main valve cover chamber, as applied to its diaphragm, is sufficient to begin closing the main valve. The main valve disk will move toward its seat until the main valve is passing just enough fuel to maintain pressure that will balance the setting of the pilot valve through the throat of the venturi.

Any later change in fuel demand will cause a change in venturi throat pressure. Even the slightest change is enough to cause the pilot valve and the main valve to assume new positions to supply the new demand. This will happen regardless of whether the demand is for a greater or lesser amount of fuel.

TOPSIDE INCREASE OF FLOW DEMAND. —An increase in the rate of flow will first cause a momentary decrease in venturi throat pressure. This decrease in pressure will allow the pilot valve to open wider, which, in turn, increases the flow rate through the ejector strainer assembly.

An increase in the ejector strainer assembly flow rate will increase the suction lift of the ejector. The increase of the suction lift is applied to the main valve cover chamber and allows the main valve to open wider.

The main valve will open in proportion to the increase of flow demand topside. The main valve will continue to open until the venturi throat pressure builds up to a point where it again balances the setting of the pilot valve spring.

TOPSIDE DECREASE OF FLOW DEMAND. —A decrease in flow rate will cause a momentary increase in venturi throat pressure. This increase in pressure will cause the pilot valve to close somewhat, restricting the flow through the ejector strainer assembly.

A decrease in flow through the ejector strainer assembly will decrease the suction lift of the ejector. This decrease of ejector suction lift will cause an increase of pressure in the main valve cover chamber and result in partial closing of the main valve.

The main valve will close in proportion to the decrease of flow demand topside. The main valve will continue to close until the venturi throat pressure drops to a point where it again balances the setting of the pilot valve spring.

SUDDEN DEMAND DECREASE. —Any sudden decrease in flow rate will create a sudden, high increase in venturi throat pressure. This sudden increase of pressure will be applied to the underside of the diaphragm of the pilot valve to close the main valve in the normal manner. Because of the small size of the orifice in the ejector strainer assembly (1/16-inch diameter), the main valve will close slowly. Venturi throat pressure will, at the same time, be applied to the underside of the diaphragm of the control valve to open the control valve. When the control valve opens, full pump discharge pressure is applied to the main valve cover chamber to quickly close the main valve. This quick closing of the main valve reduces the pressure in the distribution riser. The main valve remains closed until the pressure on the discharge side of the main valve drops below the spring setting of the pilot valve. The pressure and fuel that are trapped between the discharge side of the main valve and the discharge side of the venturi, caused by a sudden buildup of discharge pressure, are relieved through the venturi recirculating line back to the draw-off tank.

Adjustment and Settings

The pilot valve pressure adjustment is made by turning the adjusting screw to vary spring compression on the diaphragm. The control valve adjustment is made by turning the adjusting screw clockwise to increase the pressure. The procedure for adjusting the pressure setting follow:

NOTE

The following procedure should be carried out after reinstallation of the regulating valve and pilot assembly and after the maintenance check has been performed. The typical desired delivery pressure is 22 psi at the throat of the venturi.

1. Close the control valve by turning the adjusting screw clockwise.

2. Set the pilot valve at 34 psi when fuel is flowing through the main valve at 50 gpm or more.

3. Reduce the pressure setting of the control valve (by turning the adjusting screw counterclockwise) until delivery pressure drops to 32 psi at the throat of the venturi.

4. Tighten the control valve locknut.

5. Reset the pilot valve at 22 psi.

The procedure outlined above will establish the desired downstream pressure and provide the correct setting of the control valve.

Maintenance

The ejector strainer assembly should be cleaned at regular intervals in accordance with PMS requirements. Remove the 3/4-inch union ring and plug from the housing, wash in solvent, and then blow the screen out with air. At 6-month intervals, the regulating valve should be completely dismantled and thoroughly cleaned. The pilot valve and control valve should be inspected carefully for excessive wear, and, if necessary, replaced. All gages used in the pressure-regulating valve system are removed, cleaned, and calibrated every 12 months. Upon installation of new parts or repairs made on parts, all piping connections are pressure tested to check for leakage of fuel.

MOGAS PUMPS

The MOGAS pumps on LPHs are centrifugal pumps with a rated capacity of 50 gpm at 90 psi. MOGAS pumps are typically called transfer pumps. See chapter 4 for information of centrifugal pumps.

SYLPHON PACKLESS GLOBE VALVE

The Sylphon packless globe valve (fig. 6-13) is used to stop the hazardous leakage of gasoline past the

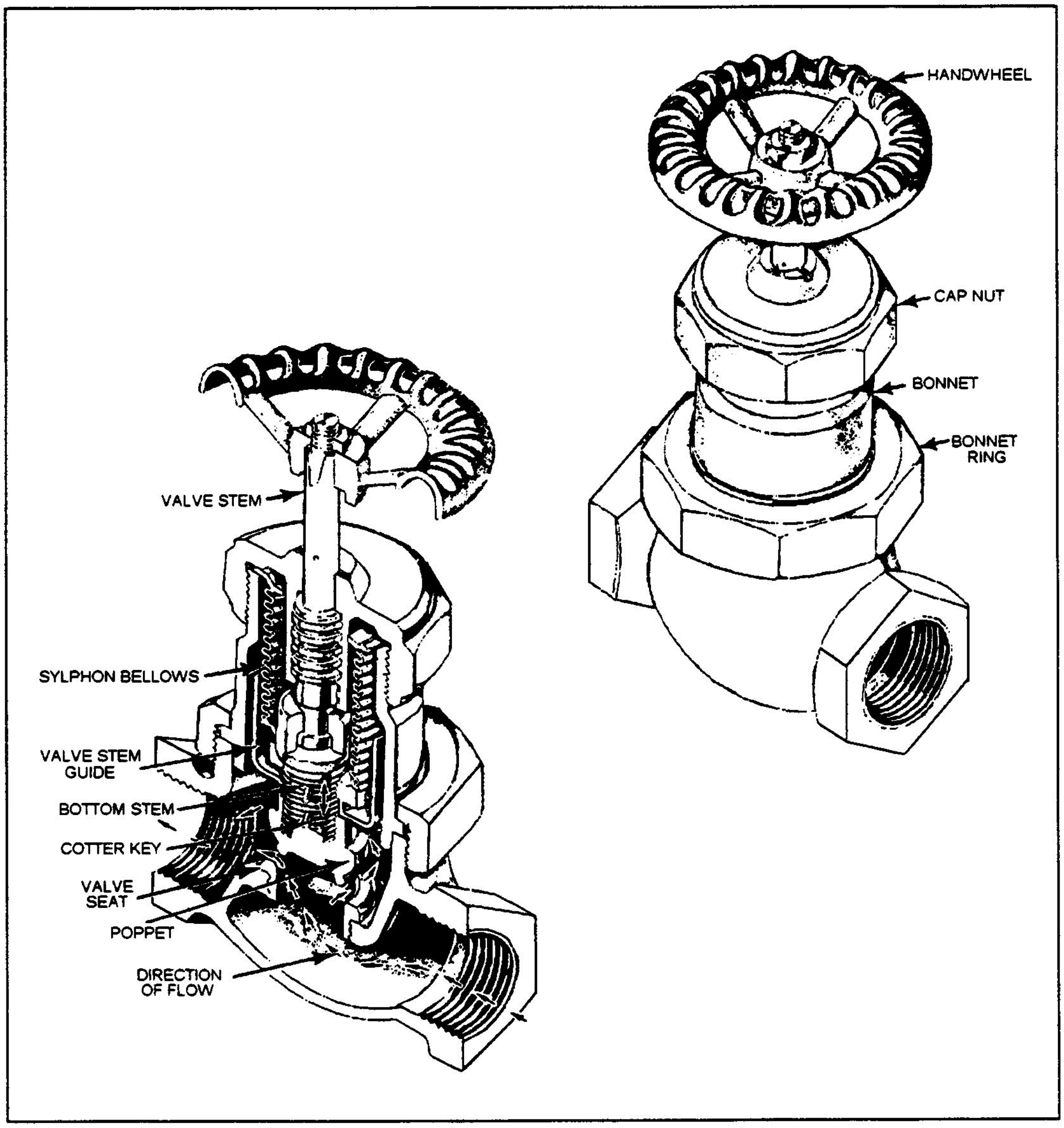


Figure 6-13.—Sylphon packless globe valve.

packing in the ordinary valve by providing a metal bellows (Sylphon), which prevents liquid from escaping through the valve stem opening.

Sylphon packless globe valves are used in the pump room on the drainage piping from the centrifugal pumps, on other small-diameter pipelines carrying gasoline or nitrogen, and on steaming-out connections.

The Sylphon packless globe valve controls the flow of liquid the same way as an ordinary globe stop valve. When the control handle is turned, a poppet at the end of the valve stem is lifted from a valve seat and permits flow through the valve. It has an expandable, metal bellows (or Sylphon) assembled between the valve poppet and the bonnet cap nut. This permits the valve stem to be raised or lowered while maintaining a complete seal around the stem at all times. In the ordinary globe valve, a fiber packing is used to prevent the escape of liquid. This packing deteriorates or shrinks and allows dangerous leakage of liquid or vapor. The Sylphon bellows may be replaced if it corrodes or breaks.

PROTECTIVE SYSTEM

Nitrogen (N_2) or carbon dioxide (CO_2) is used in cofferdams as a protection against fire and explosion, in double-walled piping to indicate the condition of the double-walled piping, and in the distribution piping for drainback, purge, and charge.

On LHAs, nitrogen was capable of being produced aboard the ship, but most of the production plants are no longer operable. Instead, it must be earned in 3000 lb bottles. Other class ships also must carry N_2 and/or CO_2 in compressed-gas bottles and the inerting process is slightly different. Consult CFOSS for the correct procedures on your ship.

Nitrogen enters the pumproom reducer at 50 psi from the nitrogen supply room. To purge and inert the MOGAS piping, the reducer is bypassed and the piping is charged directly from the nitrogen supply line. The gages must be monitored to make sure the pressure does not exceed 10 psi. The MOGAS piping is required to be inerted with a 50% N_2 inert gas concentration at 10 psi.

The reducer is used to reduce the N_2 pressure from 50 psi to 3 psi for inerting the double-walled piping, the cofferdam, and the gasoline tank (after deballasting). The double-walled piping, cofferdam, and gasoline tank (when deballasted) are required to be made inert with a 50% inert gas concentration at 3 psi.

The pressure relief valve for the piping/double-walled piping is set at 14 psi. The pressure relief valve for the cofferdam is set at 7 psi.

NOTE

Ships using carbon dioxide in place of nitrogen purge to 35% inertness minimum.

INERT-GAS-PRESSURE REGULATING VALVE

The inert gas regulating valve consists of a dome and body separated by a rubberized diaphragm. The diaphragm actuates The poppet valve in the valve body by forcing down the valve stem. A compression spring below the poppet valve tends to return the valve to its seat against the force of the diaphragm. The dome is filled with inert gas under pressure when the valve is adjusted. This gas pressure acts on the upper surface of the diaphragm. A pressure chamber on the underside of the diaphragm fills with nitrogen through an opening to the discharge, or low pressure, side of the valve. Thus, when the valve has been adjusted and is in operation, the pressure on the upper side of the diaphragm acts to force the valve open. This force is balanced by the low-pressure gas on the underside of the diaphragm and the spring under the poppet valve. When low-pressure gas is taken from the system, the pressure on the discharge side starts to fall, and the regulating valve opens to permit passage of gas from the high-pressure side of the valve. The distance the valve opens depends on how fast the low-pressure gas is being used. When use of low-pressure gas is stopped, the pressure on the underside of the diaphragm starts to increase, and the valve closes to stop the flow of high-pressure gas.

When the regulating valve is being adjusted, nitrogen gas from the high-pressure side of the valve is admitted to the dome chamber through an orifice controlled by two needle valves (fig. 6-14). A ball relief valve to the orifice will release gas if the high--pressure needle valve in the body is opened too far.

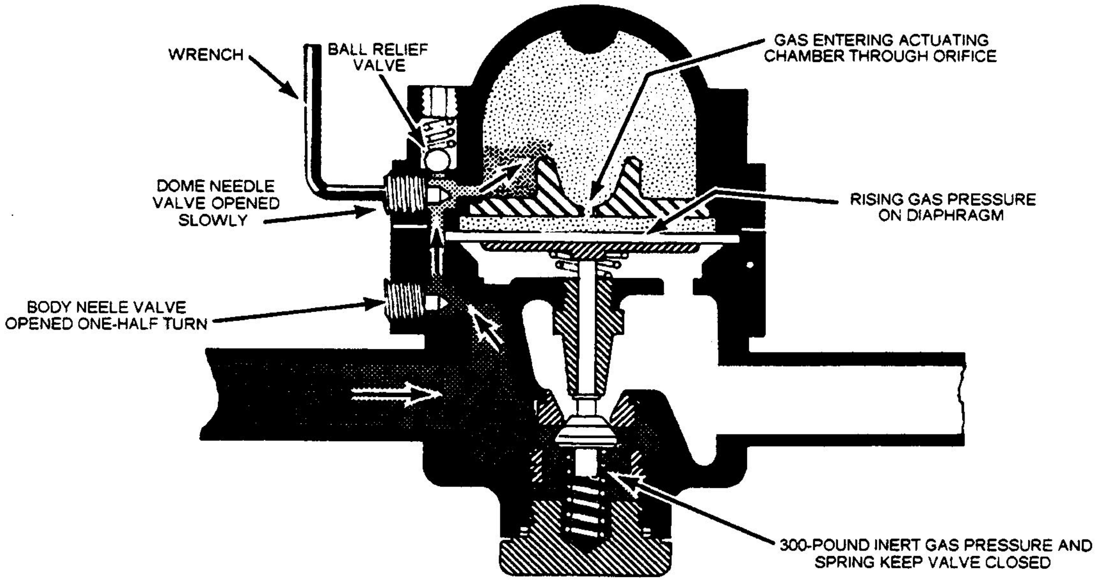


Figure 6-14.—Adjusting the inert-gas-pressure regulating valve.

To put the reducing valve in operation, use the following procedure:

1. Close the valve body needle valve and dome needle valve.

2. Close the stop valve on the low-pressure side. Open the inlet valve on the high-pressure side and open the low-pressure gage valve.

3. Open the body needle valve one-half turn to permit gas to flow into the loading channel.

4. Open the dome needle valve slowly. This permits gas to flow into the dome. Gas entering the dome flows through the orifice in the dome plate and acts on top of the diaphragm.

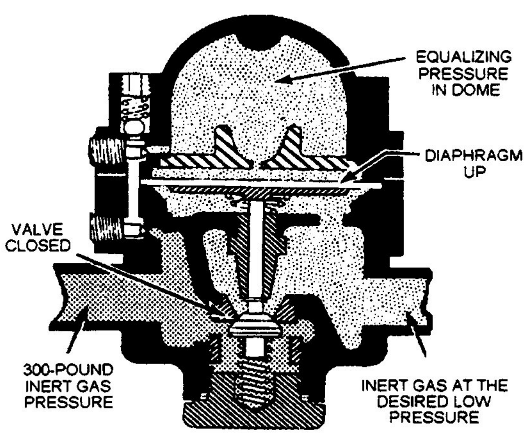


Figure 6-15.—Inert gas system balanced, valve closed.

5. The increasing gas pressure forces the diaphragm down and slowly opens the valve. Gas then flows through the valve opening into the low-pressure side of the valve and into the lower pressure chamber, There, the increasing pressure of the gas acts on the underside of the diaphragm, pushing it up to close the valve (fig. 6-15). When the low-pressure gages register the desired pressure, take the following actions:

a. Close the dome needle valve.

b. Close the body needle valve.

The valve is now adjusted and ready for use. Figure 6-16 shows the pressure-regulating valve in operation.

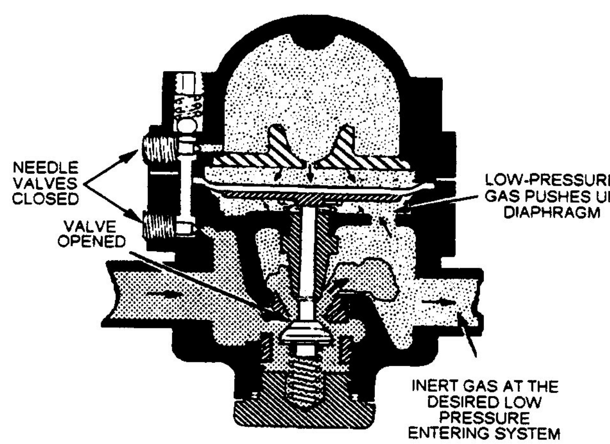


Figure 6-16.—Valve in operation.

PORTABLE INERTNESS ANALYZER

The inertness analyzer (fig. 6-17) is a portable, electrical instrument used to indicate the presence of inert gas and combustible vapors in the atmosphere in voids surrounding the gasoline storage tanks and double-wall piping when the service system is being purged.

Components and Functions

The instrument is contained in a case with a carrying handle. On the front of the box are the controls and indicating dial. An ON-OFF switch controls electrical power to the analyzer. A milliammeter indicates the analyzer current in milliamps. The galvanometers indicates presence of inert gas in percentage of inertness.

The unit has three potentiometers: the current potentiometer that is used to set the analyzer current to 150 milliamps: the sensitivity potentiometer that is used to calibrate the analyzer: and the zero potentiometer that is used to make a final adjustment to zero the galvanometer, if necessary.

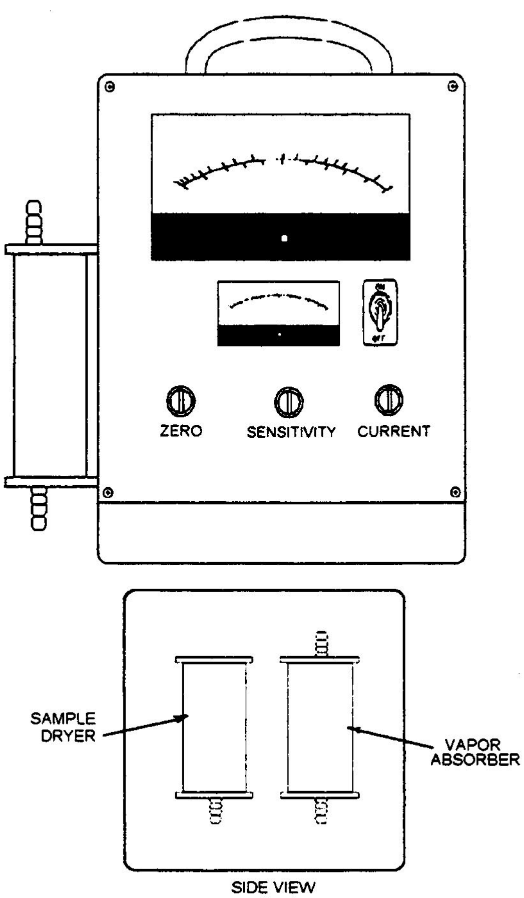


Figure 6-17.—Portable inertness analyzer.

A sample dryer (which has only a bottom hose connection) is filled with calcium chloride that absorbs moisture from the sample, and a vapor absorber (which has upper and lower hose connections) is filled with activated carbon that absorbs fuel vapors from the sample. An aspirator bulb and hoses are used to pump samples through the analyzer. The unit is powered by two 6V dc batteries.

Operation

Before using the instrument to analyze an enclosure, the unit must be prepared in normal room air. The current must be adjusted, and the analyzer must be purged and zeroed.

To prepare the analyzer for use, turn the unit ON. adjust the current to 150 milliamps, and allow 2 minutes for the analyzer to reach operating temperature. Make sure the aspirator discharge is connected to the analyzer. Then use the following steps:

1. Connect the aspirator bulb and hoses to the inlet of the sample dryer.

2. Aspirate air through the analyzer until the galvanometers needle comes to rest.

3. If necessary, set the galvanometers needle to zero using the zero adjustment.

To analyze enclosures containing air and inert gas, use the following steps:

1. Connect the aspirator bulb and hose between the sampling outlet of the enclosure to be tested and the inlet of the sample dryer.

2. Operate the aspirator bulb until the galvanometers needle comes to rest.

3. Note the reading.

To analyze enclosures containing air, inert gas and fuel vapors, use the following steps:

1. Connect the aspirator bulb and hose between the sampling outlet of the enclosure to be tested and the inlet (bottom) of the vapor absorber.

2. Connect the jumper hose between the outlet (top) of the vapor absorber and the inlet of the sample dryer.

3. Operate the aspirator bulb until the galvanometers needle comes to rest.

4. Note the reading. If this reading is not the same as the reading when testing for only air and inert gas,

fuel vapors are present and *this reading* is *the correct percentage of inertness.*

Upon the completion of all analysis, turn the analyzer off and purge the vapor absorber in a normal room atmosphere. Connect the aspirator hose and bulb to the outlet (top) of the vapor absorber and operate the aspirator bulb for three minutes.

Maintenance

The batteries have a useful life of about 100 hours. When the current adjustment rheostat does not bring the indicating needle to 150 milliamps on the scale, the batteries should be replaced.

After every 50 analysis, examine the calcium chloride and replace it if it is glazed or hard. Also, the activated carbon should be reactivated or replaced after every 50 analysis. As with all equipment maintenance, refer to the technical manual and MRCs for the correct procedures.

CO_2 FLOODING SYSTEM

Carbon dioxide is stored in steel cylinders at pressures from 700 to 1,000 psi, depending on variations in temperature. At these pressures, about two-thirds of the cylinder's contents is in liquid form. As gas is released through the opened cylinder valve, the pressure is gradually lowered until all the CO_2 turns into gas. Thus, the contents of CO_2 in the cylinder will expand about 450 to 500 times in volume when it is released. When fully charged, the large-size cylinders contain 50 pounds of CO_2.

Carbon dioxide is used for the protection of, and firefighting in, the gasoline pump room, motor room, access trunk, and fuel filter rooms, Carbon-dioxide cylinders are located in motor rooms and in compartments on the second deck directly above the filter rooms. The CO_2 release valves on the cylinder are operated by a cable, with cable pull boxes located at three places. The cylinder valves are thus opened, but they cannot be closed. Spare CO_2 cylinders are carried aboard.

The CO_2 emergency fire-extinguishing system for fuel pump rooms, motor rooms, access trunks, and filter rooms is similar on all ships.

Carbon-dioxide cylinders, located inside each of the motor rooms, are connected by piping to the fuel pump room, motor room, and access trunks. The other four are spares. The cylinders release carbon dioxide into the piping when operated by any of the pull boxes. A pull box is located inside the fifth-deck access trunk, the fire-pumproom and on the starboard side of the hangar deck across from the MOGAS-pumproom access.

The emergency pull box is watertight and has a metal cover with a rubber gasket held by friction clutches on the rim. Under the cover is a glass plate labeled with instructions for using the pull box. Also under the glass plate is a pull handle connected through a cable and pulley to a cylinder valve on the carbon dioxide cylinder head. To operate the pull box, release the friction catch to allow the cover plate to drop, break the glass and pull out the handle until the red portion of the pull cable can be seen. *After a 15-second delay,* released carbon dioxide gas flows through the piping to the fuel spaces, where it is discharged through diffusing horns and spreads as a smothering blanket, eventually filling the compartment.

Connections from the carbon dioxide-cylinder distribution lines allow carbon dioxide to operate two pressure switches. Pressure from the carbon dioxide throws electric switches to actuate a carbon-dioxide warning bell in the space, a visual alarm outside the space at the access, and to stop the exhaust ventilation system fan motors. Stoppage of the ventilation system will cause operation of an audible and visible alarm.

RECEIVING GASOLINE ABOARD

When gasoline is to be taken aboard, there are certain preparations to be made. First, establish the amount of gasoline to be received. The maximum allowable capacity required onboard will be 95% at sea or at anchor and 80% when the ship is alongside a pier. Gasoline is received aboard ship through the starboard main deck filling connections.

Equipment required at the filling connection is as follows:

- Swabs
- Rubber bucket
- Empty 5-gallon safety can
- Tool box with non-sparking tools
- Sample bottles
- Ground wire
- A portable funnel and a portable 2 1/2-inch hose connection

- Buns-N-Cork gaskets for the filling connection.

Sound-powered-phone headsets are required to establish communications between the following locations:

Filling connection

Gasoline pumproom

Venting station

Overboard discharge station

Fire-fighting stations must be manned and have equipment on hand as specified by the ship's refueling bill.

When receiving MOGAS aboard, it is mandatory to keep a refueling log. This receiving log will contain the following information:

1. Date and source received from
2. Time pumping started
3. Time pumping stopped
4. Meter reading before starting (truck only)
5. Meter reading after stopping (truck only)
6. Liquid level reading before starting
7. Liquid level reading after stopping
8. Rate of flow received
9. Average tank top pressure during operation
10. Maximum tank top pressure during operation
11. Amount received
12. Amount charged
13. Difference between 11 and 12
14. Any discrepancies that occur during the receiving operation
15. Condition of samples

The receiving operation can be accomplished in port by mobile tankers, barges, or drums. Regardless of the source of receiving, the operating steps are basically the same. Only the time required will be different.

Connect the portable 2 1/2-inch hose connector to the filling connection. Make sure the cofferdam is charged with N_2 to 50% inertness at 3 psi. Make sure the CO_2 fire extinguishing system is on, operating properly, and ready for immediate operation.

Look in the sight glass in the MOGAS tank fill line to check for the presence of seawater. If no seawater is present, open the tank top valve and introduce seawater into the tank with the seawater compensating pump until liquid is observed in the sight glass.

After all preparations are made, align the piping systems as follows:

Seawater compensation system alignment

1. Make sure the following valves are closed:
   a. Steam-out hose connection valve
   b. Seawater compensating pump valve
2. Make sure the following valves are locked open:
   a. Seawater elevated loop overboard discharge valve
   b. Seawater equalizing tank valve
   c. Seawater supply valve to the MOGAS tank

The seawater system is aligned in the following manner to allow the seawater in the MOGAS tank to be pushed out via the overboard discharge as MOGAS is pumped into the tank:

Gasoline distribution system alignment

1. Make sure the following valves are closed:
   a. Portable Inertness Analyzer (PIA) test connection valve
   b. Filter drain to MOGAS draw-off tank
   c. Venturi outlet valve
   d. Tanktop valve
   e. Vehicle fueling station isolation valve
   f. Flow meter bypass valve
2. Make sure the following valves are open:
   a. Vehicle fueling/filling station isolation valve
   b. Flow meter inlet valve
   c. Flow meter outlet valve
   d. Filling line isolation valve

Vent the distribution system as follows:

1. Align the piping to vent from the tank through the filter.

2. Open the filling valve SLOWLY at the filling station.

At this time, the distribution piping is filled with N_2 gas, which is vented to the atmosphere, and the piping filled with MOGAS prior to opening the tanktop.

3. Vent into a 5-gallon safety can.

CAUTION

Stand clear of the nozzle when venting inert gas into the atmosphere.

4. Align MOGAS piping for venting IAW CFOSS.

5. Monitor transfer pump discharge line pressure and report when inert gas (N_2) pressure is 0 psi.

6. Close the transfer pump discharge and suction valves, filter outlet and inlet valves, and venturi discharge. Report the MOGAS system is aligned for filling the MOGAS tank.

To replenish the MOGAS system, follow these procedures:

1. Before connecting the hose from the refueling source, first ground the refueling source to the deck, then to the filling connection.

2. Couple the fueling hose to the 2 1/2-inch connection and open the filling connection valve.

3. Set the flowmeter to 0 gallon.

4. Open the tanktop valve and tell the refueling source to start pumping at a low rate.

CAUTION

The pumproom operator must constantly monitor tanktop pressure when filling the tank. Do NOT exceed rated tanktop pressure (normally, 23 psi is the maximum). Throttle the filling isolation valve as necessary to maintain acceptable pressure.

5. Take a sample at the receiving station and inspect the system for leaks. If the gasoline is good and there are no leaks, increase the pumping rate.

NOTE

As soon as seawater is observed discharging from the overboard discharge, notify the pumproom operator.

6. When the tanks are approximately 75% full with MOGAS (to allow sufficient room to drain back the MOGAS distribution piping), do the following:

a. Order the refueling source to stop pumping.

b. After pumping has stopped, close the vehicle fueling/filling station isolation valve.

c. Close the tanktop valve.

To align the MOGAS system for draining, purging, and making inert after receiving, use the following procedure:

1. Make sure the following valves are closed:

a. Filling station/transfer valve.

b. Tanktop valve.

2. Make sure the following valves are open:

a. MOGAS filling line isolation valve.

b. Flow meter inlet valve.

c. Flow meter outlet valve.

d. Vehicle fueling/filling station isolation valve.

e. Flow meter bypass valve.

3. Observe the fill line sight glass to determine the liquid level in the piping. Open the MOGAS tanktop valve.

4. Open the air operated N_2 inert gas supply valve.

5. When the liquid level in the fill line sight glass disappears, close the MOGAS tanktop valve.

CAUTION

The tanktop valve must be closed immediately when the liquid level drops below the sight glass, to prevent N_2 inert gas from entering the draw-off tank.

6. Close the air-operated N_2 inert gas supply valve.

Report that the MOGAS piping is drained and the piping is now being purged. To purge the piping, use the following procedures:

1. Make sure the following valves are open:

a. Filter bypass valve.

b. Venturi outlet valve.

c. Transfer pumps blowback valve.

d. Transfer pumps pressure gage cutout valves.

2. Crack open the N_2 inert gas valve. The filling station will monitor and determine when the piping is inerted to a 50% inert gas concentration.

3. When ordered, charge piping to 10 psi by observing pump discharge line pressure gages. When the gages indicate 10 psi, close the N_2 inert gas valve.

4. Secure all distribution piping valves IAW CFOSS.

STRIPPING THE MOGAS TANKS

As stated earlier, there are two stripping systems installed in the MOGAS tank. They are the hand-operated and the motor-driven systems.

Hand Stripping Procedures

To hand strip the MOGAS tank with the hand-stripping pump, use the following procedures:

1. Make sure the following valves are closed:

a. Motor-driven stripping pump suction and discharge.

b. Isolation valves to and from the MOGAS service system.

c. Portable eductor hose hookup to the overboard discharge.

2. Open the following valves:

a. Hand-stripping pump suction valve.

b. The designated tank valve (drawoff or outer).

c. The designated valve for receiving the pump discharge (overboard or outer tank).

3. Report that the hand-stripping pump is aligned.

4. Operate the hand-stripping pump and strip until an acceptable sample is obtained or the tank is empty (based on the purpose for stripping).

5. Report that stripping is complete.

6. Close the following valves:

a. Designated tank suction valve.

b. Designated discharge valve.

c. Stripping pump suction valve.

7. Report that stripping alignment is secured.

Motor-Driven Stripping Procedures

The motor-driven stripping system is typical] y used to deballast the MOGAS tank. To deballast the MOGAS tank, use the following procedure:

1. Vent the tank to the atmosphere prior to deballasting.

2. Make sure the following valves are closed:

a. MOGAS transfer pump suction isolation valve.

b. MOGAS transfer pump discharge isolation valve.

c. Stripping pump test connection valve.

d. Eductor overboard discharge connection.

e. Hand-stripping pump overboard discharge valve.

f. Stripping pump isolation valve.

3. Open the following valves:

a. Overboard discharge line.

b. Stripping pump suction and discharge valves.

4. Report valve alignment complete.

5. To deballast the draw-off tank:

a. Open the draw-off tank stripping valve.

b. Start the stripping pump.

c. Observe the sight glass and when no liquid is visible, stop the pump.

d. Close the draw-off tank stripping valve.

6. To deballast the outer tank:

a. Open the outer tank stripping valve.

b. Start the pump.

c. Observe the sight glass and when no liquid is visible, stop the pump.

d. Close the outer tank stripping valve.

7. To secure from deballasting:

a. Make sure the outer tank stripping valve is closed.

b. Make sure the drawoff tank stripping valve is closed.

c. Close the stripping pump suction and discharge valves.

d. Close the overboard discharge valve

8. Report deballasting secured.

9. Inert the MOGAS piping to 50% inertness with nitrogen at 10 psi.

MOGAS SERVICING AND SECURING OPERATIONS

As with receiving gasoline aboard, there are specific procedures to be followed to ensure safe and efficient servicing with MOGAS.

The first step is to vent the system to the atmosphere. Follow the following procedures:

1. Make sure the following valves are closed:

a. MOGAS fill isolation valve.

b. PIA test connection valves.

c. N_2 inerting supply valves.

d. Flow meter and filter bypass valves.

e. Stripping pump suction and discharge.

f. Steam-out connections.

2. Open the following valves:

a. Vehicle fueling station cutout valves.

b. Flow meter inlet and outlet valves.

c. Filter inlet and discharge valves.

d. Filter pressure gage cutout valves.

e. Transfer pump suction and discharge valves.

f. Transfer pump gage cutout valves.

3. Set the flow meter to 0.

4. Report that the piping is aligned for venting inert gas.

5. Monitor transfer pump discharge line pressure and report when inert gas pressure is 0.

6. Vent into a 5-gallon safety can.

CAUTION

Stand clear of the nozzle when venting inert gas into the atmosphere.

7. Secure the following valves when venting is complete:

a. Transfer pump suction and discharge valves.

b. Filter inlet and outlet valves.

To align the MOGAS system for transferring MOGAS to vehicles, use the following procedures:

Sea Water Compensation System

1. Make sure the following valves are opened:

a. Seawater elevated loop overboard discharge valve (must be locked open).

b. Seawater supply valve to the tank (must be locked open).

c. Seawater sea chest valve.

d. Sea water equalizing tank valve.

e. Seawater compensating pump discharge valve.

2. Report that the seawater compensating system is aligned.

3. Start the seawater compensating pump.

Transfer Pump Alignment

1. Open the following:

a. Transfer pump recirculating valves.

b. Recirculating valve to drawoff tank.

c. Draw-off tanktop valve.

d. Designated transfer pump suction valve.

e. Venturi recirculation valve.

2. Start the pump.

CAUTION

Do NOT operate the transfer pump when the thermometer in the discharge header exceeds 100°F.

3. Report that the pump is started and recirculating.

4. SLOWLY open the pump discharge valve.

Filter Alignment (Do NOT vent the filter overboard in port.)

1. Open the following:

a. Filter gage cutout valves.

b. Filter vent valve.

c. Inlet valve (SLOWLY).

d. Drain valves to the drain tank.

2. When MOGAS appears at the filter vent sight glass, close the vent valve and slowly open the filter discharge.

3. Report that the filter is vented and the discharge open.

Fuel vehicles in accordance with CFOSS and your command's instructions. Always ensure that qualified supervisors are on station.

To secure from fueling:

1. Secure the station IAW CFOSS.

2. Secure the transfer pump:

a. Stop the pump.

b. Secure the tanktop valve.

c. Close the inlet and discharge valve.

d. Close the suction and discharge pressure cutout valves.

e. Close the recirculating line valves.

3. Drain back the piping:

a. Close the automatic filter drain valve.

b. Close the drain tank valve.

c. Open the following valves:

(1) Fueling station/fill station isolation valve.

(2) Fill line isolation valve.

(3) Tanktop valve.

(4) Flow meter bypass valve.

(5) Transfer pump blow back valves.

(6) Filter drain valve and drain valve to the draw-off.

d. Ensure the following is opened:

(1) Filter inlet and bypass.

(2) Transfer pump discharge valves.

(3) Venturi discharge valve.

(4) Flow meter inlet and discharge valves.

(5) Transfer pump recirculating valves.

(6) Draw-off tanktop valve.

(7) Draw-off recirculating tanktop valve.

e. Open the air-operated N2 inert gas supply valve located on the second deck.

f. Observe the reflex sight glass gage. When liquid is no longer visible, close the following:

(1) Tanktop valve.

(2) Draw-off tanktop valve.

(3) Draw-off recirculating valve.

(4) Air-operated N_2 inert gas supply valve.

g. Report that the piping is drained.

4. Purging the MOGAS system.

a. Open the following valves:

(1) Drain tank vent valve.

(2) Drain tank valve.

(3) Filter vent valve.

(4) Crack open the N_2 inert gas supply in the pump room.

b. Monitor inertness at the filling station.

c. Purge until 50% inertness is attained.

5. Inerting (charging the piping).

a. Monitor the transfer pump and filter discharge gages.

b. Close the N_2 inert gas supply valve in the pumproom when 10 psi is reached.

c. Report 10 psi on the piping.

6. Secure by closing the following valves:

a. Filter vent.

b. Fill line isolation valve.

c. Flow meter inlet, outlet, and bypass valves.

d. Transfer pump blow back, inlet, and discharge valves.

e. Filter inlet, outlet, and bypass valves.

f. Filter drain valves.

g. Venturi discharge.

h. Fueling station/fill station isolation valve.

GAS-FREEING THE MOGAS SYSTEM

All gasoline tanks, voids, and piping must be certified “Safe For Men/Safe For Hot Work” by the Gas Free Engineer before any work is done on the system. After off-loading of gasoline, the tanks are flushed with seawater to rid the tanks of traces of liquid gasoline. Three complete changes of seawater are required to ensure proper flushing.

To flush the tanks, use the following procedures:

1. Strip the outer and draw-off tanks as described in the earlier section for stripping procedures.

2. Make sure the following valves are closed:

a. Tank seawater supply line steam-out valve.

b. Sea chest steam-out valve.

3. Open the following valves:

a. Seawater elevated loop overboard discharge valve.

b. Seawater equalizing tank valve.

c. MOGAS tank seawater supply valve.

d. Seawater sea chest valve.

4. Start the seawater compensating pump, then open the discharge valve to fill the tanks with seawater.

5. When seawater is visible in the sight glass in the fill line, close the tanktop valve.

6. Stop the seawater compensating pump when the equalizing tank is full:

a. Close the discharge valve.

b. Close and lock the sea chest valve.

7. Complete the deballasting and filling evolution three times.

8. Report that flushing is complete.

After the tanks are emptied of all seawater, they are steamed to get rid of all traces of gasoline vapor. The tanks are coated with a zinc base that is not damaged by steam.

The procedures for steaming the tanks are as follows:

1. Close all valves in the system.

2. Connect a steam hose to the steam-out connection in the seawater supply line.

3. Open the following:

a. Tanktop fill valve.

b. Fill line isolation valve.

c. Flow meter bypass.

d. Filling station isolation valve.

NOTE

The system will be vented overboard from the most remote fueling station.

4. Remove the hose from the reel at the fuel station.

5. Commence steaming:

a. Steam the tank for 6 to 12 hours.

b. The temperature must not exceed 240°F.

c. Low-pressure air is injected with the steam to control the temperature and assist in forcing the steam through the piping.

6. Test the steam exhaust. (This is done by the Gas Free Engineer, using a Combustible Gas Indicator.)

7. When a negative reading is obtained, secure the steam and allow the tank and piping to cool.

8. Remove a positive stop valve close to the steam-out connection and check for damage.

The distribution piping must be steamed and gas freed for major maintenance such as welding, brazing, etc. Steam-out procedures for the distribution piping are as follows:

1. Connect a steam hose to the gasoline pump suction header steam-out connection.

2. Make sure the following valves are closed to prevent steam from entering the drawoff tank:

a. Tanktop valve.

b. Tanktop recirculating valve.

c. Tanktop drain line.

3. Replace the pressure regulator and a transfer pump with a spool. (This prevents damage to the seals and rotating element of the pump).

4. Open the valves in the distribution riser from the gasoline pump suction to the most remote fuel station:

a. Transfer pump inlet and discharge.

b. Filter bypass.

c. Venturi discharge.

d. Flow meter bypass.

e. Station isolation valve.

NOTE

Do not open the filter valves. The filter is steamed separately.

5. Remove the hose from the fuel station hose reel.

6. Commence steaming:

a. Steam the piping for 6 to 12 hours.

b. The temperature must not exceed 240°F.

c. Low-pressure air is injected with the steam to control the temperature and assist in forcing the steam through the piping.

d. Steam that condenses into water in the pump suction header may be stripped into the outer tank.

7. Test the steam exhaust. (This is done by the Gas Free Engineer, using a Combustible Gas Indicator.

8. When a negative reading is obtained, secure the steam and allow the piping to cool.

9. Remove appositive stop valve and check for damage.

The filter must be steamed prior to filter element removal/replacement and maintenance. To steam the filter, use the following procedures:

1. Remove the rotary control valve and install a blank flange and gasket on the sump.

2. Make sure the following valves are closed:

a. Filter inlet valve.

b. Filter drain valve.

c. Filter vent valve.

3. Open all valves from the filter discharge to the fill connection.

4. Connect an extension hose to the fill connection and lower it over the side to the water line.

5. Commence steaming:

a. Steam for 6 to 12 hours.

b. Do not exceed 15 psi.

c. Condensation that accumulates in the filter sump may be manually drained.

6. Test the steam exhaust. (This is done by the Gas Free Engineer, using a Combustible Gas Indicator).

7. Remove a positive stop valve and inspect for damage.

NOTE

At the end of steaming, check the tightness of all flange connections and inspect butterfly valves.

After the tanks have been steamed and maintenance completed, they must be refilled with seawater. Seawater will be taken on in deep water where the chance of picking up mud and silt from the bottom is remote.

To fill the tanks with seawater, use the following procedure:

1. Make sure the overboard discharge valve is locked open.

2. If icing conditions exist, cut in the steam coil for the overboard discharge line and vent.

3. Vent the tanks through the fill piping to the fill connection using all bypasses.

4. Line up the seawater system by opening the following valves:

a. Sea chest valve.

b. Seawater compensating pump inlet and discharge.

c. Outer tank supply riser.

5. Start the seawater compensating pump. Seawater is now being pumped into the outer tank.

6. When seawater appears in the sight glass in the tank fill line, close the tanktop.

7. When the seawater compensation tank sight glass indicates the tank is full, stop the seawater compensating pump.

8. Close and lock the sea chest valve.

SUMMARY

The catapult lube oil system and MOGAS system are small, simple systems to operate. As stated previously, following proper procedures will ensure safe operations. However, because of the hazards involved when handling MOGAS, it is MANDATORY that all safety precautions be adhered to, not just before pressurizing the system, but even before entering the pumproom.

CHAPTER 7

ASHORE SYSTEMS AND OPERATIONS

Among the more important duties performed in support of aircraft at naval air activities are those involving the handling of aviation fuel. Properly executed fuel-handling practices are deterrents to personnel injury, loss of life, and destruction of Government property on the ground and in the air. Personnel (whether military, civil service, or contractor employed) who are involved with these duties should possess a thorough knowledge of the equipment they operate and must follow the procedures associated with each operation.

Because of the variety of fuel-handling facilities and the types of fuel-handling equipment in use at air activities ashore, we cannot include in this manual all the pertinent information dealing with fueling facilities and equipment. Also, except for preoperational checks on trucks and pits, the ABF on shore duty rarely performs maintenance on the equipment. For this reason, equipment is identified where it would normally go and it's function is given, but the equipment is not broken down into parts. The operating procedures listed are typical for shore activities. Always use the approved operating procedures for each individual activity.

ASHORE FUELING EQUIPMENT

LEARNING OBJECTIVES: Identify the equipment used in fueling systems ashore. Explain the "function of equipment used in fuel systems ashore and describe where the equipment is located.

The following paragraphs provide a general description and the minimum requirements for equipment common to all ashore refueling systems, including mobile equipment. These requirements apply to both new and existing equipment. Figure 7-1 illustrates the typical arrangement for ashore systems.

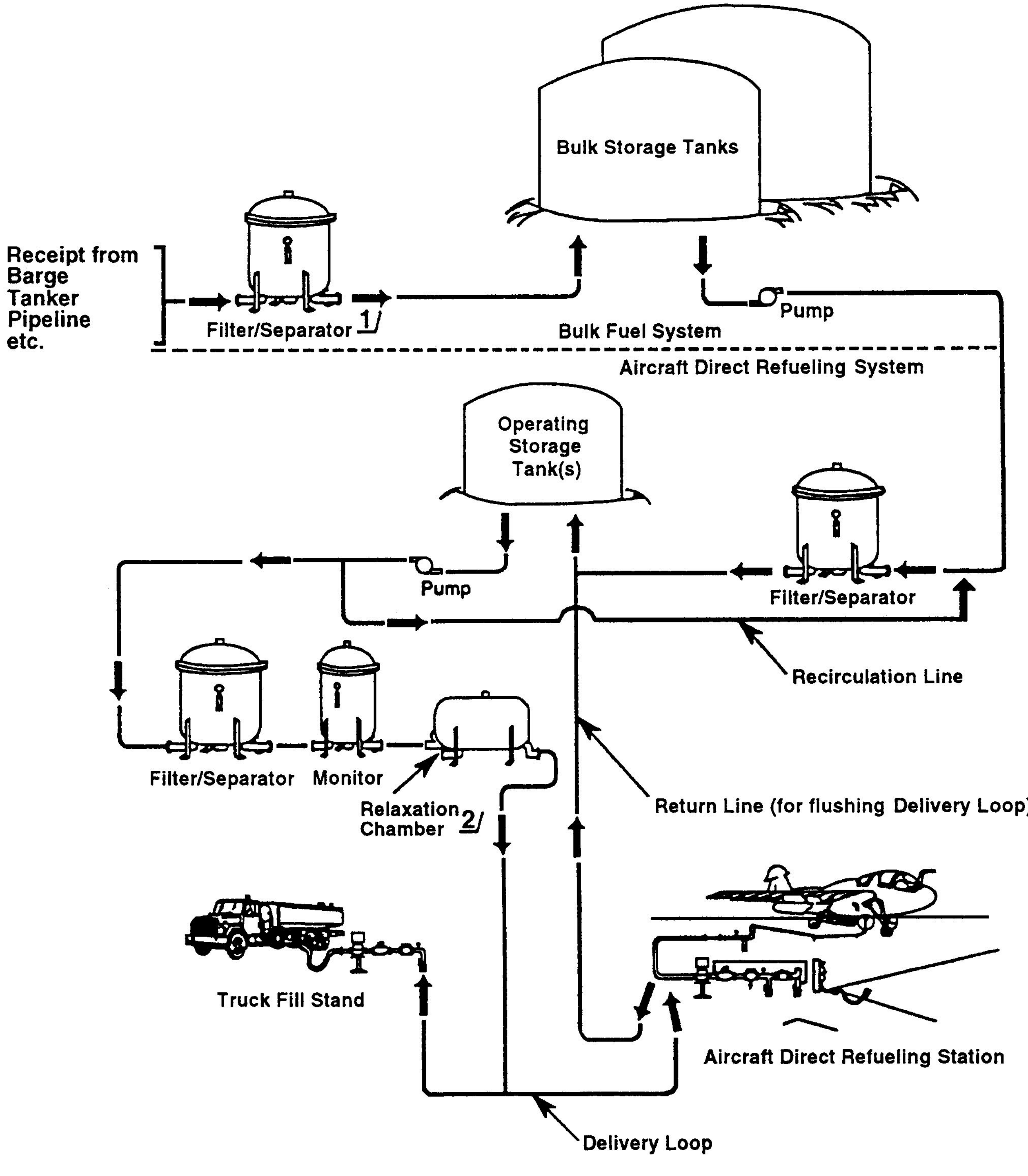
FILTER/SEPARATORS

The filter/separator is the primary device used at shore stations to keep aviation fuels clean and dry. Filter/separators are designed to remove 98% of all solids and 100% of all water. Each filter/separator is outfitted with the following minimum accessories:

- Manual water drain valve from the bottom of the water sump.
- Automatic air eliminator valve.
- Differential pressure gage with 1-psi graduations to measure the pressure differential across the elements.
- Pressure relief valve.
- Diaphragm-operated control valve on the main discharge line with a flow-limiting pilot and a float-operated pilot to close the main valve if the water level in the sump rises above the set point. This is commonly called a "slug valve."
- All manual water drains are connected to a portable or permanently installed recovery system. Pressure relief valves and the air eliminator should also be connected to a recovery system.

Filter/separators are provided at the following locations:

- In receiving lines upstream of all tanks from which fuel can be pumped directly to aircraft.
- In supply piping (downstream) from storage tanks to aircraft refueler truck fill stands.
- On any discharge (downstream) side of transfer pumps that supply aircraft or refuelers.
- On any equipment (including mobile and portable) that directly fuels aircraft.
- Upstream of the main receiving points for the bulk storage tanks. Filter/separators will reduce receipt of water and sediment into bulk storage tanks and increase the time between tank cleanings. The installation of a filter/separator is not practical at all receiving points. However, some device for the removal of particulate should be used, depending on the method of delivery and flow rates involved.



Notes: 1/ Pre-Treatment filtration system dependent on method of receipt, e.g., strainers, cyclonic filters.

2/ Downstream piping is acceptable substitute provided 30 seconds of relaxation time achieved.

Figure 7-1.—Ideal ashore fuel system flow diagram.

FUEL-QUALITY MONITORS

Fuel-quality monitors (formerly called go/no-go gages) are installed after filter/separators on truck fill stands and on all equipment that directly fuel aircraft. Monitors are not required for use with product receipt filters or those used exclusively for recirculation of fuel. A pressure gage is also installed on each monitor housing so that the differential pressure across the elements can be recorded. If the filter/separator also incorporates fuel monitor elements, the gage or gages are installed so that the pressure losses across the filter elements and monitor elements can be recorded separately.

The fuel-quality monitor (fig. 7-2) provides a continuous check on the cleanness of the fuel passing through the filter/separator. Fuel that meets a predetermined standard of cleanness passes through the monitor with a minimum drop in pressure. Fuel containing quantities of solids and/or water above the predetermined acceptable level is automatically cut off.

The fuel-quality monitor has an aluminum housing and various numbers of fuses, depending on the model. Each fuse of the monitor is a self-contained unit consisting of specially treated paper washers housed within a metallic housing and fitted with plastic end fittings. The sensing washers, housed within the metallic housing, absorb free or suspended water from the fuel.

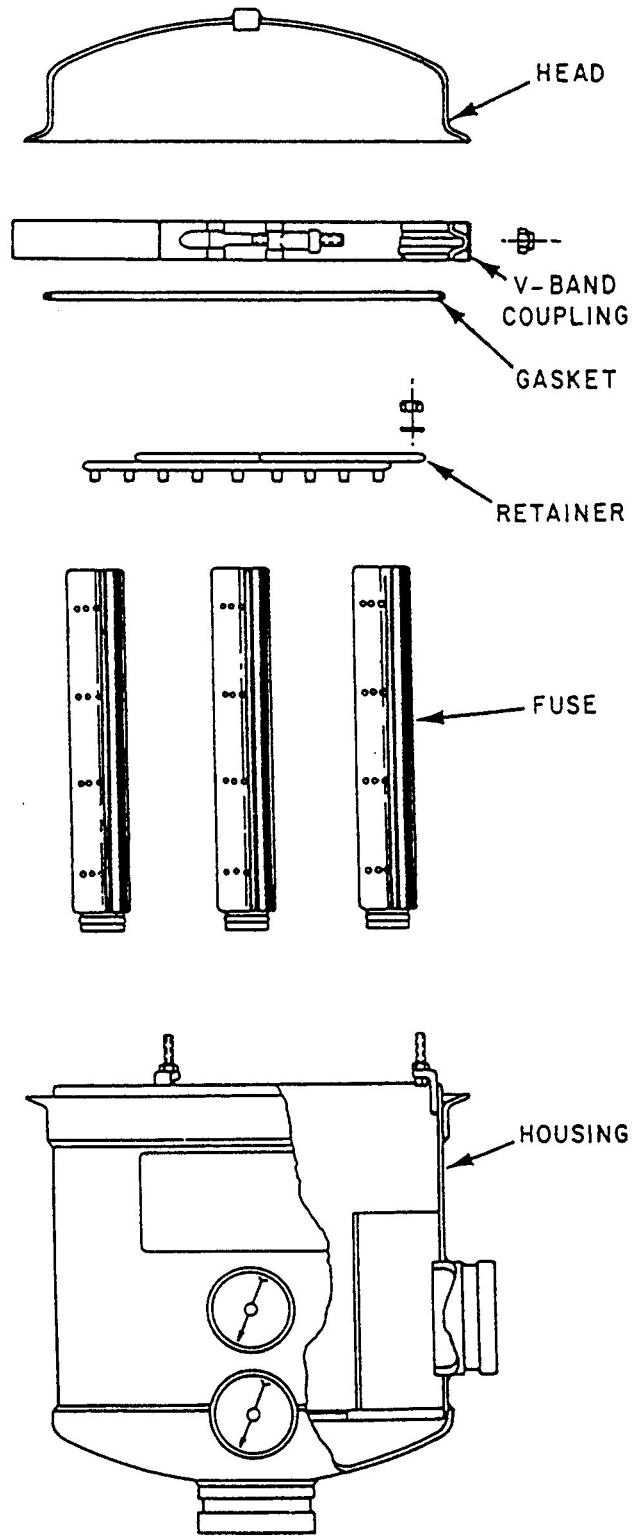


Figure 7-2.—Fuel-quality monitor.

RELAXATION CHAMBERS

A relaxation chamber, consisting of a tank or piping, follows the fuel monitor, or filter/separator if no monitor is installed in the system. This chamber allows static electric charges, which develop as the fuel passes through the filtration equipment, to "relax" before the fuel enters a tank. Since the fuel must be in contact with the metal walls of the relaxation device for at least 30 seconds, the exact size of the relaxation tank, or length of piping, is determined from the maximum flow rate of the system. Only one relaxation chamber is needed for each fuel monitor, filter/separator combination. Any tank, chamber, or other arrangement used to meet this requirement must assure complete product turnover, have a water drain at its low point, and a manual or automatic air eliminator.

FUEL METERS

Temperature-compensated meters should be installed at point of custody transfer. Meters used for services such as fueling of aircraft, motor vehicles, and boats or loading of tank trucks or tank cars are positive displacement meters. Turbine meters may be used for larger volume steady transfers such as loading of ships, barges, or pipeline transfers.

FUEL PRESSURE GAGES

Pressure gages must be easy to read and accurate within 1 psi, with graduations in 1-psi units.

SAMPLING CONNECTIONS

All sampling connections are the flush-type, dry-break, quick-disconnect (Gammon fittings) with dust caps. Fuel-sampling and pressure-testing connections are installed at the following locations:

- Receiving points
- Tank outlets
- Inlet and outlet sides of filter/separators and fuel monitors
- Refueling nozzles
- Each side of a block valve, so that the fuel remaining in each portion of a fuel transfer pipeline can be sampled.

HOSES

All hoses used for aviation fuel service at shore activities should be semihard-wall, noncollapsible hose. The diameter of the hose must be compatible with the desired delivery rate to the aircraft. Unless otherwise specified, aircraft delivery hose on refueler trucks must be a minimum of 50 feet long.

Shore-base hoses contain no electrical bond or bonding wire through the center of the hose. Where two hose assemblies are attached to the same outlet or source of fuel, each hose assembly must have its own shutoff valve in the piping upstream of the hose.

EMERGENCY DRY-BREAKAWAY COUPLING

An emergency dry-breakaway coupling should be installed on the refueling hose at or near the place where the hose attaches to refueling equipment piping or the hose reel. This device is required for each direct refueling system pantograph and is recommended for all other installations.

DRY-BREAK QUICK-DISCONNECT COUPLING

A dry-break quick-disconnect coupling is installed at the nozzle end of the hose and has a 60- or 100-mesh screen that is readily accessible without the use of tools.

HOSE END PRESSURE REGULATOR

The single point pressure refueling nozzle assembly includes a hose end pressure regulator set for a maximum of 55 psi.

AIRCRAFT REFUELING NOZZLES

The pressure refueling nozzles used for shore refueling are the same as for afloat refueling. The typical nozzle is the Carter D-1 or MD-1.

The overwing (gravity) nozzles used for shore refueling are also the same as used for afloat refueling. See chapter 5 for details on both types of nozzles.

AIRCRAFT REFUELER TRUCK FILL STANDS

The loading rack has a separate loading system for each grade of product to be handled. The equipment required at a truck fill stand for aviation fuel is as follows:

SPR (pressure) nozzle with dry-break quick-disconnect and strainer.

Loading hose approximately 10 feet long or mechanical loading arm with nonlubricated swivels.

Loading-hose fuel-thermal-pressure relief valve.

Diaphragm-operated two-stage control valve (low flow/high flow) with adjustable time delay to prevent the high-flow pilot from opening until 1 minute after start of fuel flow.

Meter with rated capacity equal to the maxium flow rate of the loading station. Temperature-compensating positive displacement meters are recommended.

Filter/separator.

Fuel-quality monitor.

Relaxation tank or equivalent piping.

Shutoff valves for maintenance.

Sample outlet.

A high-level cutoff system.

Low-intensity instrument lighting to permit full visibility of all equipment and controls during night operations.

Spill containment system that will prevent the run-off of fuel in the event of tank rupture or a major spill during loading operations.

Overhead lighting in the immediate truck-fueling area.

RECEIVING STATIONS

Fuel can be received by pipeline, barge, railroad tank car, tank truck, or any combination thereof. Receiving stations are tailored to the method, quantities, and rates of fuel delivery. Aviation fuel should be received through a filter/separator or other appropriate filtration device. This is an essential requirement when fuel is received directly into an air station's or facility's operational storage tanks. Weight-handling equipment may be necessary with barge receipts to help with large-diameter-hose handling. Communications equipment may be necessary for barge or pipeline receipt to coordinate an uninterrupted product flow. Appropriate environmental protection equipment, facilities, and procedures must be provided to comply with Federal, state, and local environmental laws.

STORAGE TANKS

Tanks located at air activities provide the operating supplies of aviation fuel for aircraft. Storage tanks are classified as bulk storage or operational storage.

All tanks must comply with the following requirements:

All operational or ready-issue steel tanks must be 100 percent coated with an inert material such as polyurethane or epoxy. All bulk-steel fuel storage tanks must be coated on the bottom and up 18 inches on the walls. All concrete tanks storing aviation fuel must be 100 percent lined on the floor and walls to make them impervious to fuel.

All aviation turbine fuel operational storage tanks must be equipped so the fuel can be circulated through a filter/separator and returned to the tank, thus removing any bottom sediment and water. Outlets must be at lowest point of the tank, to prevent water-bottoms. All aviation fuel tanks must also be equipped with a water-stripping system.

Tank roofs must be in good repair and must not allow rainwater to enter.

Fill connections for all types of tanks must be sized so that the velocity of the fuel during falling will not exceed 3 feet per second. Inlets discharge fuel horizontally near the bottom of the tank.

All bulk storage tanks must be equipped with adequate sumps, drain lines, and water draw-off lines, so that tank water-bottoms can be kept to an absolute minimum. Recovery tanks that remove water and recover fuel are recommended for environmental reasons.

All tanks must be fitted with automatic gageing devices and high- and low-level alarms and controls to prevent the overfilling of tanks and the exposure of pumps to cavitation. The alarms are left in the active mode at all times.

All aboveground tanks must be within an enclosure capable of holding the entire capacity of the tank plus l-foot freeboard, in case the tank should rupture or leak. This is usually accomplished with impermeable dikes.

Other environmental facilities/equipment as necessary to comply with Federal, state, and local laws.

TRANSFER LINES

Fuel passes through transfer pipelines of various diameters and construction materials in its route from tank to tank, storage to truck fill stands, and storage to hydrant systems. Transfer lines must not leak or introduce excessive contaminants to the fuel. Internally coated pipe or other noncorrosive materials in these lines should be used to reduce iron contamination in fuel.

All piping systems are marked to identify the grade of product being carried. These markings (fig. 7-3) are placed next to all operating accessories such as valves, pumps, regulators, and manifolds. Table 7-1 lists the sizes of bands and letters used for petroleum products.

AIRCRAFT FUELING SYSTEMS

LEARNING OBJECTIVES: Identify the typical fueling systems used on shore activities. Describe the equipment contained in each system.

The following are three typical aircraft fueling systems used on shore activities:

- Aircraft Direct-Refueling System (more commonly known as a "pit").
- Mobile Aircraft Refuelers. These are tanker trucks of various capacities and configurations.
- Portable Fueling Systems. These are air-transportable, advanced base systems used primarily to support tactical operations. As an ABF, you most likely will never use this type system; therefore, it is not discussed further in this manual.

AIRCRAFT DIRECT-REFUELING SYSTEM (PIT)

Aircraft direct-refueling systems (fig. 7-4) are designed primarily for "hot" refueling of aircraft. All direct-refueling systems have the following minimum features:

Filter/separator.

Fuel-quality monitor.

Relaxation chamber or equivalent piping configuration capable of providing 30 seconds of static relaxation from point of last filtration to the nozzle.

Diaphragm-operated primary control valve.

Remote, hand-held, deadman control for each pantograph or hose installed at each station.

Emergency pump-shutoff switch.

Meter on each station outlet.

Recirculation/flushing capability of the nozzle and/or hose/pantograph system.

Emergency dry-breakaway coupling on each hose or pantograph.

Bonding/grounding cable. This requirement is considered satisfied if the fueling hose/pantograph system has continuity (10,000 ohms or less).

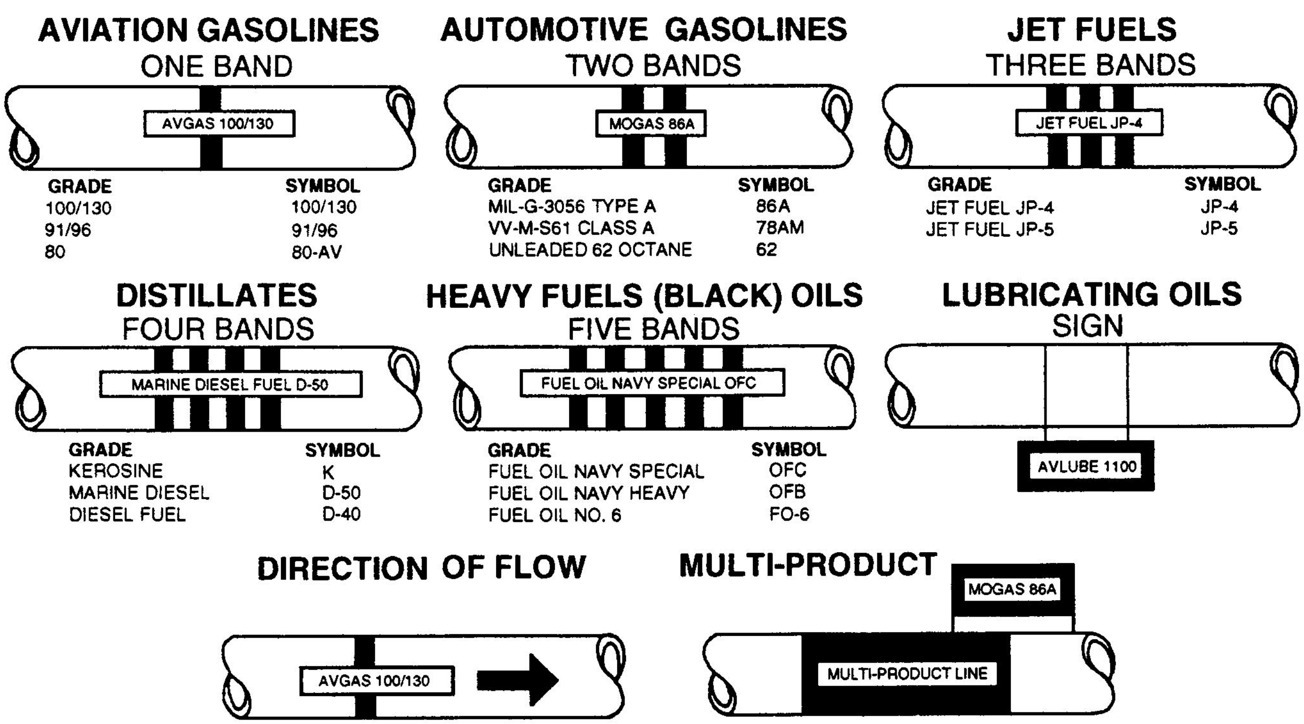


Figure 7-3.—Identification for bulk petroleum product lines.

Table 7-1.—Sizes of Bands and Letters for Petroleum Products

	Width of Bands		Space Between Bands	Length of Bands	Title Letter Size
	Wide	Narrow			
Pipe Diameter: Under 3"	6"	3"	3"	encircle	1/2"
3" to 6"	6"	3"	3"	encircle	1"
6" to 9"	6"	3"	3"	encircle	2"
Over 9"	8"	4"	4"	encircle	3"
Tank Capacity: 10,000 bbl and under	6"	3"	3"	33"	6"
Over 10,000 bbl	8"	4"	4"	54"	12"
Tank Car, Trucks: 2,000 gal and under	6"	3"	3"	24"	3"
Over 2,000 gal	6"	3"	3"	33"	6"

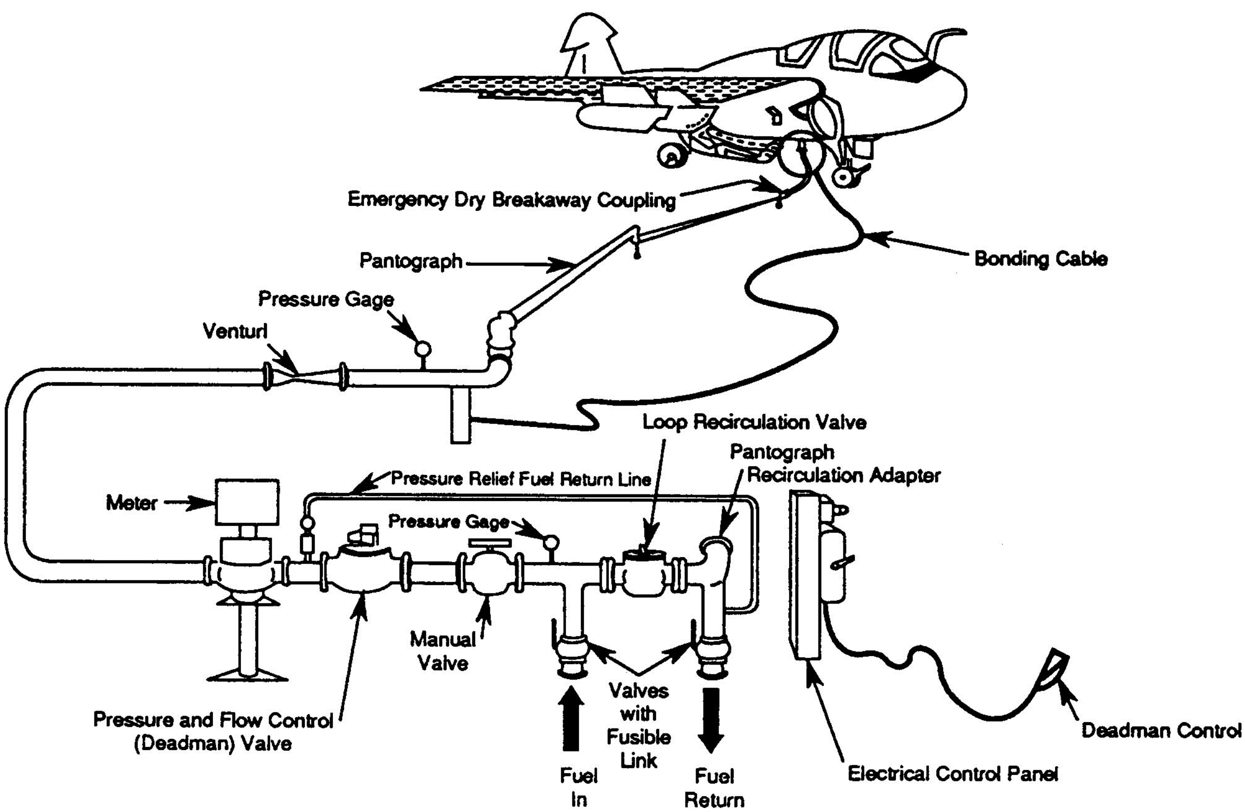


Figure 7-4.—Aircraft direct refueling system (pit).

Pantograph and/or hose with approved, nonlubricated swivel. Zerk-type grease fittings in pantograph swing joints are not authorized, because of the possibility of contaminating the fuel with grease.

Dry-break quick-disconnect fuel-service coupling with a 60- to 100-mesh strainer.

Single-point-pressure refueling nozzle with a 55-psi maximum pressure regulator.

Fire extinguisher(s) in accordance with NAVAIR 00-80R-14 (minimum of one 150-pound Halon or TAU unit per fueling point).

Emergency eyewash/shower system available in the immediate area.

Fire alarm.

MOBILE AIRCRAFT REFUELERS

Mobile refuelers are used primarily for cold fueling operations, with occasional hot-refueling operations at stations where installation of a direct refueling system is not justified. If continuous or extensive hot fueling is being performed with mobile refuelers, the use of an anchored pantograph, as shown in figure 7-5, should be considered.

Mobile aircraft refuelers vary in capacity and configuration. However, whether contractor- or Government- owned, all mobile aircraft refuelers have the same basic requirements. These requirements are the following:

Tank construction is one compartment only, with necessary baffles. Tank must completely drain at the low point without traps of liquid remaining in pockets. The tank is designed so that all portions are accessible for cleaning and maintenance.

Tank is aluminum or stainless steel.

Tank top opening(s) must be semi-permanently secured and used only for inventory and for interior inspections and repairs. Manhole covers must in-corporate a fusible plug or plugs, each equipped with fine screens to provide additional emergency release of vapor.

Tank must be configured for bottom loading. The bottom loading hardware includes a cutoff valve, an adapter to accept the standard pressure (SPR) nozzle, and must be of sufficient size to receive the product at 600 gallons per minute. A fill stand anti-driveaway device is incorporated.

Each tank must have an electronic system for controlling the filling operation (Scully Dynaprobe or equivalent) that is compatible with the system on the truck fill stand. It should be located near the bottom loading adapter and include art anti-driveaway feature (can be combined with anti-driveaway device previously mentioned).

The piping system, including all hardware components, must be capable of dispensing fuel at the rated flow. A flow diagram of the general configuration of these system devices is shown in figure 7-6.

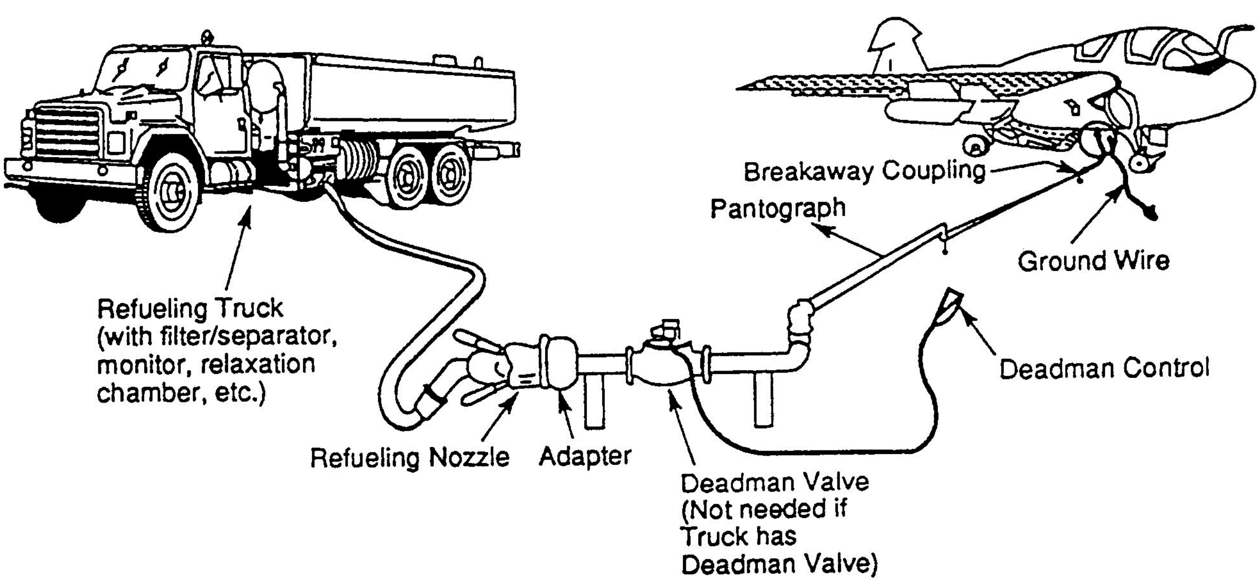


Figure 7-5.—Hot-refueling with truck and pantograph.

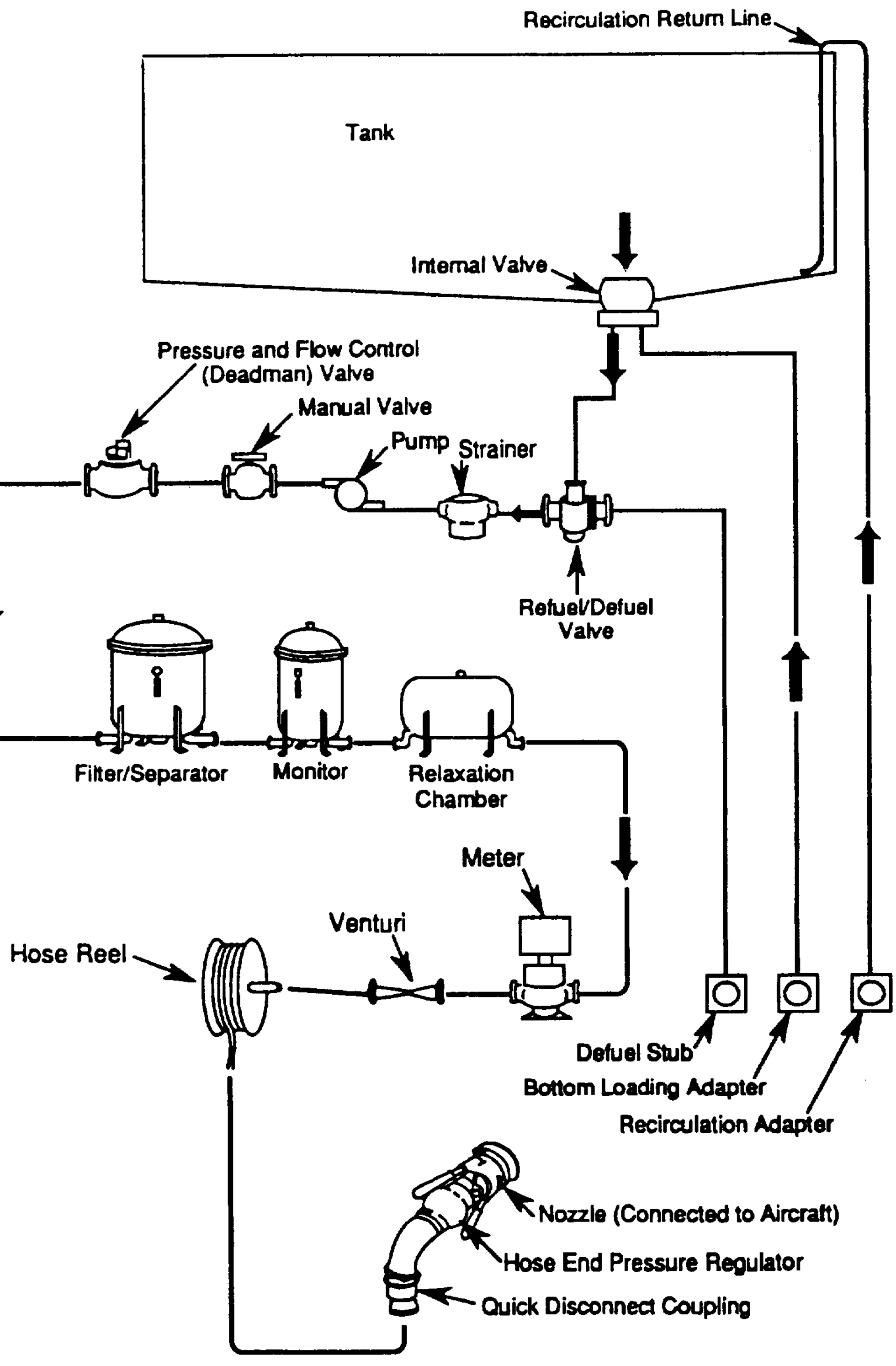


Figure 7-6.—Flow diagram for mobile refuelers.

Filter/separators.

Fuel-quality monitor.

Relaxation chambers.

Pressure and differential pressure gages.

Meter (temperature-compensating meters are desired).

Approved aircraft-refueling hoses.

Dry-break quick-disconnect coupling.

Hose-end pressure regulator.

Approved aircraft-refueling nozzles.

NOTE

Refueler/defuelers have two separate hose/pressure nozzle assemblies: one includes a hose end pressure regulator (for refueling service) and the other doesn't (for defueling operations).

Bonding cable.

Aircraft fuel servicing vehicles must have at least two fire extinguishers installed: One must be on the left front (driver's) side, readily accessible from the operator (refueler control panel) position. The other extinguisher must be on the right rear portion of the vehicle.

Remote, hand-held deadman control.

Tires are of a non-FOD type, with slick tread or wide-lug, wide-groove tread. The tread must NOT have a narrow groove design, in which small stones and foreign matter could become imbedded and deposited on airfield surfaces. Recaps and slicks are not authorized for use on the steering wheels when the vehicle is operated off base.

The exhaust of all engines, including auxiliary engines, must have a suitable spark arrestor.

Refuelers/Defuelers

The most ideal and cost-effective method of handling non-suspect defueled aviation turbine fuel is to reissue it to an aircraft. Most facilities that handle size able quantities of such fuel have designated one or more aircraft refueling trucks as "refueler/defuelers."

In addition to the requirements for refuelers, refueler/defuelers must also meet the following minimum requirements:

- Refuel/defuel trucks carry the marking "JET FUEL/JP" in place of the normal markings (for example, "JP-5 JET FUEL F-44" or "JP-4 JET FUEL F-40").
- A dedicated defuel connection to piping system that passes the fuel through the pump, falter/separator, monitor, and relaxation chamber before it enters the tank.
- Separate hose and nozzle assemblies provided on refuel/defuelers for each of the two different operations, refueling and defueling.
- Maximum defuel is 100 gpm.
- High-level alarm. A high-level cutoff system is also highly recommended.

Defuelers

Defuelers are used for defueling only. Fuel placed in a defueler is not to be directly reissued into an aircraft; since the defueler is generally configured without filtration equipment, the fuel placed in a defueler unit is often suspect. Fuel in a defueler must be sampled and tested to determine disposition.

CAUTION

Hose evacuation systems must NOT be used for defueling.

Defuelers must have the following minimum requirements:

- A centrifugal pump with the maximum defuel rate of 100 gpm
- A cutoff or alarm system for overfill protection
- A defuel hose and nozzle

PREVENTIVE MAINTENANCE PROGRAM (INSPECTIONS)

Proper maintenance is critical to the delivery of clean, dry, uncontaminated fuel to aircraft. A well-executed and documented PM program will help achieve this goal, but a formal inspection program is also necessary. The implementation of an inspection program is the responsibility of the Fuel Management

Officer (FMO). The inspection program includes the following:

- Inspections of equipment and facilities before use
- Inspections before major operations
- Seasonal or special inspections
- Routine inspections and checklists

Inspections Before Use

New construction, out-of-service facilities, broken equipment, and facilities or equipment undergoing corrective or programmed maintenance must be inspected before acceptance or reactivation. Special attention should be given to rated capacities of hardware, pipeline sizing, drainage, accessibility, emergency controls, safety, and fire prevention features.

Inspections must be conducted before starting major operations, such as receipt of products from a ship or barge, transfers between large storage tanks, or high-tempo training exercises. Inspections should cover equipment performance, pipeline integrity, valve positioning, tank arrangement. and personnel manning.

Seasonal or Special Inspections

In climates where freezing weather is encountered, winterization inspections should be made in early autumn. Extensive inspections for damage or malfunctioning should be conducted following any storm, flood, fire, earthquake, lightning strike, suspected act of sabotage, or vandalism. Special inspections are called for when abnormal variations in performance, flow rates, pressures, or capacities are experienced by operators.

Daily Checks

A daily check (once in every 24-hour period) must be conducted on all aircraft fuel delivery equipment that is in continuous use. Equipment that fails to meet established requirements must be removed from service until corrective action is completed.

The inspection varies on different equipment, and locally developed checklists that are specific to individual installations or systems may be developed. A typical daily checklist includes the following:

1. Check that fire extinguishers are in place, filled, operable, and have a current inspection tag.

2. Inspect the nozzle for damage.

3. Hook up the nozzle to the bottom-loading adapter or recirculation fitting and again inspect the nozzle for damage or evidence of leaks.

4. Check the entire length of the hose for cuts, cracks, abrasions, and fuel saturation.

5. Check that bonding cables are in place and in good condition, clean, and have serviceable plugs and clips securely attached.

6. Carefully inspect tanks, piping, valves, pumps, meters, and couplings for leaks.

7. Check the emergency valve controls for condition and ease of operation.

8. Make sure exterior surfaces are wiped clean of oil, grease, and fuel. Make sure the cabinets, troughs, cab, and any enclosures are free of an accumulation of fuel, dirt, cleaning material, and unnecessary items. Check fenders and mudguards to ensure adequate protection against the throwing of mud and dirt on fueling equipment and the rear of the unit.

9. Check the fluid levels of the battery, radiator, gas, and engine oil.

10. Make sure all lights are operable, all electrical wiring outside the cab is enclosed in tubing, and the rear view mirrors are serviceable.

11. Drain all low-point drains (tank, filter/separator, monitor, relaxation chamber). If water is found, empty the sample into a safety can and repeat the process until a clean, water-free sample is obtained.

12. Carefully inspect the exhaust pipe and muffler system, including any auxiliary engine system, for leaks, cracks, noise, and proper placement.

13. Check the emergency brake to make sure it holds.

14. Drain air tanks of moisture and check for fuel contamination.

15. Engage the pump and pressurize the system. Check the entire system for leaks.

16. Place the nozzle's flow-control handle in the fully opened and locked position and recirculate. On refueling trucks. recirculation is to be performed at standard RPM settings, where flow rates and differential pressures can be accurately measured. The recirculation of trucks more than one-half full is limited to 10 minutes, each 10-minute period followed by a 1-minute rest to allow electrostatic charges to dissipate. For trucks less than one-half fill, the recirculation time is limited to 3 minutes. All equipment must be

recirculated long enough to flush out all piping downstream of the fuel monitor elements.

17. Check the operation of the pump. Listen for unusual sounds and feel for overheating and/or abnormal vibrations.

18. Obtain a nozzle sample and visually inspect it for color, water, and solids. Record the results.

19. With the system recirculating, observe and record the pressure drop across the filter/separator and the monitor.

Weekly Checks

The weekly check is performed by a senior operator or fuel shop personnel. The weekly inspection is also required to be performed on equipment being returned to service following any DOWN time that exceeds 72 hours. The typical weekly inspection checklist is as follows:

1. Complete items 1 through 17 on the daily checklist.

the CFD and FWD. Log the results in the appropriate laboratory log.

3. Clean and inspect all nozzle screens (pressure and overwing).

4. Inspect tires, brakes, horn, windshield wipers, steering, trainer coupling and electrical wiring. The brake linings and/or pads must be checked by normal application of the brake while observing pedal travel. Test the emergency brake under drive conditions. Make sure all electrical wiring outside of the cab is encased in tubing that terminates in securely mounted vapor-tight fixtures or junction boxes with compression fittings. The use of a transportation inspector is recommended for these checks.

5. Measure and record the pressure drop across the filter/separator and the fuel monitor using a sensitive, hand-held pressure gage accurate to 1 psi, with graduations in 1 psi, or smaller, units, This measurement MUST be taken with the system operating under normal flow conditions.

Monthly Checks

The monthly checks require special equipment and moving of mobile equipment to a location other than the operating area. The typical monthly checklist is as follows:

1. Complete the daily and weekly checklists.

2. Check the continuity of grounding cables, bonding cables, and reels. Continuity must be measured with the cable in the stowed, intermediate, and fully extended positions. Check the continuity of the grounding cable on each overwing fueling nozzle.

3. Inspect and clean all line strainers, including the meter strainers when installed.

4. Test the anti-driveaway device installed on all refuelers.

5. Perform the engine spark check at night. The purpose of this check is to locate any electrical arcing over the outside surfaces of wiring, spark plugs, and the like. Any auxiliary engines should be included in the test. Any observed arcing—however slight—is sufficient cause to remove the equipment from service.

6. Test maximum flow rate. If pressure tests indicate that nozzle pressure exceeds 55 psi or that the flow rate exceeds 600 gpm, the equipment must be removed from service.

7. Test the primary pressure-control system.

8. Check the refueling adapters (receptacles), using the go/no-go gage.

9. Make sure fuel-handling equipment is marked in accordance with NAVFAC P-300 or MIL-STD-161.

Periodic Inspection and Annual Record

The Periodic Inspection and Annual Record provides an important historical record for each piece of refueling equipment. It is a written record of inspections, calibrations, element changes, and other maintenance actions performed through the year. As with other checklists, this record may be tailored to meet the requirements of each station.

Filter/Separator—Fuel-Monitor Pressure Log and Graph

The pressure drop across each housing must be accurately determined so that the integrity of the elements can be verified. Over time, differential pressure will increase as more and more dirt and/or water is trapped. Additionally, ruptures or breaks are identified by a significant drop in differential pressure. All activities must maintain a log for each filter or monitor.

Filter and monitor elements in refueling equipment or at truck-fill stands are changed every 3 years unless an earlier change is forced by one of the following conditions:

- The pressure drop across either the filter or the monitor elements reaches 20 psi.

- The combined pressure drop across the filter and monitor elements reaches 25 psi.

- A significant drop in differential pressure occurs, indicating an element rupture.

- The differential pressure fails to increase after an extended pied, indicating either ruptured elements or improper installation.

- The complete shutdown of fuel flow and/or a very rapid increase in pressure differential across the monitor elements. This usual] y indicates a failure of the filter/separators. If this condition occurs, both the filter/separator and monitor elements must be changed.

During filter changes, the permanent second-stage water separator elements should be tested for their ability to repel water. If the separator element does not repel or cause the water to bead, it should be washed with warm water and tested again.

Records and Reports

Observation of abnormal operating conditions is vital to a good preventive maintenance program. The detection of small operating faults and their subsequent minor correction or repair can often avert the development of major problems requiring extensive repairs. Such conditions must be promptly reported to the proper authorities in order to achieve the necessary repairs or corrections. These deficiency reports are in written form.

Facilities "must maintain maintenance records in sufficient detail to provide the following:

- Identification of each major structure, equipment item, group of items, or system

- Current maintenance status, including unfunded deficiencies and uncompleted job orders

- Past maintenance history, including description and cost of major repairs or replacements

- Recommendations for future programmed repairs or replacements, including estimates of funds or manpower requirements

ASHORE OPERATING PROCEDURES

LEARNING OBJECTIVE: Explain the procedures for various ashore fueling operations.

The operating procedures presented and discussed in this section are for general types of fuel facilities and equipment common to all or most activities engaged in the fueling of aircraft. Since the actual facilities and equipment vary greatly from installation to installation, these procedures and accompanying information are designed to serve as a basic outline and guide. As always, use your station's specific operational procedures for actual fueling and defueling operations.

SPILL PREVENTION AND CONTROL

Proper training of fuel-servicing personnel is essential. Proper maintenance of the equipment is equally essential. Leaking or malfunctioning equipment must be removed from service. Self-closing nozzles or deadman controls must not be blocked open or bypassed. Kinks and short loops in fuel hoses should be avoided. In addition, a fuel-spill/fire prevention drill must be conducted at least quarterly.

When a spill is observed, the fuel servicing must be stopped immediately by release of the deadman control, by closing the nozzle handle, or by operation of the emergency fuel shutoff. The supervisor is notified at once, and the operation must not be resumed until authorized by the supervisor. Every fuel spill must be investigated to determine the cause, whether emergency procedures were properly carried out, and what corrective measures are required.

Priming Spills

Pint-size spills, involving an area less than 18 inches in any dimension, require no emergency action during cold-refueling operations. However, ramp personnel should stand by with a fire extinguisher until operations are complete and/or the aircraft departs. A spill or leak of any size is cause for terminating a hot-refueling operation.

Small Spills

Other small spills involving an area of from 18 inches to 10 feet in any dimension must have a fire guard posted, equipped with at least one fire extinguisher. Either absorbent cleaning agent or emulsion compound may be used to absorb the spilled fuel. Contaminated absorbent must be placed in metal containers with closed lids until it can be removed and disposed of according to local hazardous-waste disposal procedures. An exception to this method maybe authorized if the spill occurs in an area where no operations are in progress or will be conducted until ample opportunity is provided for volatile fuels to evaporate harmlessly. In such an event, the area must be roped off. Fuels such as JP-5, which will not evaporate readily, must be removed by one of the methods indicated previously.

Large Spills

Spills covering an area greater than 10 feet in any dimension or more than 50 square feet in area require handling by the Spill Response Team. The team must be summoned immediately and all other personnel evacuated to a safe distance. No one will be permitted to walk through the liquid area of a fuel spill.

All fuel spills must be reported immediately to the activity's Environmental Coordinator in accordance with the local oil-spill contingency plan. All fuel-handling personnel must be familiar with the local oil-spill contingency plan.

PRESSURE REFUELING AT DIRECT FUELING STATIONS (PITS) WITH ENGINES OFF (COLD REFUELING)

Cold refueling of aircraft at fueling hydrants, direct refueling stations, skid mounts, and other fuel service units requires a minimum of two people. Required are a nozzle operator (supplied from the squadron, maintenance department, or transient line) and a fuel system operator (from the fuels division), who also performs the duty of a fire extinguisher operator. Aircraft refueling tasks are to be performed in the following sequence and verified by the pit station operator. The individual who actually performs the task is indicated within parentheses following the task.

1. Recirculate (flush) the station and take fuel sample(s) for quality control checks as appropriate (station operator). Fuel is recirculated or flushed through the refueling hose and nozzle, and tested for contamination prior to refueling the first aircraft each day. Fueling must not begin until acceptable results have been obtained.

2. Check for "hot-brake" condition (plane captain). The hot-brake check applies to fixed-wing aircraft only.

3. Tow the aircraft into the direct refueling station; position and chock it (plane captain).

4. Secure all electronic and electrical switches on the aircraft not required for fueling (plane captain).

5. Verify that fire-fighting equipment is in the immediate vicinity of the refueling operation and manned (station operator).

6. Attach the bonding cable between the refueling equipment and the aircraft (plane captain). In direct fuel systems, bonding is usually accomplished through the nozzle/hose/pantograph system. If bonding is not accomplished via the nozzle/hose/pantograph system, the bonding connection is made using the grounding receptacle near the aircraft's refueling adapter. If this is not possible, the connection must be to bare metal on the aircraft.

7. Pull out the pantograph (or reel out the hose) and place it in the proper position for refueling (nozzle operator and station operator).

8. Remove the refueling adapter cap from the aircraft and the dust cover from the pressure nozzle. Inspect the face of the nozzle to make sure it is clean, and verify that the flow-control handle is in the fully closed and locked position (nozzle operator).

CAUTION

A worn or broken adapter can defeat the safety interlocks of the refueling nozzle, permitting the poppet valve to open and fuel to spray or spill.

9. Visually inspect the aircraft's adapter (receptacle) for any damage or significant wear (nozzle operator).

CAUTION

The nozzle must seat firmly on the adapter and not be cocked. Cocking can indicate a malfunction of the nozzle's safety interlock system, which could lead to a fuel spray or spill.

10. Lift the nozzle by the lifting handle; align the lugs with the slots on the aircraft adapter; and hookup to the aircraft by pressing the nozzle firmly onto the adapter and rotating it clockwise to a positive stop (nozzle operator).

11. Zero the refueling station's meter or note the station's totalizer reading (station operator).

12. Upon receiving signals from the nozzle operator and plane captain that hook-up has been completed and the fueling operation is ready to begin, the station operator actuates the remote, hand-held deadman control. Deadman controls must NOT be blocked or overridden in any way. Such action defeats the purpose of the device and can lead to a catastrophic accident.

13. Rotate the nozzle flow control handle to the FULL OPEN position. The handle must rotate 180 degrees to ensure that the poppet valve is fully open and locked (nozzle operator). The flow-control handle of the pressure refueling nozzle will be placed in either of two locked positions: fully open or fully closed. The handle is NOT to be used as a flag to indicate fuel flow. Excessive wear on the aircraft adapter and the fuel nozzle poppet will result if the handle is allowed to "float" in the unlocked position.

14. Once fuel flow is established, test the aircraft's precheck system (plane captain).

NOTE

The precheck system simulates the completion of a complete refueling by closing all the tank inlet shutoff valves within the aircraft. All fuel flow into the aircraft should stop within a few seconds to 1 minute of actuating the precheck system. The refueling station meter is the primary means of detecting that fuel flow has stopped and that the precheck was successful. If a meter is not available, successful precheck may be confirmed by observing the jerk and stiffening that occurs in the refueling hose and/or the pressure spike that occurs at the refueling station. An aircraft may be cold refueled if it fails precheck but special procedures are required. See the appropriate aircraft NATOPS manual. Cold refueling after precheck failure should be done only if it is an operational necessity.

15. Fuel aircraft as directed by the plane captain. The plane captain monitors the aircraft vents, tank pressure gage(s), and/or warning lights as necessary.

16. When directed by the plane captain, release the deadman control (station operator).

17. Rotate the nozzle flow-control handle into the OFF and fully locked position (nozzle operator, and verified by the station operator). Failure to lock the flow-control handle in the OFF position can contribute to failure of the nozzle's safety interlock system and could result in a fuel spray or spill.

18. Disconnect the nozzle from the aircraft adapter (nozzle operator).

19. Stow the pantograph or hose (nozzle operator and station operator).

20. Complete the paperwork (nozzle and station operators).

Overwing (Gravity) Refueling at Direct Fueling Stations (Pits)

Overwing (gravity) refueling of aircraft at fueling hydrants, direct refueling stations, skid mounts, and other fuel service units is done using the procedures previously mentioned but with the following modifications:

- The overwing nozzle must be bonded to the aircraft via a nozzle bonding cable prior to removing the filler cap.

CAUTION

Overwing refueling with the aircraft's engines operating (hot refueling) is NOT authorized

- The overwing nozzle is inserted into the aircraft's refueling port. Metal-to-metal contact between the nozzle and the aircraft fueling port must be maintained during the entire fueling operation.

TRUCK FILL STANDS

Operating truck fill stands is a one-person operation for trucks equipped with high-level alarms/shutoff and deadman control valves at the fill stand. This is a two-man operation for equipment not having these devices.

CAUTION

Top loading must NOT be performed. This method of filling is extremely dangerous because of the highly flammable vapors and static charges produced.

Trucks are filled in the following sequence:

1. Position the truck, turn off lights, place the gear shift in the neutral or park position, set the parking brake, stop the engine, and turn off all switches except necessary alarms.

2. Verify the product and estimate the amount of product to be loaded.

CAUTION

Vehicles without high-level controls or alarms must be monitored via the fill stand meter during the filling process. Secure pumping if the meter exceeds the amount previously issued from the truck.

3. Connect the bond or high-level control cable.

4. Connect the delivery nozzle to the truck's bottom loader.

5. Set the meter and enter the necessary information on the truck fill order or other form.

6. Start the filling operation slowly.

CAUTION

Trucks that have been completely drained must be minimally fueled (500 to 1,000 gallons) using another truck set at a low flow rate, to cover the bottom inlet valve inside the empty truck's tank.

7. After the tank is filled, secure the pump unless it has secured automatically.

8. Disconnect the nozzle.
9. Disconnect the bond or high-level control cable.
10. Complete the paperwork.

11. Inspect the truck for leaks.

12. Remove the refueler to the truck parking area.

COLD REFUELING OF AIRCRAFT BY TRUCK

Positioning of refuelers to service aircraft is done in the same manner—without variation—so that all personnel involved know exactly what to expect. Whenever possible, refuelers should proceed down a line of parked aircraft, with the driving path perpendicular to the aircraft fuselage axis, at the maximum distance the hose length will permit servicing. However, a truck must never approach closer than 10 feet of an aircraft. The normal refueler approach path, shown in figure 7-7, applies to all fixed-wing tactical aircraft and helicopters. Normally, no turns are made except at the end of the parking line. Driving between aircraft parked in line should be avoided; however, the preferred approach is not always possible. Figure 7-8 shows acceptable alternate methods when aircraft are not parked in line or when hose lengths are insufficient for service. Figure 7-9 shows the safe approach paths to prop, prop/jet, and

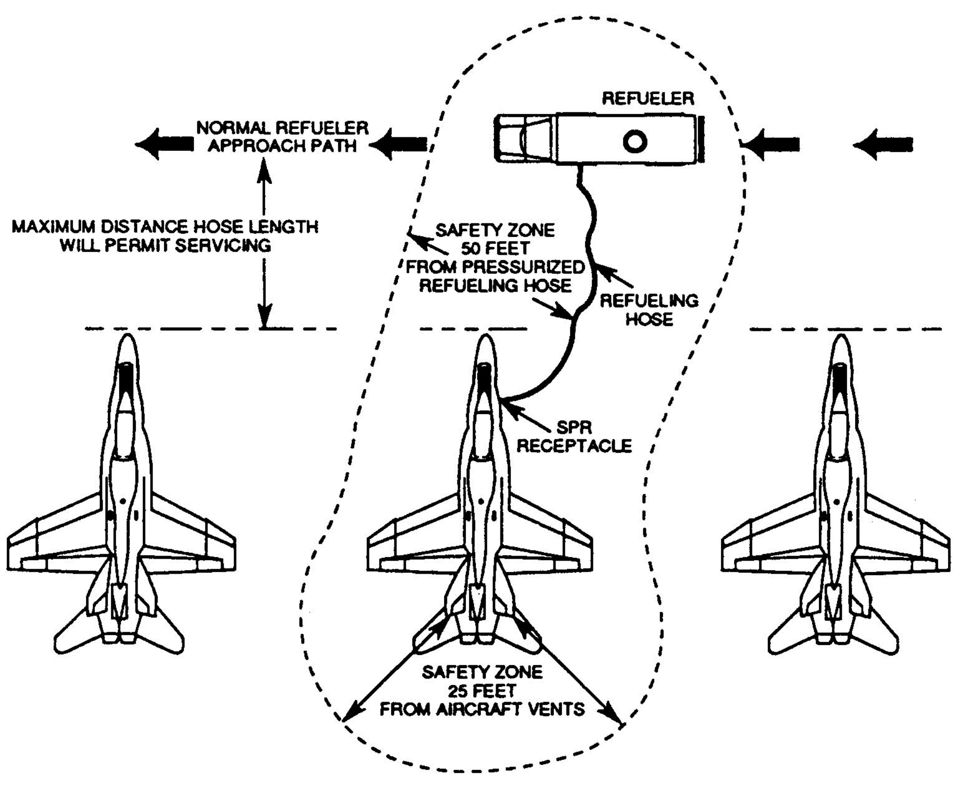


Figure 7-7.—Normal refueler approach path and safety zone.

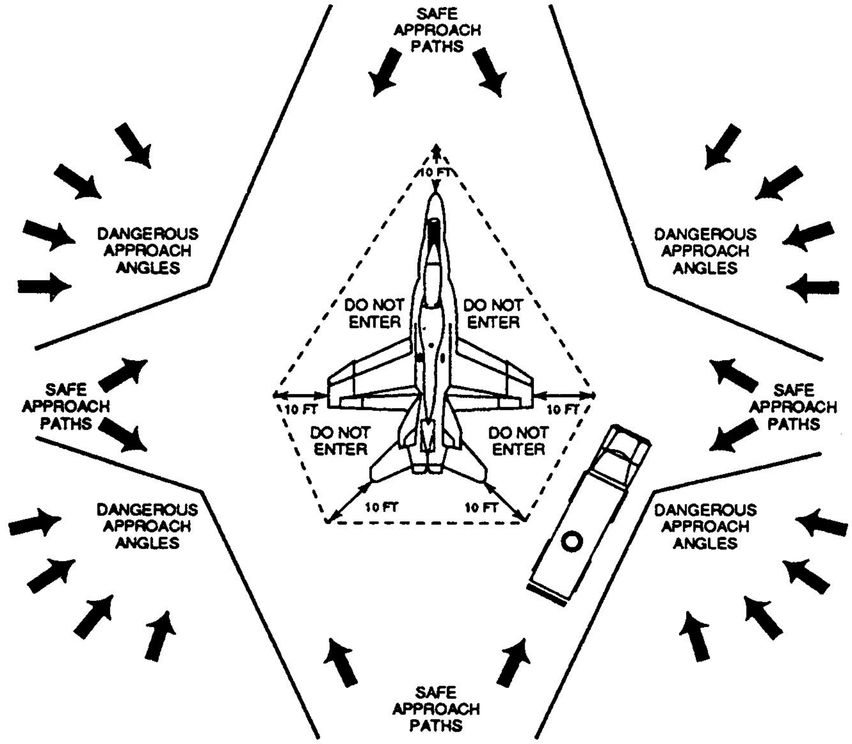


Figure 7-8.—Alternate refueler approach paths.

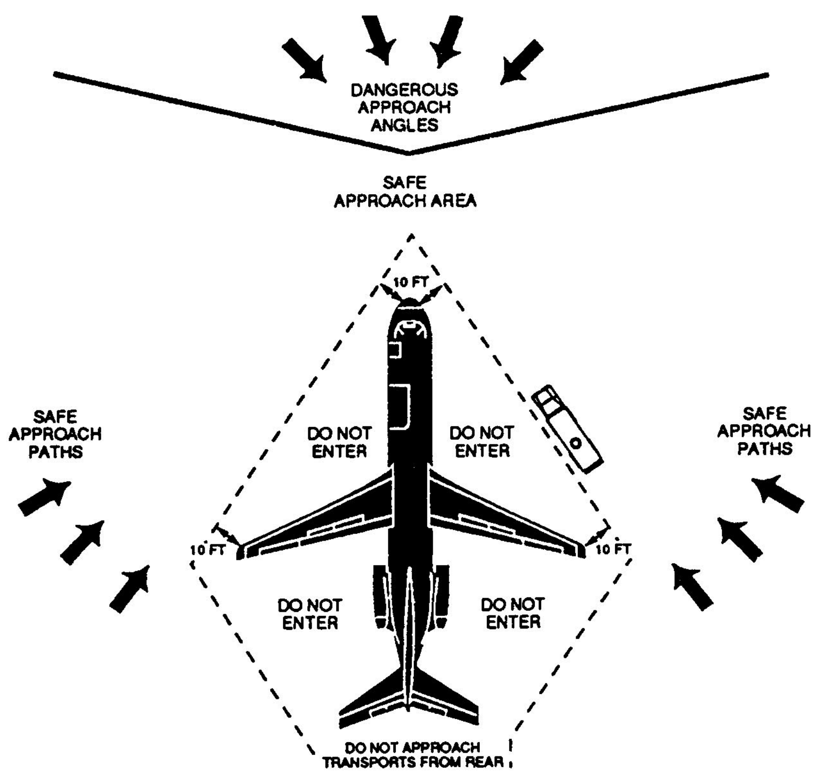


Figure 7-9.—Refueler approach to prop, prop/jet, and transport aircraft.

transport aircraft; figure 7-10 illustrates the alternate approach paths for helicopters. Refuelers must NEVER

- be left pointing toward any part of an aircraft;

- be driven in the area described by straight line projections connecting points 10 feet from an aircraft's extremities (see figures 7-8, 7-9, and 7-10); or

- be backed in proximity to aircraft.

The refueler is parked in a position on the same side of the aircraft as the aircraft's adapter, so that the driver/operator has a direct line of sight to the refueling nozzle operator while actuating the deadman control. Failure of the driver/operator to visually observe the nozzle operator throughout the refueling operation can lead to a fuel spill and fire.

Tailpipe temperature and the location of aircraft tank vents are important considerations when determining alternate routes and fueling positions.

The hose must NOT pass underneath the aircraft's fuselage to reach the aircraft's fueling adapter.

Aircraft refueling with trucks is a three-person function. Required are a nozzle operator (supplied from the squadron, maintenance department, or transient line), a driver/operator (from the fuels division), and a fire extinguisher operator (supplied by the squadron). The nozzle operator assists the driver/operator in removing and replacing the hose on the refueler.

The driver/operator prepares the truck for refueling operations as follows:

1. Recirculate (flush) the truck and take a fuel sample for quality control checks as appropriate. Fuel is recirculated/flushed through the refueling hose and nozzle, then tested for contamination prior to refueling the first aircraft each day. Fueling must NOT begin until acceptable results have been obtained.

2. After a hot-brake check of the aircraft (fixed-wing only) has been performed, drive the refueler into position for refueling, following the approach paths discussed previously. The refueler should be positioned so that it can be driven away quickly in an emergency. Wheel chocks should NOT be used.

3. Set the brakes.

4. Place the gear shift in neutral.

5. Turn off the headlights and unnecessary switches.

6. Open the driver's side door. It remains partially open during the entire refueling operation.

CAUTION

A window in the truck cab must be kept at least partially open whenever the truck is stationary and the engine is running, to prevent the buildup of carbon monoxide inside the cab.

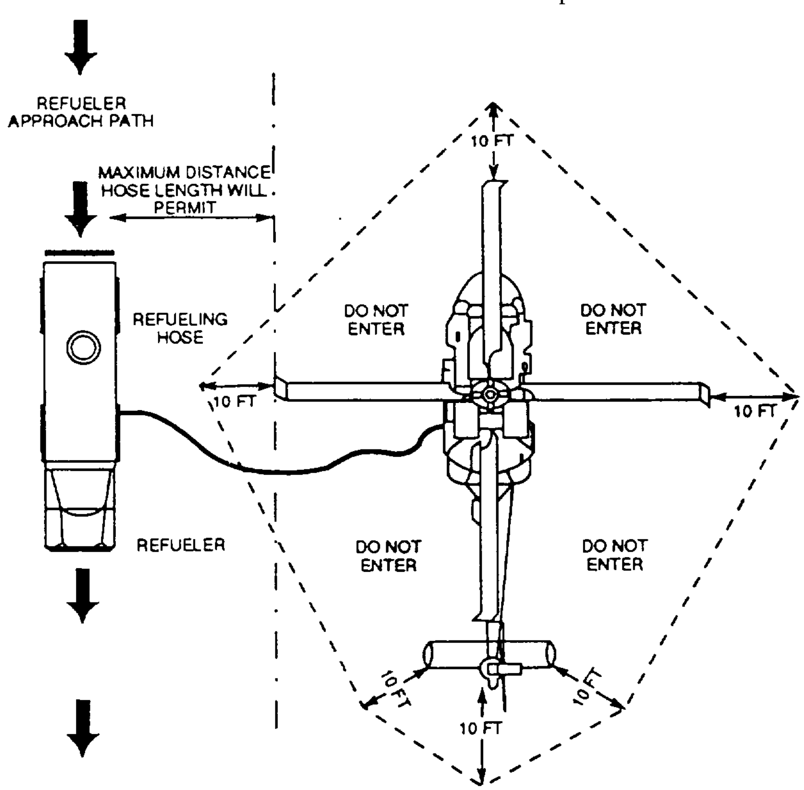


Figure 7-10.—Alternate refueler approach to a helicopter.

When the truck is in position and prepared as above, conduct fueling operations as follows:

1. Secure all electronic and electrical switches on the aircraft that are not required for fueling (plane captain).

2. Verify that manned fire-fighting equipment is in the immediate vicinity and upwind of the refueling operation (refueler operators).

3. Attach the bonding cable between the refueling equipment and the aircraft (plane captain).

4. Pull out the hose (or pantograph) and place it in the proper position for refueling (nozzle operator and refueler operator).

5. Remove the refueling adapter cap from the aircraft, and the dust cover from the pressure nozzle. Inspect the face of the nozzle to make sure it is clean, and verify that the flow-control handle is in the fully closed and locked position (nozzle operator).

6. Visually inspect the aircraft's adapter (receptacle) for any damage or significant wear. A worn or broken adapter can defeat the safety interlocks of the refueling nozzle, permitting the poppet valve to open and fuel to spray or spill.

7. Lift the nozzle by the lifting handles, and align the lugs on the nozzle with the slots on the aircraft adapter. Hook up the nozzle to the aircraft by pressing the nozzle firmly onto the adapter and rotating it clockwise to a positive stop (nozzle operator). The nozzle must seat firmly on the adapter and not be cocked. Cocking can indicate a malfunction of the nozzle's safety interlock system, which could lead to a fuel spray or spill.

8. Zero the refueling meter or the totalizer reading (refueler operator).

9. Rotate the nozzle flow-control handle to the FULL OPEN position. The handle must rotate 180 degrees to ensure the poppet valve is fully open and locked (nozzle operator).

10. Upon receiving signals from the nozzle operator and the plane captain that the hook-up has been completed and that they are ready to begin the fueling operation, the refueler operator actuates the remote, hand-held deadman control.

11. Once fuel flow has been established, test the aircraft's precheck system (plane captain).

12. Fuel the aircraft as directed by the plane captain. The plane captain monitors aircraft vents, tank pressure gage(s), and/or warning lights, as necessary.

13. When directed by the plane captain, release the dead man control (refueler operator).

14. Rotate the nozzle flow-control handle to the OFF and fully locked position (nozzle operator, and verified by the refueler operator).

15. Disconnect the nozzle from the aircraft adapter (nozzle operator).

16. Stow the pantograph or hose (nozzle operator and refueler operator).

17. Complete the paperwork (nozzle and refueler operators).

OVERWING (GRAVITY) REFUELING BY TRUCK

Overwing (gravity) refueling of aircraft from trucks is done using the procedures as above but with the following modifications:

- The overwing nozzle must be bonded to the aircraft via a nozzle bonding cable prior to removal of the filler cap.

CAUTION

OverWing refueling with the aircraft's engines operating (hot refueling) is NOT authorized.

- The overwing nozzle is inserted into the aircraft's refueling port. Metal-to-metal contact between the nozzle and the aircraft fueling port must be maintained during the entire fueling operation.

REFUELER PARKING

All activities require that refueling vehicles be constantly attended whenever the engine is operating. The operator is considered in attendance when performing tasks directly associated with fueling an aircraft; for example, assisting the aircraft refueling operator, transporting the hose. If the operator is to leave his truck unattended, he must first

1. drive the truck clear of the aircraft;

2. place the air brake in ON and LOCKED position, if applicable;

3. set the parking brake;

4. direct the front wheels to an open, unobstructed area;

5. stop the engine; and

6. chock the drive wheels.

FUELING WITH ENGINES OPERATING (HOT REFUELING)

Hot refueling is performed only when operations require rapid turnaround of aircraft, since hot refueling is significantly more dangerous and costly in terms of fuel and manpower expenditures. Only pressure hot refueling is performed.

A minimum of three ground crew personnel are required for each hot-refueling operation. All personnel performing hot-refueling operations must be fully trained and qualified. The usual duties of each of these personnel are listed in the following paragraphs. Local conditions or procedures, however, may require that the duties be distributed differently among the refueling personnel. If the station is configured such that the deadman control operator does not have a direct line-of-sight of both the aircraft pilot and the nozzle operator, a fourth person (refueling coordinator) is mandatory.

Personnel required for hot-refueling aircraft are as follows:

- One station operator. The station operator must be a fully qualified station operator from the local fuels management organization. He or she must be positioned to observe and monitor the entire hot-refueling operation. Duties include actual operation of the deadman control.

- One nozzle operator. The nozzle operator must be a squadron crewmember qualified for aircraft refueling duties related to the specific aircraft type model being refueled. Duties include the performance of necessary aircraft refueling checks, such as the testing of the precheck system and the vent and refueling panel monitoring. The nozzle operator remains at the nozzle throughout the refueling and leaves only to conduct necessary vent checks.

- One fire watch operator. This operator is normally TAD from one of the squadrons being refueled.

- One refueling coordinator (plane captain). The refueling coordinator will be a crewmember of the squadron whose plane is being hot-refueled. The coordinator's primary duties include directing all movements of the aircraft and coordinating hand signals between fuel crew and the pilot. If the deadman control operator has a direct line-of-sight to both the aircraft pilot and the nozzle operator, the refueling coordinator's duties may be performed by either the station operator or the nozzle operator.

Equipment Requirements

The following equipment is the minimum required to conduct hot-refueling operations at shore activities:

One fuel service unit, such as a direct refueling station (pit) or mobile refueler. This unit must possess all of the required features and systems listed earlier in this chapter for systems/facilities that refuel aircraft (filter/separator, fuel monitor, and so forth). The fuel service unit MUST have a completely operational deadman control, which MUST cut off the flow of fuel to the aircraft immediately (within 2 seconds) upon release. Leakage past this valve with the deadman in the released position cannot exceed 1 gallon in 5 minutes.

A pantograph or a minimum of 50 feet of refueling hose. Pantograph fueling arms are preferred, because they are significantly less prone to rupture.

One bonding/grounding cable. Newer direct refueling stations (pits) are designed with the bonding/grounding cable built into the pantograph and along the hose. A separate bonding cable is therefore not needed with these systems. Both the truck and aircraft must be grounded to the earth as well as bonded to each other during hot-refueling operations with trucks.

Aircraft wheel chocks.

Sound-attenuating ear protectors, goggles, cranials, and long-sleeved shirts and pants for each crewmember. Personnel must NOT wear shoes that have nails or other metal devices on the soles of their shoes that might cause sparking.

A fire extinguisher at each relueling station. All ground personnel involved in the hot-refueling operation must be qualified in operating the fire-extinguishing equipment in use.

One emergency dry-break quick-disconnect. This device is attached to the refueling hose near the pantograph (on direct refueling stations) or attachment point to the fuel servicing unit.

Hot-Refueling Procedures

The following must be accomplished before aircraft enter the hot-refueling area:

CAUTION

No nozzle samples are taken after the aircraft has taxied into the designated hot-refueling area. Sampling increases the possibility of a fuel spill.

• The station or mobile refueler must be recirculated (flushed) and fuel sample(s) taken for quality control checks as appropriate (station operator).

• The area must be policed for FOD.

• Ground crew must wear sound-attenuating ear protectors, goggles, and cranials.

CAUTION

Hot refueling must NOT be performed if a hot-brake condition exists.

• Fixed-wing aircraft must be checked for hot-brake condition (plane captain). The hot-brake check is applicable to fixed-wing aircraft only.

• Qualified squadron personnel MUST verify that all ordnance is safed. *Safed* is defined as the replacement of any mechanical arming level, safety pin, electrical interrupt plug/pin; securing of armament switches; and/or any other action that renders any ordnance earned as being safe.

• The aircraft is taxied into the hot-refueling area under the guidance of a qualified aircraft director. The aircraft enters the area so that the refueling receptacle is on the side of the aircraft nearest the pantograph or hose.

CAUTION

The pantograph must be extended a distance sufficient for the emergency dry-break-away device to work properly without the pantograph interfering with movement of the aircraft. See figure 7-11.

— The hose or pantograph must NOT pass underneath the aircraft to reach the nozzle receptacle.

— Refueling must be stopped immediately if any leaks are discovered during the operation.

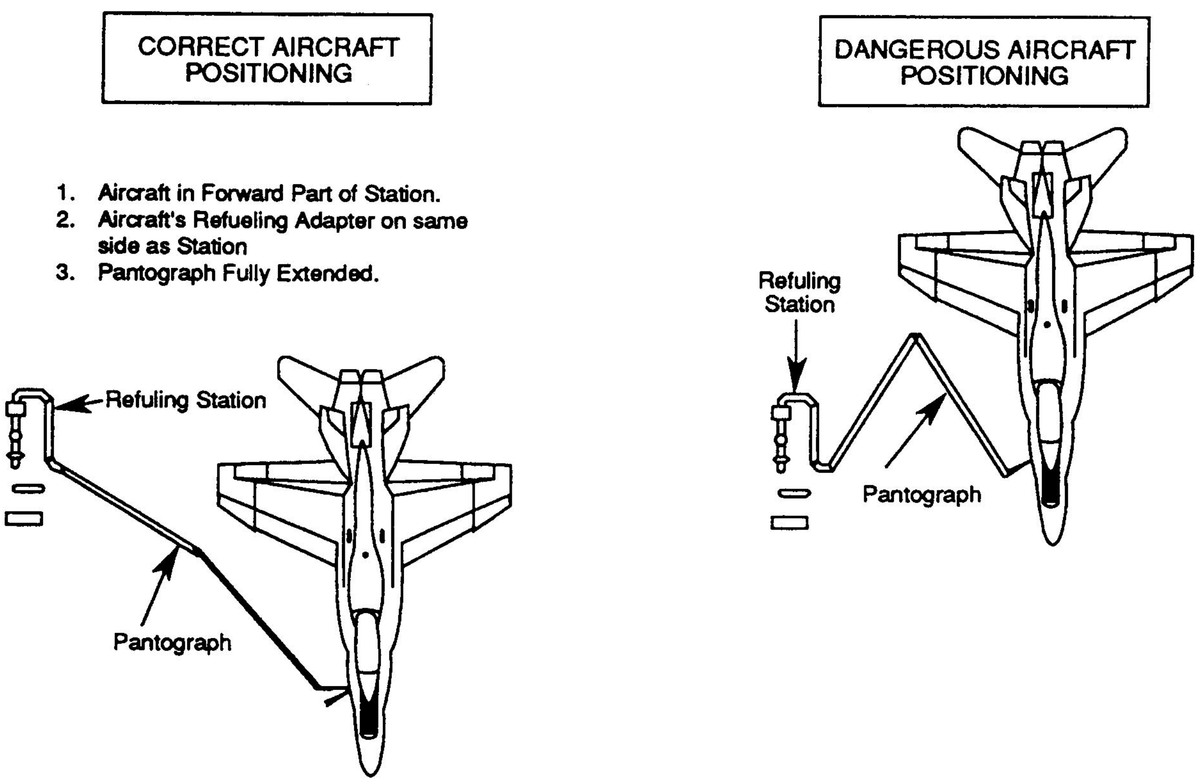


Figure 7-11.—Positioning aircraft for pantograph refueling.

— The deadman control operator must have a direct line-of-sight to the refueling nozzle operator at the aircraft receptacle whenever he or she is actuating the deadman control.

— If either the primary or secondary shutoff-valve test indicates a failure, stop the hot-refueling operation immediately.

— The aircraft canopy remains closed during the entire refueling evolution.

— Both engines on dual-engine aircraft are assumed to be operating. Although some aircraft can, and do, shut down the engine on the side where the refueling adapter is located (F-14), most aircraft currently do not (F-18, A-6).

— Hot refueling of rotary-wing aircraft by mobile refueler without the use of a pantograph is accomplished only with the rotor blades disengaged. Hot refueling by mobile refueler should be avoided whenever possible. refueler operators must be thoroughly checked out and PQS-certified in hot-refueling operations.

• Secure all unnecessary electrical and electronic equipment.

• Verify that manned fire-fighting equipment is in the immediate vicinity of the refueling operation (station operator).

• Attach the bonding cable between the refueling equipment and the aircraft (plane captain). In direct fuel systems (pits), bonding is usually accomplished through the nozzle/hose/pantograph system. If bonding is not accomplished via the nozzle/hose/pantograph system, the bonding connection is made using the grounding receptacle near the aircraft's fueling adapter. If this is not possible. the connection must be to bare metal on the aircraft.

• Pull out the pantograph (or reel out the hose) and place it in proper position for refueling (nozzle operator and station operator).

• Remove the refueling adapter cap from the aircraft and the dust cover from the pressure nozzle. Inspect the face of the nozzle to make sure it is clean, and verify that the flow control handle is in the fully closed and locked position (nozzle operator).

• Visually inspect the aircraft's adapter (receptacle) for any damage or significant wear. A worn or broken adapter can defeat the safety interlocks of the refueling nozzle, permitting the poppet valve to open and fuel to spray or spill.

• Lift the nozzle by the lifting handles and align the lugs with the slots on the aircraft adapter. Hookup to the aircraft by pressing firmly onto the adapter and rotating it clockwise to a positive stop (nozzle operator). The nozzle must seat firmly on the adapter and not be cocked. Cocking can indicate a malfunction of the nozzle's safety interlock system, which can lead to a fuel spray or spill.

• Zero the refueling meter or note the totalizer reading.

• Upon receiving signals from the nozzle operator and plane captain that hook-up has been completed and that the fueling operation is ready to begin, the station operator actuates the remote, hand-held, deadman control.

CAUTION

The deadman controls must NOT be blocked open or overridden in any way. This defeats the purpose of the device and can lead to a catastrophic accident.

Once a fueling evolution has commenced, the aircraft's electrical power status and connections must not be changed until the evolution has been completed or refueling has been stopped for an emergency. NO aircraft engines or auxiliary power units can be started or stopped, and external power CANNOT be connected, disconnected, switched on or off. Changing the aircraft's electrical power status can create significant ignition sources.

• Rotate the nozzle flow-control handle to the FULL OPEN position. The handle must rotate 180 degrees to make sure the poppet valve is fully open and locked (nozzle operator). The flow-control handle of the single-point pressure refueling nozzle is-placed in either of two locked positions: fully open or fully closed. The handle is NOT to be used as a flag to indicate fuel flow.

Excessive wear on the aircraft adapter and the fuel nozzle poppet will result if the handle is allowed to float in the unlocked position.

- Once fuel flow has been established, test the aircraft's precheck system (qualified squadron personnel).

- Fuel the aircraft as directed by the plane captain. The plane captain monitors aircraft vents, tank pressure gage(s), and/or warning lights as necessary.

- When directed by the plane captain, release the dead man control.

- Rotate the nozzle flow control handle into the OFF and fully locked position (nozzle operator, and verified by the station operator). Failure to lock the flow control handle in the OFF position might result in a fuel spray or spill.

- Disconnect the nozzle from the aircraft adapter (nozzle operator).

- Stow the pantograph or hose (nozzle operator and station operator).

- Complete the paperwork (nozzle and station operator).

- Make sure the area is clear of equipment and personnel.

MULTIPLE-SOURCE REFUELING

Normally only one refueling truck at a time is used to service aircraft. However, there are situations when multi-truck or truck and hydrant servicing is considered desirable, especially when very large aircraft must be refueled. The advantage of multiple-source refueling is reduced aircraft turnaround time. The aircraft's NATOPS manual or equivalent aircraft servicing manual should be consulted for specific guidelines and instructions on multiple-source refueling before such operations are performed.

PIGGYBACK REFUELING

Piggyback refueling is a special refueling process sometimes used to refuel very large aircraft such as C-5As or E-6As. Two or more refueling trucks are used. One truck is attached to the aircraft's refueling adapter, and other trucks are used to refuel this truck while it continuously refuels the aircraft, This is a potentially dangerous operation and will be conducted only with properly configured vehicles and under the direct supervision of the Fuels Maintenance Officer.

REFUELING AIRCRAFT WITH AUXILIARY POWER UNIT (APU) RUNNING

The aircraft's APU may be used to supply electrical power for pressure refueling on military aircraft so equipped. This operation is not considered "hot refueling." However, the following precautions are observed in addition to the normal refueling procedures:

One man remains outside the aircraft within 10 feet of the APU exhaust with a fire extinguisher of the size specified by the station's Fire Chief.

The fuels operator verifies that the aircraft is grounded.

One person is at the GTC controls in the cockpit.

Communications are established between the cockpit and the personnel performing the refueling, to ensure immediate shutdown in an emergency.

Personnel near the aircraft must wear sound-attenuating ear protectors.

DEFUELING AIRCRAFT

As was stated in chapter 5, defueling is one of the most technically demanding and potentially dangerous operations performed by fuels personnel. The following rules apply to every defueling operation performed on shore stations:

1. Aircraft defueling must be requested by an authorized representative of the squadron's CO, using an Aircraft defueling Certificate similar to the one

shown in figure 7-12. The Fuels Maintenance Officer of each activity maintains a list of these officially designated personnel. This list is updated at least quarterly.

2. During defueling operations, maintenance not directly required to facilitate the defueling operation is NOT to be performed.

3. Aircraft will be spotted 100 feet from all structures and other aircraft. Grounding and tiedown padeyes must be available. In addition, at least one fire extinguisher must be available in the immediate vicinity of the operation.

4. Only defueled aviation turbine fuel can be reissued to aircraft. All defueled AVGAS is downgraded and not used as aviation fuel.

5. Suspect aviation turbine fuel must be removed from the aircraft using a defueler only (not a refueler/defueler) and deposited in a designated holding tank. Ultimate disposition will depend on the results of later laboratory tests. Every effort should be made to reclaim off-specification fuel as JP-5, F-76 or fuel oil reclaimed (FOR).

6. All fuel removed from turbine engine aircraft is assumed to be a mixture of JP-4 and JP-5. Defueled turbine fuel must not be returned to JP-5 storage tanks without first confining the flash point of the fuel to be 140°F or higher.

7. Fuel containing leak-detection dye can be reissued to aircraft of the same squadron as long as the squadron's requesting official signs a statement that the fuel is nonsuspect and is safe for use.

NOTE

Refuelers/defuelers may be used to defuel dyed fuel. However, this may present logistics problems since it may take several loads of fuel to flush the dye out of the refueler/defueler. The fuel may appear off-color when sampled prior to issue to another squadron's aircraft.

8. The Fuels Maintenance Officer will personally decide the disposition of all defueled products.

9. The defueling unit is required to maintain a flooded suction above the anti-vortex splash plate in its tank to minimize turbulence and possible ingestion of air. Historically, a minimum of 1,000 gallons has been required in the defueling unit to resolve turbulence and air ingestion problems. Because of the wide variety of configurations of pump piping systems and tank sizes, 1,000 gallons of product mayor may not be enough. It is up to the local commands to determine the minimum amount by using manufacturers' technical manuals and historical data.

10. The valve(s) that control the flow of fuel from the tank to the upstream side of the pump remain closed during defueling operations. This is to prevent the recirculation of product in the tank. The valve(s) may be opened to prime the pump only when the pump is not operating.

11. If, during the defuel operation, the pump starts to lose prime or cavitates, the operation must be discontinued until the problem is resolved and the fuel supervisor authorizes a restart. At no time will a restart be authorized without waiting a minimum of 1 MINUTE to allow relaxation of any static charges.

12. At no time will defueler tank tops be opened during defueling operations.

13. Every aircraft defueling operation requires a minimum of three personnel: the defuel truck operator (supplied by the fuel division), a nozzle operator (supplied by the squadron), and a fire watch (supplied by the squadron).

14. A special log of each defueling operation is maintained. The following minimum information is contained in the log:

a. Complete list of all squadron personnel authorized to sign defuel request forms. This list must be updated at least quarterly.

b. All abnormal happenings.

c. Aircraft buno number.

d. Defueler number.

e. Grade of product.

f. Amount of product actually defueled.

g. Scheduled amount to have been defueled.

h. Disposition of product.

i. Times when the defuel operation was started and completed.

j. Names of the defueler operator and squadron personnel present during the defuel operation.

AIRCRAFT DEFUELING CERTIFICATE

PART I [to be completed by person authorizing the defuel operation (person's name shall be on file with the fuel officer).]

I CERTIFY THAT THE AVGAS/TURBINE FUEL (cross out one) TO BE DEFUELED FROM AIRCRAFT NUMBER ______________________:

- ☐ WOULD NOT PREVENT THE RELEASING OF THIS AIRCRAFT FOR FLIGHT.
- ☐ IS SUSPECT OF CONTAMINATION WITH ______________________ ______________________
- ☐ CONTAINS DYE BUT WOULD NOT PREVENT THE RELEASING OF THIS AIRCRAFT FOR FLIGHT. REISSUE DYED FUEL TO AIRCRAFT NUMBERS ______________________ AND ____________.

THE ESTIMATED GALLONS TO BE DEFUELED ARE: ______________________

THE REASON FOR DEFUELING IS: ______________________

____

Signature	Title	Date

PART II [to be completed by operator after completion of defueling operation.]

METER READING: ______________________

VOLUME OF FUEL REMOVED FROM AIRCRAFT: ______________________

Signature	Title	Date

Figure 7-12.—Aircraft Defueling Certificate.

Defueling Procedures

Aircraft defuelings are to be performed in the following sequence:

1. Prior to starting the defuel operation, take samples of the fuel to be defueled from the aircraft's drains and visually inspect them for contamination (qualified squadron personnel under the observation of the driver/operator).

2. Determine the status of the fuel, that is, suspect or nonsuspect (defuel truck operator). The person requesting the defueling operation will confirm that the fuel is or is not suspect. Fuel is considered suspect if the aircraft has malfunctioned and the fuel is believed to have contributed to the problem or the fuel is thought to be of the wrong type.

3. Determine the amount of fuel to be removed from the aircraft (defuel truck operator). Again, the squadron personnel requesting the defueling operation will provide this estimate as part of the official request.

4. Select the defueling equipment to be used, that is, defueler for suspect product or refueler/defueler for nonsuspect fuel (FMO and station operator). Always check the remaining capacity of the defueler or refueler/defueler to make sure there is adequate room to hold the fuel being defueled. In addition, remember that sufficient fuel must be in the defueling tank to maintain a flooded suction above the anti-vortex splash plate.

5. Position the defueler (defuel truck operator).

6. Verify that the aircraft is spotted properly (all personnel).

7. Check for possible sources of ignition (all personnel).

8. Verify that the defueling request chit corresponds to the instructions from the dispatcher (defuel truck operator).

9. Connect the bonding wire from the defueler to the aircraft (defuel truck operator).

10. Unload, position, and connect the defuel hose to the aircraft and the defueling stub on the defueler (plane captain).

11. Start defueling upon signal from the nozzle operator (defuel truck operator).

12. Adjust the valve downstream of the pump to optimize the defuel rate. Maximum defuel rate is 100 gpm (defuel truck operator). When nearing completion of the defuel process, very close attention should be paid to the defuel rate to prevent pump cavitation and/or loss of prime. Discontinue defueling of an aircraft if pump cavitation is a persistent problem.

13. Upon completion of the defuel operation, secure all equipment and CHECK THE AREA FOR FOD (all personnel).

Disposition of Nonsuspect Fuel Removed From Aircraft

All USN and USMC aircraft are authorized to use JP-4, JP-8, commercial JET A and JET A-1, as well as JP-5 fuel. Fuel removed from a USN or USMC aircraft will contain mixtures of these fuels, and the specific grade of fuel will be impossible to determine without extensive specification testing. USA and USAF aircraft also may contain such mixtures. Therefore, fuel in any properly operating DOD aircraft with turbine engines that is NOT suspect of being contaminated can be defueled into a designated refueling vehicle and then used to refuel any aircraft with the user's knowledge and permission.

First preference will be given to using the fuel to load an aircraft in the same squadron as that from which the fuel originated. Second choice will be to issue the fuel to aircraft having engine fuel controls that automatically compensate for fuel density changes. Aircraft with T-56 engines, such as the P-3 and E-2, should be preferentially used since these engines are the most tolerant to such fuel changes. In addition, the following roles apply to reissuing defueled fuel:

1. Since fuel removed from any aircraft almost definitely has a flash point below 140°F, it must NOT be used to refuel any aircraft scheduled for immediate sea duty.

2. Any designated defuel or refuelers must pass their fuel through filter/separators and fuel monitors before reaching the aircraft.

3. The FSII content of defueled turbine fuel must be checked using the FSII refractometer prior to refueling S-3 and SH-60 USN aircraft and all U. S. Army and U.S. Air Force and foreign aircraft.

Nonsuspect fuel that has been dyed for the detection of aircraft fuel system leaks also can be used in aircraft provided the above procedures are followed. Nonsuspect fuel removed from piston engine aircraft can also be reissued provided

1. the fuel is a known grade (80/87 or 100/130), and

2. it is properly filtered before reissue.

Disposition of Suspect Fuel Removed From Aircraft

Fuel removed from any aircraft that has recently experienced engine or airframe fuel system problems possibly related to fuel quality must be segregated by collecting in a designated defueler, a clean storage tank, or any container as "salvage fuel." It must then be sampled and tested to determine if it is in conformance with the deterioration use limits. If the fuel tests within the established limits, it can be returned to station storage and reissued as the grade and type determined providing adequate filtration and water separation can be accomplished prior to dispensing the fuel.

Aviation turbine fuels that do not meet the requirement specified previously generally cannot be downgraded for any aircraft use. Questions concerning the use or disposition of fuel not meeting the deterioration use limits should be referred to the Naval Petroleum Office.

PRODUCT RECEIPT

Barge or tanker receipt of product requires planning. The Fuel Maintenance Officer must post written orders designating the following:

1. Pier preparation and inspection
2. Pipelines to be used
3. Number and sizes of hoses to be connected
4. Tanks into which cargo is to be received
5. Pumphouses and pumps to be operated
6. Number of samples and location where samples are to be taken
7. Tests required
8. Communications to be used
9. Personnel assignments
10. Preparation of the "Declaration of Inspection" (an Environmental Protection Agency requirement in the 33 Code of Federal Regulations administered by the Coast Guard).

The activity instruction covers standard operating procedures for the following:

1. Filling of lines before the barge is docked
2. Notification to start unloading
3. Unloading speed
4. Line patrol and gage check
5. Changing tanks
6. Change in pump operation
7. Barge stripping procedure and stripping speed
8. Final inspection of barge tanks
9. Draining pier lines
10. Personnel manning level
11. Personnel training requirements
12. Special clothing requirements
13. Fuel sampling and testing requirements

Pipeline receipt of product requires essentially the same planning as barge receipt, and a written order is required. Some pipeline operations, however, are relatively simple and, therefore, require minimum personnel.

Incoming tank trucks and tank cars of aircraft fuel might arrive separately or in groups. All must be sealed at the source of supply. Unloading of tank trucks requires approximate y 1/2 hour and is a two-man operation. Tank cars are usually left on a siding or in place for the offloading operation. The following procedures apply to both tank truck and tank car receipt:

1. Ensure that the seals are intact.

2. Verify that seal numbers are identical to those on the shipping document.

3. Verify the specification and grade number of the product on the shipping document.

4. Make sure the fuel level coincides with the marking on the tank and the quantity on the shipping document.

5. Take a bottom sample from each compartment, first drawing off water if present.

6. Make a visual inspection of samples.

7. Unload the product into a segregated storage tank.

8. Check the vehicle's tank interior after delivery.

9. Upon completion of fuel receipt (multiple tank car or truck loads), sample the storage tank and perform quality control tests.

CHANGE OF PRODUCT IN AIRCRAFT REFUELERS

Change of product in mobile refuelers is performed according to table 7-2. Product used to flush tanks and piping MUST be treated as contaminated fuel. Samples must be visually inspected for sediment and water, and the specific gravity of each must check within 0.5 of the corrected API of the appropriate product in storage.

Change of Product in Storage Tanks

The Naval Petroleum Office must be contacted concerning instructions for the change of product grade in storage tanks.

ASHORE AVIATION FUELS SAFETY

LEARNING OBJECTIVE: Describe the safety requirements and procedures that must be followed during fueling operations ashore.

This section contains safety procedures and requirements that either are general in nature and therefore not covered in other chapters of this manual or are extremely important and repeated here for emphasis. Any departure from the procedures of this section may adversely affect the overall safety of the operation being performed.

Although the procedures and requirements contained in this manual are as complete as possible, they are no substitute for experience and a thorough knowledge of aviation fuels and their inherent

TO→ FROM ↓	AVGAS LOW GRADE	AVGAS HIGH GRADE	JP-4	JP-5	JP-8
AVGAS LOW GRADE	N.A.	C	C	C	C
AVGAS HIGH GRADE	A	N.A	C	C	C
JP-4	B	B	N.A.	D	D
JP-5	B	B	A	N.A.	A
JP-8	B	B	A	B	N.A.
MOGAS	B	B	C	C	C
KEROSENE	B	B	B	B	B
DIESEL	B	B	C	C	C

Table 7-2.—Change of Grade Procedures for Aircraft Refuelers

LEGEND:

A. Drain, fill with desired product.

B. Drain, flush 300 gallons (600 gallons if total filter/separator capacity is 600 gpm) of desired product, drain, fill with desired product. recirculate, sample and test. Pay particular attention to sumps, pumps, filters, hoses and other components likely to trap quantities of liquid.

C. Drain, steam clean, and dry. Remove fuel from all refueling system components—that is, sumps, pumps. filters, hoses, and piping—prior to initiating steam cleaning. Replace the filter separator and monitor elements.

D. Drain, gas-free, and fill with desired product.

characteristics and dangers. The better you, as an ABF, know and understand aviation fuel hazards, the better you will be at avoiding, or correcting, unsafe situations.

REDUCING ELECTRO-STATIC CHARGES

One of the primary sources of ignition is static electricity. To ensure the safe relaxation of static charges relevant to fuel operations, all activities must do the following:

Prohibit the top loading or splash filling of any fuel trucks or tanks.

Refill filter/separator slowly or monitor vessels whenever they have been drained.

Keep tanks free of foreign objects, such as small conductive objects that can be floated by foaming fuel, thereby becoming an unbonded charge collector. This does not prohibit suspending thermometers or samplers in tanks. However, these devices must be removed prior to any receipt.

Always electrically bond the refueling equipment to the aircraft or truck into which the fuel is being loaded.

Earth (ground) the aircraft and the refueling vehicle whenever refueling operations are conducted on any surface other than concrete, such as asphalt and plastic-coated surfaces. Earthing is also required for all hot-refueling operations and when refueling U.S. Air Force aircraft.

Check the electrical resistance of pressure nozzles monthly.

Bond overwing (gravity) refueling nozzles to the aircraft, using a separate bonding pigtail before tank's caps are removed.

Attach bonding cables to aircraft, using plug and jack method whenever available.

Inspect bonding and grounding cables, clamps, and plugs daily.

Check the electrical resistance of cables monthly.

Never conduct fuel operations during an electrical storm .

Remove refuelers from aircraft parking areas during electrical storms.

Require fuel personnel to wear non-static-producing clothing, such as cotton.

ELIMINATING OTHER SOURCES OF IGNITION

To prevent or eliminate other sources of ignition, activities must ensure the following:

Never allow fuel personnel to wear shoes that have nails or other metal devices on the soles.

Advise fuel personnel not to carry or wear loose metal objects, such as knives or keys.

Check the exhaust piping on mobile refuelers daily to ensure that holes, cracks, or breaks do not exist.

Never permit smoking, spark- or flame-producing items, open flames, or hotwork within 50 feet of any refueling operation.

Defer all repair work on fueling equipment during fuel-handling operations.

Except approved safety lights for use in hazardous locations, do NOT introduce lights into any compartment or space where fuel or flammable vapors may be present.

Do NOT allow fuel personnel to carry "strike anywhere" matches or cigarette lighters.

Be certain that no repair or maintenance work is being conducted on the aircraft before starting the refueling or defueling operation.

Be certain that LOX operations are not being performed and that LOX-handling equipment is not located within 50 feet of fuel operations.

Be certain that aircraft radar and all unnecessary radio equipment is switched off before refueling or defueling is begun.

Do NOT conduct aircraft fuel-handling operations within 300 feet of ground radar equipment.

Equip all internal combustion engines operated within 50 feet of fuel-handling operations with spark-arresting-type mufflers.

Do not start or stop any engine, regardless of its configuration, within 50 feet of a fueling or defueling operation. This prohibition includes aircraft being serviced and adjacent aircraft, as well as ground support equipment. The starting or stopping of an engine within 50 feet of a fueling or defueling operation is sufficient cause for the operator to immediately shutdown the fuel pump.

Open valves slowly to reduce or prevent any splashing in tanks.

Conduct overwing refueling only as a last resort and then only if of operational necessity or if aircraft design dictates.

Hold hot-refueling operations to the absolute minimum possible. Cold refueling operations are inherently safer and are preferred to hot refueling.

REDUCING AND CONT ROLLING VAPOR GENERATION

To help prevent fires by reducing or controlling vapor generation, activities must ensure the following actions:

1. Do NOT handle aviation fuel in open containers.

2. Do NOT refuel, defuel, or drain aircraft or conduct fuel-handling operations in a hangar or confined area except for the removal of water and the extraction of samples from aircraft low-point drains. This does not apply to structures specifically designed for these operations.

3. Keep all fuel containers, such as aircraft fuel tanks or filters, closed except when necessary to open for actual operation or maintenance.

4. Avoid spilling fuel during fuel-handling operations.

5. Take immediate action to clean up any spill that occurs.

6. Properly dispose of oily waste or rags immediately after using.

7. Never drive or move a refueler or defueler with a leak in the tank, piping, or other equipment.

8. Report all leaks in any portion of the fuel-handling facilities to the FMO.

9. Treat empty or apparently empty carts or containers that formerly held aircraft fuels as though they still contain fuel. These containers will still contain vapors and are dangerous for many days after they have been emptied.

10. Be aware that fuel vapors are heavier than air and will collect in low places, such as pits, sumps, and open sewers.

11. Never dispose of waste fuel in storm water or sanitary sewer systems.

12. Never top load or splash fill tanks. (This does not prohibit overwing refueling of aircraft that are solely configured for this operation).

13. Keep all equipment and work areas neat, clean, orderly, and in good mechanical condition.

14. Make sure fire-fighting equipment and extinguishers are in good condition and readily available.

15. Never use gasoline or jet engine fuel as a cleaning agent.

EXTINGUISHING FIRES

Although the Air Station's Crash Crew has prime responsibility for firefighting, all fuel-handling personnel should be aware of the basic principles involved in extinguishing fires, as well as the equipment used. They also should make certain that appropriate fire-fighting equipment, in good condition, is readily available whenever and wherever fuel-handling operations are being conducted. All refueling personnel will receive flightline fire-fighting training initially and annually thereafter.

MINIMIZING HEALTH HAZARDS

Not only must aviation fuels be handled with caution because of the obvious dangers associated with possible fires and/or explosions, the materials themselves present a danger to the health of fuel-handling personnel. These dangers are equally important as those of fires and explosions even though they are not so well known.

To minimize health dangers, fuel-handling personnel must take the following actions:

Avoid entering enclosed areas where fuel vapors are present.

Keep to an absolute minimum the amount of time spent breathing fuel vapors. Good ventilation of work spaces is essential.

Stay on the windward, or upwind, side of a spill if you must remain in an area where a large spill has occurred.

Stay on the windward, or upwind, side when conducting fuel-handling operations where the formation of vapors is unavoidable, such as at a truck fill stand.

Stop the fuel-handling operation and move to a fresh air location immediately if you feel dizzy or nauseated.

Avoid skin contact with liquid fuels and tank water bottoms that can contain a high concentration of FSII. If fuel or water bottoms do contact the skin, wash with soap and water immediately.

Never wash hands in gasoline or jet engine fuels.

Remove fuel-soaked clothing or shoes at once.

Wear eye protection and clothing that leaves a minimum amount of skin exposed during refueling operations. This will help reduce bums in a fire.

Only use footwear that completely covers the feet to provide protection against fuel spills and fires. Shoes made of fabric or other absorbent materials are not acceptable.

CONFINED SPACES

Personnel entering or working in or around confined spaces who are exposed to fuels and fuel vapors might encounter hazards such as

- the lack of sufficient oxygen,
- the presence of flammable or explosive vapors, or
- the presence of toxic vapors and materials.

These hazards may not always be readily apparent, detectable by odor, or visually obvious to persons entering or working within such spaces. Therefore, all confined or enclosed spaces such as fuel tanks, refueler/truck tanks and unvented deep pits (more than 5 feet) must be well-ventilated and tested prior to entry. Poorly vented or unvented pump rooms, storage areas, and unvented shallow pits (under 5 feet) must be surveyed to determine steps necessary for gas-freeing or designation as a safe work environment.

To reduce risk, fuel-handling personnel ensure the following:

1. NEVER enter a tank or equipment that has contained any fuel until all safety precautions have been followed, and then only with experienced, knowledgeable supervision present.

2. Always use a blower-type mask or positive pressure hose mask, boots, and gloves if you must enter a confined area where fuel vapors may be present.

3. Employ the buddy system when entering deep unvented or poorly vented pits—that is, low-point drain pits.

SUMMARY

In summary, it is noted that the fueling operations ashore or afloat are similar. The functions are basically the same, but the problems are a little different. Many of these problems are made more acute, because of the sprawling area covered by fuels operations ashore and the many chances for introducing foreign or contaminating materials into the fuel.

Some of the problem areas that require special attention from senior ABFs are quality surveillance; the close supervision and training of new personnel; an effective training program; preventive maintenance and proper use of equipment; cheerful cooperation with civilian personnel of the fuels division; and good management practices within the division.

CHAPTER 8

ADMINISTRATION

As the saying goes, "No job is complete until the paperwork is done." This holds true for the ABF. Additionally, often you need more information before you can even start a task.

There is no way you can remember every specification, instruction, rule, or requirement. The further you advance, the more you are required to know. The key to not being overwhelmed by this required knowledge is to learn as much as you can, *but always know where to get the information you need.*

This chapter will cover technical/maintenance manuals, instructions, reports, and logs. We will discuss their purposes, how they are kept current, and where they are found.

TECHNICAL/MAINTENANCE MANUALS

Technical/Maintenance Manuals are the sources of information for guiding naval personnel in the operation and maintenance of all equipment within the Naval Establishment. The manuals are divided into two major types: operational and maintenance.

Operational manuals are publications and other forms of documentation that contain a description of systems and instructions for their effective use. An example of an operational manual is the *Aircraft Refueling NATOPS Manual,* NAVAIR 00-80T-109 (fig. 8-1).

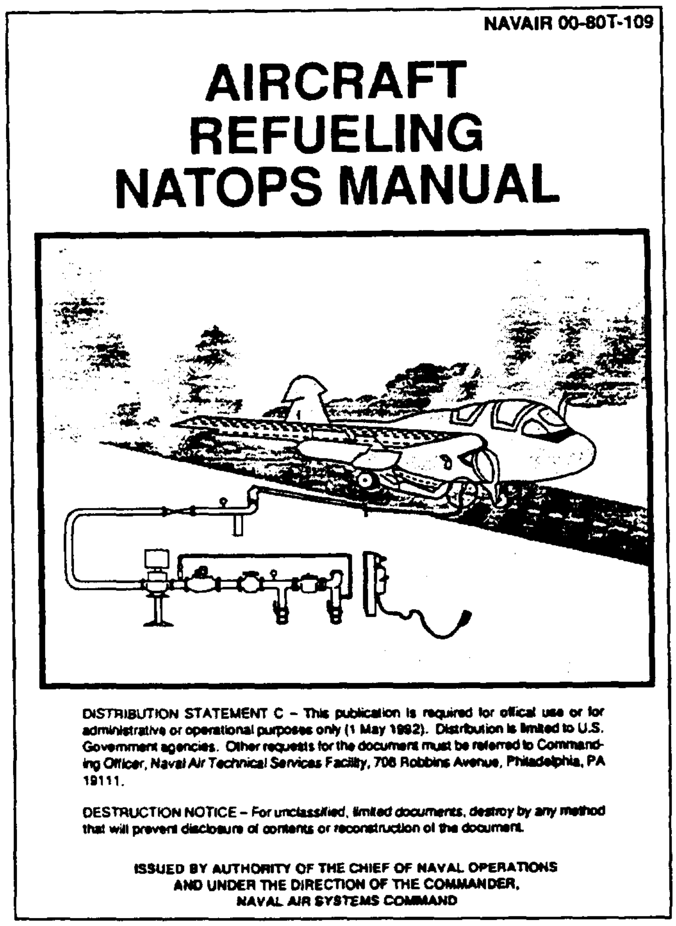
Maintenance manuals are documents containing a description of individual systems for the purpose of

TECHNICAL LIBRARY

A technical publications library serves two important functions. First, it provides a central source of up-to-date information for the use of all personnel in the performance of their work. Second, it is an excellent source of reference information to help in the training of personnel. To perform these functions properly, the library must contain at least one copy of all publications affecting the equipment the division is responsible for.

Typically, the technical library is located in the division office or maintenance office. Management of the library should be assigned to a senior individual who will ensure that all required publications are on board and that all updates and changes are made to the affected publications.

Often, individual workcenters will keep the publications normally used by the workcenter. This is acceptable. However, the technical library manager should maintain a list of all publications held in a workcenter so that those manuals also will receive updates and changes when required. A technical manual used to rebuild a pump is worthless if updated changes are not made and entered on the Record of Changes.



NAVAIR 00-80T-109

AIRCRAFT REFUELING NATOPS MANUAL

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Figure 8-1.—Aircraft Refueling NATOPS Manual.

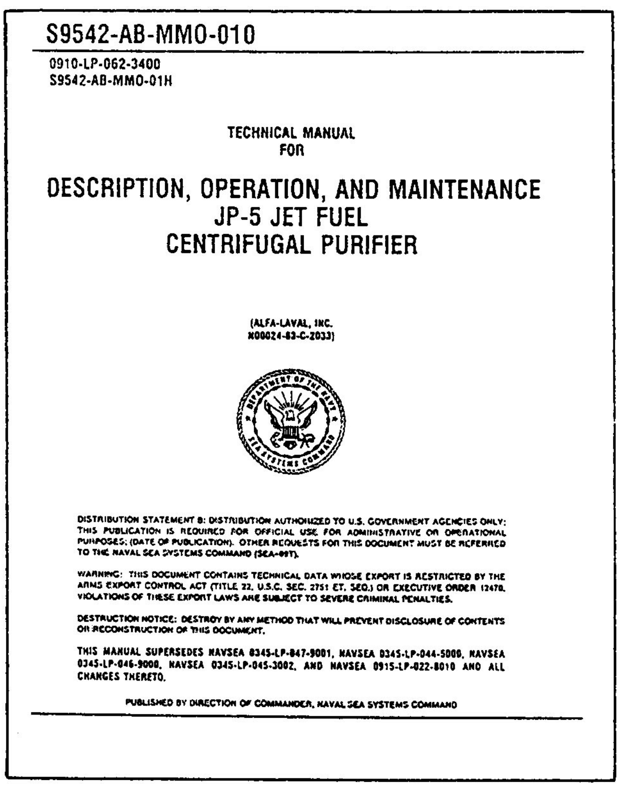
maintenance and repair. An example of a maintenance manual is the *Technical Manual for Description, Operation, and Maintenance of the JP-5 Jet Fuel Centrifugal Purifier,* NAVSEA S9542-AB-MMO-010 (fig. 8-2).

By proper use of these publications, all equipment can be operated and maintained in the same efficient manner throughout the Navy.

Technical/Maintenance manuals do not contain detailed descriptions or procedures concerning preventive maintenance, since this information is contained on maintenance requirement cards (MRCs). For information on the 3-M System, consult OPNAVINST 4790.4 (series), *Ship's Maintenance Material Management Manual.*

Technical/Maintenance Manuals do contain the following:

- A description of the equipment
- The theory of operation
- Troubleshooting techniques
- Corrective maintenance information
- Specific safety requirements
- Parts breakdown and numbers
- Sketches, diagrams, and schematics
- Operating and design limits



S9542-AB-MMO-010

0910-LP-062-3400
S9542-AB-MMO-01H

TECHNICAL MANUAL
FOR

DESCRIPTION, OPERATION, AND MAINTENANCE
JP-5 JET FUEL
CENTRIFUGAL PURIFIER

(ALFA-LAVAL, INC.
N00024-83-C-2033)

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PUBLISHED BY DIRECTION OF COMMANDER, NAVAL SEA SYSTEMS COMMAND

Figure 8-2.—JP-5 Centrifugal Purifier Technical Manual.

Senior petty officers must be able to interpret technical publications and to supervise their use. The senior ABF also must know how to obtain technical publications and how to keep them up-to-date.

Many technical publications issued by the Naval Air Systems Command are of interest to the ABF. The General Information and Servicing section of the Maintenance Instructions Manual for each type of aircraft covers the required procedures for refueling the aircraft. Mobile refuelers and aircraft-handling equipment are covered by other Naval Air Systems Command publications.

Technical publications issued by the Naval Sea Systems Command cover most of the shipboard equipment used by the ABF. The fuel system for each ship is covered in a Ship's Information Book (SIB), The SIB for the ship to which the ABF is attached should be studied thoroughly. Also, each major component is covered by a Technical/Maintenance Manual issued by the Naval Sea Systems Command.

INSTRUCTIONS AND NOTICES

The Navy Directives System is used throughout the Navy for the issuance of nontechnical directive-type releases. These directives establish policy, organization, methods, or procedures. They require action to be taken or contain information affecting operations or administration. This system provides a uniform plan for issuing and maintaining directives. Conformance to the system is required of all bureaus, offices, activities, and commands of the Navy. Instructions and Notices are the two types of authorized releases.

Information pertaining to action of a continuing nature is contained in "Instructions." An Instruction has permanent reference value and is effective until the originator supersedes or cancels it. "Notices" contain information pertaining to action of a one-time nature. A Notice does not have permanent reference value and contains provisions for its own cancellation.

For identification and accurate filing, all directives can be recognized by the originator's abbreviation, the type of release (whether an Instruction or a Notice), a subject classification number, and in the case of Instructions only, a consecutive number. Because of their temporary nature, Notices are not assigned consecutive numbers. This information is assigned by the originator and is placed on each page of the directive.

Don't let the word instruction fool you. It may sound like something clerical, but instructions and notices provide us with a tremendous amount of information, and some instructions can be quite large, such as the previously mentioned OPNAVINST 4790.4 (series), *Ships' 3-M Manual* (fig. 8-3).

MAINTAINING AN ALLOWANCE OF PUBLICATIONS

There are four mandatory requirements to be met in maintaining an allowance of publications (technical and otherwise). These requirements are the following:

- The prescribed publications be on board

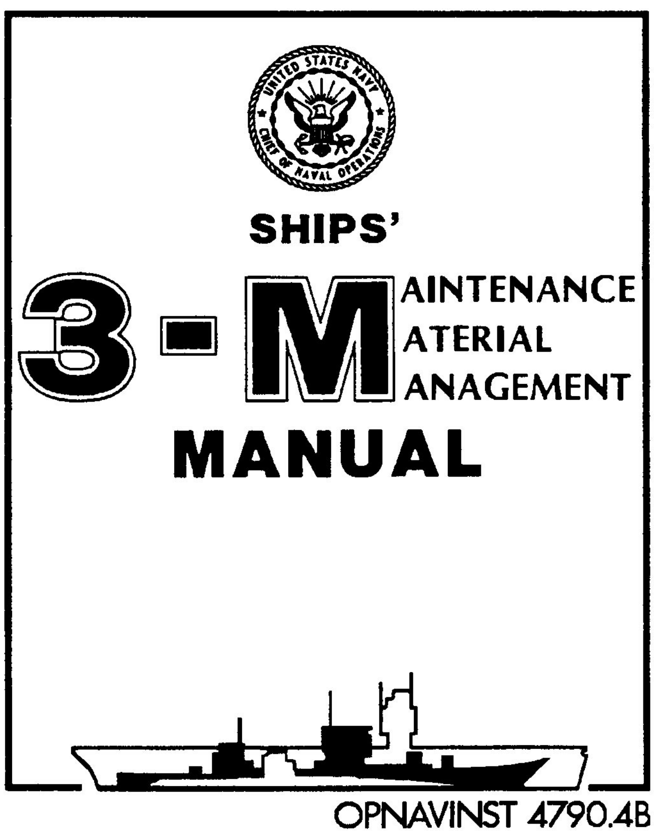

Figure 8-3.—Ships' 3-M Manual.

- The publications be maintained up to date

- The publications be ready for immediate use

- Applicable security provisions be observed

The primary index used to order all Navy technical manuals and forms is the *Navy Stock List of Publications and Forms,* NAVPUBFORMCEN Pub. 2002.

MAKING CHANGES TO PUBLICATIONS

Most changes to publications are issued in the form of loose-leaf pages, pen-and-ink changes, or complete revisions. When changes are issued in numbered pages, the old page with the corresponding number is removed and the new replacement page inserted in its place. Specific instructions are normally given with each change on the method to be used in incorporating the change. Changes should be made immediately upon receipt.

A checklist of pages, which are to remain in the publication after the changes have been incorporated, is provided with changes issued for some publications. This checklist should be compared to pages remaining in the publication to ensure they agree. Extra pages are removed and missing pages ordered to bring the publication up-to-date. Obsolete pages removed should be disposed of in accordance with applicable regulations.

When pen-and-ink changes are made, the change number and date should be entered with each change for future reference. Sometimes it is convenient to cut out pen-and-ink changes and insert them in their proper place in a publication by fastening them with transparent tape or glue.

A record sheet is maintained in the front of each publication, indicating the date and number of each change incorporated and the name or initials of the person completing the change. This procedure makes it simple to check if the publication is up-to-date.

EQUIPMENT RECORDS AND REPORTS

Maintaining records and reports is one of the major responsibilities of the senior ABF. All records and reports must be accurate, up-to-date, and according to established standards.

Work and Maintenance Logs

In the work (or operational) logs, hours of operation and operating pressures should be recorded. This information will be very useful in keeping current the maintenance project cards of the ship. Any other operational data that could be useful at a future date should be recorded. A daily inspection of the fuel system should be made for leaks and other discrepancies and recorded in the log.

The maintenance logbook should contain all work performed on the aviation fuels systems by the repair crews. It should be recorded in a day-to-day order.

Other logbooks required to be kept are the following:

- Fuels security watch log.
- Filter sample/pressure drop log (fig. 8-4).
- Quality surveillance sample log.
- Equipment running logs (fig. 8-5). Each piece of equipment should have its own log, such as service pump #2. transfer pump #1, purifier #3.
- Stripping logs.

All logbooks should be inspected frequently by appropriate petty officers, the work center chief, and the division officer. Often, the information contained in a log may indicate the impending failure of a piece of equipment long before the actual failure occurs.

Checklists

Checklists (fig. 8-6) provide a minimum written list of items for inspection. Checklists are typically tailored to fit specific equipment or operations and can cover everything from a pre-operational check on a fuel truck to inspecting the entire fuel system after an underway replenishment.

The advantage of using a checklist is obvious. With the items to be inspected written, you are less likely to miss a step or procedure. If you use checklists, make sure all PMS requirements are met.

Aircraft Checker Reports

One of the major problems encountered by senior ABFs in operating an aviation fuels system is keeping accurate records of fuel expenditures. The measuring instruments (meters, liquid-level indicators, sounding tapes) are not sufficiently accurate for use in computing fuel expenditure for a particular aircraft or squadron.

The most accurate way of computing the amount of fuel issued to a particular aircraft is with the use of the aircraft's fuel gages. At the time of arrestment, by subtracting the fuel load from the total capacity of the aircraft's fuel tanks, you can determine how much fuel is needed to top off the tanks. The aircraft's fuel gages are calibrated in pounds of fuel, and a conversion must be made to convert the pounds of fuel issued to gallons.

Fuel checkers are assigned the duty of keeping an account of all fuels issued to or taken from an aircraft.

Checker cards are useful for this purpose. These cards (or sheets) should have places for the date and the checker's name at the top. There should be spaces

FILTER SAMPLE PRESSURE DROP LOG   DATE: ____________

FILTERS: 1-2-3-4

TIME	INLET PRESS	COALESCER DIFF PRESS	SEPARATORY DIFF PRESS	FALLOUT DIFF PRESS	DISCHARGE PRESS	SUMP SAMPLE	VISUAL SAMPLE	LAB RESULT	SERVICE TANK NO.	SIGNATURE

NOTE: SAMPLES SHALL BE TAKEN IAW AFOSS

SIGNATURE: ____________

Figure 8-4.—Example of a fuel sample/pressure drop log.

EQUIPMENT RUNNING LOG DATE: ____________
EQUIPMENT NAME: ____________
SUPERVISOR: ____________
PREV ACCU RUN TIME: ____________

START TIME	STOP TIME	TOTAL TIME	FROM	TO	AMOUNT TRANSF	DUTY FILTER	DEFUEL TANK	VISUAL SAMPLE	LAB SAMPLE	OPERATOR

TOTAL RUN TIME THIS PAGE ______ DIV OFFICER/CPO: ____________

Figure 8-5.—Example of an equipment-running log.

on the cards for the squadron number, aircraft side number, the pounds of fuel issued or defueled from the aircraft, the total fuel load, the time of fueling or defueling, and the plane captain's initials. These cards should be turned in to the division petty officer responsible for keeping the fuel expenditure records.

Vehicle or Hydrant #		Meter Reading		Product	Date ______ Time ______
#	Item (See paragraph 12.3.3.1)	OK	Adjust	Repair	REMARKS
1	Fire extinguishers (in place, filled, operable, current inspection tag)				
2	Nozzle stowage dust cover and bonding cable on gravity nozzle				
3	Hook up nozzle to bottom loading adapter or recirculation fitting, and check entire nozzle assembly				
4	Hose: Check entire length for cuts, cracks, abrasions and fuel saturation				
5	Static bonding cable, plug/clip				
6	Leaks (tank, piping, valves, pumps, etc.)				
7	Emergency valves (operation of controls)				
8	Cleanliness				
9	Battery, radiator, gas and oil levels				
10	Lights, reflectors, rearview mirrors				
11	Drain all low point drains (tank, filter/separator, monitor, relaxation chamber)				
12	Exhaust pipe and spark arresting muffler (leaks, cracks or noise)				
13	Emergency brakes				
14	Drain water from air tanks				
15	Fill hose with full pump pressure and check entire system for leaks				
16	Open nozzle valve, check nose seal for leaks, circulate fuel, and check flow rate				
17	Pump (noise, overheating, vibration)				
18	Draw nozzle sample, visually inspect for water, solids and color and record results	Water ______ Color ______			Sediment ______
19	Record pressure differential reading from filter/separator and monitor	Pump Pressu. ______ Pump R.P.M. ______ Flow Rate ______			Filter Press. Diff. ______ Monitor Press. Diff. ______

COMMENTS

INSPECTOR'S SIGNATURE | SUPERVISOR'S SIGNATURE

Figure 8-6.—Example of a daily aircraft refueling equipment checklist.

They are used in filling out squadron requisitions. In case of an aircraft accident, the cards should be removed from use and filed for future use in the accident investigation, if required. These cards are also used in accounting for the amount of fuel on board the ship.

The fuel checker cards are used in conjunction with the daily pumproom reports to establish the amount of fuel delivered and the amount of fuel remaining on board daily. The cards are used to compute the amount of fuel used by each squadron. A supply requisition is sent to each squadron for payment for the amount of fuel used. The cost of the fuel is paid for out of that squadron's operation and line maintenance of aircraft allotment.

Sounding Report

Another report required in V-4 Division is the daily sounding report. This is a two-copy report; one copy is submitted to the engineering log room, and the other copy is retained in V-4 division files. The daily sounding report contains tank numbers, capacity (in gallons and in feet and inches), the previous day's soundings, the present soundings, and the percentage of fuel on board.

Daily Fuel Reports

The daily fuel report is compiled from the aircraft checker cards, the pumproom reports, and tank sounding reports. This report shows the total amount of fuel on board. It is normally signed by the V-4 division officer and submitted to each of the following officers:

- Commanding officer
- Air officer
- Engineering officer
- Operations officer
- Officer of the deck
- Supply officer

CASUALTY REPORTING

The casualty report (CASREP) has been designed to support the Chief of Naval Operations (CNO) and fleet commanders in the management of assigned forces. The effective use and support of Navy forces require an up-to-date, accurate operational status for each unit. An important part of operational status is casualty information. The reporting of casualties results in operational commanders and support personnel being advised of the status of significant equipment malfunctions that could result in the degradation of a unit's readiness. The CASREP also reports the unit's need for technical assistance and/or replacement parts to correct the casualty.

A *casualty* is defined as an equipment malfunction or deficiency that cannot be corrected within 48 hours that

- reduces the unit's ability to perform a primary mission, or
- reduces the unit's ability to perform a secondary mission, or
- reduces a training command's ability to perform its mission, or a significant segment of its mission, and cannot be corrected or adequately accommodated by rescheduling or double-shifting lessons or classes.

The CASREP system contains four types of reports: initial, update, correct, and cancel. These reports are described in general in the following paragraphs. For more complete information on preparation and submission of the reports, see *Operational Reports*. NWP 10-1-10. (Formerly NWP 7, Revision A.)

Initial Casualty Report (Initial)

An Initial casualty report identifies the status of the casualty and any parts and/or assistance that is needed. Operational and staff authorities use this information to set priorities for the use of resources.

Update Casualty Report (Update)

An Update casualty report contains information similar to that submitted in the Initial report and/or submits changes to previously submitted information.

Correction Casualty Report (Correct)

A unit submits a correction Correct casualty report when equipment that has been the subject of casualty reporting is repaired and back in operational condition.

Cancellation Casualty Report (Cancel)

A unit submits a cancellation Cancel casualty report when equipment that has been the subject of casualty reporting is scheduled to be repaired during an overhaul or other scheduled availability. Outstanding casualties that will not be repaired during such availability will not be canceled, and will be subject to normal follow-up casualty reporting procedures as specified.

SURVEYS

The purpose of surveys is to determine the reasons and/or responsibilities for the loss, damage, or destruction of Government material and to determine the actual loss to the U.S. Government. Immediately upon the discovery of the loss, damage, or destruction of Government material, a preliminary investigation is conducted. The investigation is conducted to determine if there is evidence of negligence, willful misconduct, or deliberate unauthorized use. This preliminary investigation is conducted by the department head or division officer (or equivalent) responsible for the material. When circumstances warrant, such as an indication of criminal action or gross negligence, the CO or OIC may appoint a surveying officer or a survey board to investigate the situation further. However, individuals who are accountable or responsible for the material in question may not be appointed as a surveying officer.

An investigation or a review must determine what caused the loss, damage, or destruction of the material being surveyed. The facts surrounding the incident must be thoroughly and quickly investigated to determine the cause. However, the investigation or review should not be limited to the verification of statements from individuals. The investigation should be broad enough to ensure that the interests of the Government, as well as the rights of the individual(s) and the Navy activity, are fully protected. A review is required to prove or refute statements from individuals and to place the responsibility where it belongs.

Research action is not required when the CO or OIC believes that negligence was not involved in the loss, damage, or destruction of Government property. When, for reasons known to the CO or OIC, negligence or responsibility cannot be determined and for those reasons research would be an unnecessary administrative burden, research action is not required. Research action is not usually required when an individual accepts responsibility for the loss, damage, or destruction of property and voluntarily offers to reimburse the Government for the material.

There are many situations that may require a survey, but the ABF is concerned mainly with bulk petroleum products. If a loss exceeds stated allowances (for example, MOGAS – one half of one percent; JP-5 – one quarter of one percent), a survey is required. If the cause of the loss is unresolved, a DD Form 200, Report of Survey, will be initiated.

More detailed information is available in NAVSUP Pub. 485, *Afloat Supply Procedures.*

SUMMARY

There is no possible way every instruction or manual you will be required to use can be covered here. As systems and equipment are tailored for each command, so too are the publications required to support the command. As was stated earlier, you may not know a specific detail of an operation or maintenance, but you should know where to get the information. Learn to use your instructions, technical manuals, and other publications early in your career. You can ‘t go wrong.

APPENDIX I

GLOSSARY

ABRASION— Wearing away of a surface by friction, either by motion while in contact with another part, or by mechanical cleaning or resurfacing with abrasive cloth or compound.

ADDITIVES— Chemicals added in minor proportions to fuels or lubricants to create, enhance, or inhibit selected properties; for example, fuel system icing inhibitor (FSII).

ADHESIVE— Sticky or tenacious; glue.

AMBIENT— Encompassing on all sides, as temperature.

AMMETER— Electrical instrument for measuring the flow of current.

ANODE— The positively charged electrode of an electrolytic cell.

ANSI— Abbreviation for American National Standards Institute.

ANTIFREEZE— A substance having a low freezing point, usually used to inhibit freezing of cooling system fluids in engines.

API— Abbreviation for American Petroleum Institute.

API GRAVITY— Petroleum industry scale for measuring the density of oils, adopted by the American Petroleum Institute.

ARC— A luminous, electrical discharge across a gap in a circuit or two electrodes, as in arc welding.

ASTM— Abbreviation for the American Society for Testing Materials.

AUTOIGNITION TEMPERATURE— The temperature at which a substance will ignite without further addition of energy (heat, spark, or flame) from an outside source.

AVGAS— Common term for aviation gasoline.

BALLAST— Water, usually salt water, earned in cargo tanks when free of petroleum products to reduce buoyancy and improve stability and sea-keeping qualities. Ballast may be clean or dirty, depending on whether it is contaminated with petroleum products.

BARREL— Measure of volume as used in the petroleum industry, equivalent to 42 U.S. gallons.

BLACK OIL— general term applied to crude oil and the heavier and the darker colored petroleum products such as residual fuel oils.

BONDING— See GROUND.

BOOM— Flexible floating barrier consisting of linked segments designed to contain free oil on the surface of a body of water.

BOOSTER PUMP— Pump installed along the run of a long pipeline to increase (boost) the pressure.

BOTTOM LOADING— Method of filling tank trucks or tank cars through a leakproof connection at the bottom.

BREAKAWAY COUPLING— Coupling designed to part easily with a moderate pull.

BREATHING— The movement of vapors in and out of the vent lines of storage tanks because of natural heating or cooling.

BS&W— Common abbreviation for bottom sediment and water; a test made on some heavier petroleum products to show the approximate amount of sediment and water.

Btu— Abbreviation for British thermal unit, a unit of heat commonly used in heat engineering. It is the amount of heat necessary to raise the temperature of 1 pound of water one degree Fahrenheit.

BULK STORAGE TANK— A fixed tank used to receive, store, and issue fuel for further transportation, storage, handling, or treatment before it reaches art operating tank.

CALIBILITION— Adjustment of the scale of a graduated device (such as a pressure gage) to meet an established standard.

CO_2—Chemical Chemical notation for carbon dioxide, a heavy, colorless gas that will not support combustion. It is used for fighting small fires and in protection systems in MOGAS and JP-5 spaces aboard ship.

CATHODE— The negatively charged electrode of an electrolytic cell.

CATHODIC PROTECTION— A method for preventing the corrosion of metals by electrolysis.

CENTRIFUGAL— Moving or tending to move away from the center axis of a rotating or turning object.

CENTRIFUGAL PUMP— A rotating device that moves liquids and develops liquid pressure by imparting centrifugal force.

CENTRIFUGAL PURIFIER— A rotating device that cleans fuel by using centrifugal force.

CLEAR AND BRIGHT— Term for uncontaminated fuel; indicating a complete absence of haze, free water, or particulate matter that would be visible to the naked eye.

CLEAVAGE— The point of interface between two different liquids, such as oil and water.

CLOUD POINT— The temperature at which a fuel develops a cloudy or hazy appearance due to the precipitation of wax or moisture.

COALESCER— A tube (unit or element) that unites water droplets when fuel passes through it.

COFFERDAM— The space surrounding the MOGAS storage tanks aboard ship; a watertight box.

COMBUSTIBLE LIQUID— A liquid having a flashpoint at or above 100°F.

COMMINGLING— Tie mixture of two or more petroleum products resulting from improper handling, particularly in pipeline or tanker operations.

CONSOLIDATE— To merge into one. To consolidate a nest of tanks means to pump the remaining fuel from several partially empty tanks into a single tank.

CONTAMINATION— The addition of some material not normally present in a petroleum product, such as dirt, rust, water, or another petroleum product.

CONTINUITY— To have a complete, uninterrupted electrical circuit.

CORROSION— The process of dissolving, especially of metals, due to exposure to electrolytes.

CRUDE OIL— Petroleum in its natural state.

CV— Aircraft Carrier.

CVN— Aircraft Carrier (nuclear-powered).

DAY TANK— Fuel storage tank used for daily issue of fuel.

DEADMAN CONTROL— A control device requiring manual operation, such as a switch or valve, designed to stop flow if the operator releases it.

DIAPHRAGM— Separating device of rubber composition used to regulate all hydraulically operated valves.

DIFFUSE— To spread widely, scatter,

DIFFUSER— A mechanical device used to diffuse.

DIKE— An embankment or wall, usually of earth or concrete, surrounding a storage tank to impound the tank's contents in case of a leak or spill.

DISSOLVED WATER— Water absorbed into the fuel that is not visible. The amount of dissolved water a fuel will hold depends upon the fuel's temperature.

DISTILLATE— Common term for several fuels obtained directly from distillation of crude petroleum; typically includes kerosene, JP-5, light-diesel, and other light-burner fuels.

DOUBLE-WALLED PIPING— Piping with two independent chambers, one surrounding the other (an inner and an outer). Typically used in shipboard gasoline systems. The inside chamber carries the fuel, the outside chamber holds a protective gas (such as CO_2 or N_2).

DOWNGRADE— To designate a fuel for a lesser purpose than originally specified, often because of contamination.

EARTHING— *See* **GROUND.**

EDUCTOR— A jet-type pump with no moving parts. An eductor moves liquid by entraining the pumped liquid in a rapidly flowing stream of water (venturi effect). Normally used to dewater bilges and tanks.

EMULSION— The suspension of fine droplets of one liquid in a second liquid with which the first will not mix.

ENTRAINED WATER— Free-water contaminant in a fuel in the form of very small droplets, fog, or mist. It may or may not be visible.

EVAPORATE— To change into vapor.

EVAPORATION LOSS— Loss of liquid petroleum into the atmosphere caused by evaporation.

FILTER— A porous object through which a liquid is passed to remove unwanted particles of solid matter.

FILTER SEPARATOR— A filter or combination of filters designed to remove particulate matter and to coalesce entrained water.

FLAMMABLE LIQUID— A liquid having a flash-point below 100°F.

FLASHPOINT— The lowest temperature at which a fuel will vaporize enough to form a combustible air-vapor mixture.

FLOATING-ROOF TANK— Storage tank with a roof that floats on the liquid surface and rises and falls with the liquid level.

FLUSHING— Pumping fuel through a system to clean the system or component.

FREE-WATER— Undissolved water contaminant in fuel. The water may be in the form of a cloud, emulsion, entrained droplets, or in gross amounts.

FREEZE POINT— The temperature at which wax crystals form in fuels.

FUEL-QUALITY MONITOR— Special type of filter designed to stop the flow of fuel if water or sediment contamination becomes too large.

GAS-FREE— Clear of any gaseous vapors.

GASOLINE— A blend of light, volatile, liquid hydrocarbons used mainly as fuel for spark-ignition, internal combustion engines.

GPM— Abbreviation for gallons per minute.

GROUND— To connect a conductor (usually a heavy gage wire) between the earth and an object to allow for the dissipation of the static charge in that object. On shore activities this is also called **BONDING** or **EARTHING.**

HEADER— A. horizontal run of piping used to group the components of a system.

HOT REFUELING— Aircraft refueling with one or more of the aircraft's engines operating.

HYDRANT SYSTEM— Distribution and dispensing system for aviation fuels, consisting of a series of fixed outlets or hydrants connected by piping.

HYDROMETER— An instrument used for determining the specific gravity of a liquid.

HYDROSTATIC TEST— A test for leaks in a piping system (including hoses) using liquid under pressure as the test medium.

INHIBITORS— Chemical compounds that reduce the rates of chemical reactions.

INNAGE— Depth of liquid in a tank, measured from the liquid's surface to the bottom of the tank.

JP FUEL — Fuel used in turbine engines.

LHA— Amphibious Assault Ship (general purpose).

LPD— Amphibious Transport Dock.

LPH— Amphibious Assault Ship.

LOX— Abbreviation for liquid oxygen.

LUBE OIL— Common term for lubricating oil; used to reduce friction and cool machinery.

MAXIMUM— The largest allowable quantity.

MICRON— A unit of length equal to one-millionth of a meter.

MILITARY SPECIFICATIONS (MILSPECS)— Guides for determining the quality requirements for materials and equipment used by the military services.

MINIMUM— The smallest allowable quantity.

MOGAS— Common term for motor gasoline.

N_2—Chemical chemical notation for nitrogen.

NAVEDTRA— Naval Education and Training.

NONSPARKING TOOLS— Tools made of a metal alloy that when struck against other objects, will not cause sparks of sufficient temperature to ignite fuel vapors.

NON-VORTEX— An attempt by mechanical means to stop the swirling motion of a liquid.

OHM— Measured unit of electrical resistance equal to that of a circuit in which a potential difference of 1 volt between two points will produce a flow current of 1 ampere.

ORIFICE— A device used for narrowing the inside diameter of a pipe and restricting the flow for metering purposes.

OUTAGE— *See* **ULLAGE.**

PANTOGRAPH— A series of pipes, joined by flexible joints, used to connect fueling equipment to aircraft.

PARTICULATE MATTER— refers to the solid particles of fuel contaminants, such as dirt, grit. or rust.

PICKLING— Name given to the procedure of filling a new hose with fuel and letting it stand for several days when preparing the hose for use.

POL— A broad term that includes all petroleum products used by the Armed Forces. It originated as an abbreviation for *petrol, oil,* and *lubricants.*

PSI— Abbreviation for pounds per square inch, the unit of pressure measurement.

QUADRANT— Commonly refers to one quarter of a fuels system on an aircraft carrier. Quadrants are divided into forward port, forward starboard, aft port, and aft starboard. Each quadrant is designed to operate independently of the other, if required.

RECLAMATION— Procedure required to restore or change the quality of contaminated fuel to meet desired specifications.

REFUELER— Tank vehicle used to resupply aircraft with fuel. (DEFUELER is a tank vehicle used to remove fuel from aircraft).

RELAXATION TANK— Small tank in a piping system designed to remove static electricity from the liquid stream.

RHEOSTAT— A variable resistor used to regulate the amount of electrical current.

RISER— A vertical section of piping usually connected to the discharge side of a pump.

ROTARY PUMP— A positive displacement pump that operates in a rotary fashion, such as vane, gear, or screw pump.

RPM— Abbreviation for rounds per minute.

SIGHT GLASS GAGE— A glass gage installed in piping to visually check the liquid flow.

SPECIFIC GRAVITY— The ratio of the weight of a given volume of material at 60°F to the weight of an equal volume of distilled water at the same temperature.

STATIC ELECTRICITY— Term applied to the accumulation of electrical charges on materials and objects and the later recombination (relaxation or discharge) of these charges. Static charges are created when two materials (or objects of different composition) are rubbed or passed across each other.

STRIPPING— The act of removing settled liquids and solids from selected fuel tanks.

SUMP— A low area or depression that collects drainage.

SURGE— Sudden increase in fluid pressure caused by the stopping of a moving stream, as by quickly closing a valve; hydraulic shock.

SURGE SUPPRESSOR— Device to control or reduce surges.

THERMOMETER— Device used for measuring temperature.

THROTTLE— To increase or decrease the flow rate or pressure of a liquid through a pipe with a valve (normally a globe valve).

ULLAGE— The distance from a reference point at the top of stank to the liquid content. Used to determine the volume of the contents.

VENTURI— A tapered portion of a piping system that reduces pressure and increases flow. Used in some MOGAS systems.

VORTEX— A swirling mass of liquid forming a vacuum at its center.

WICK— A solid, such as clothing, that has absorbed fuel. JP-5 can easily ignite in this manner even at a temperature well below its flashpoint.

APPENDIX II

REFERENCES USED TO DEVELOP THE TRAMAN

NOTE: Although the following references were current when this TRAMAN was published, their continued currency cannot be assured. Therefore, be sure you study the latest revision.

Chapter 1

Aircraft Refueling NATOPS Manual, NAVAIR 00-80T-109, Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 01 May 1992.

Personnel Qualification Standard for Air Department Aviation Fuels Afloat, NAVEDTRA 43426-4A, Department of the Navy, Chief of Naval Education and Training, CNET, 250 Dallas St, Pensacola Fl 32508-5220, Oct 1988.

Chapter 2

Blueprint Reading and Sketching, NAVEDTRA 10077-F1, Department of the Navy, Chief of Naval Education and Training, CNET, 250 Dallas St, Pensacola Fl 32508-5220, 1988.

Use and Care of Hand Tools and Measuring Tools, NAVEDTRA 12085, Department of the Navy, Chief of Naval Education and Training, CNET, 250 Dallas St, Pensacola Fl 32508-5220, 1992.

Quality Assurance Manual (Forces Afloat), COMNAVAIRLANTINST 9090.1B/ COMNAVAIRPACINST 9090.1, Commander Naval Air Force, United States Atlantic Fleet, Norfolk, Virginia 23511-5315 and Commander Naval Air Force, United States Pacific Fleet, San Diego, California 92135-5100, 02 Jan 1992.

Ships' Maintenance and Material Management (3M) Manual, OPNAVINST 4790.4B, Department of the Navy, Office of the Chief of Naval Operations, Washington DC 20350-2000, 13 Aug 1987 with change 1, 26 Sep 1990.

Chapter 3

Air Department Standard Operating Procedures, COMNAVAIRPAC/COMNAVAIRLANTINST 3100.4A, Commander Naval Air Force, United States Atlantic Fleet, Norfolk, Virginia 23511-5188 and Commander Naval Air Force, United States Pacific Fleet, U.S. Naval Air Station, North Island, San Diego, California 92135, 02 Dec 1987.

Aircraft Refueling NATOPS Manual, NAVAIR 00-80T-109, Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 01 May 1992.

Aircraft Refueling Handbook, MIL-HDBK-844(AS), Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 20 Oct 1992.

Contaminated Fuel Detector A.E.L. MK.III, Technical Manual, NAVSEA 0315-LP-014-5001, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, Jan 1966.

Gasoline and JP-5 Fuel Systems, Naval Ships' Technical Manual, S9086-SP-STM-010/CH-542, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 28 Sep 1990.

Petroleum Fuel Storage, Use, and Testing, Naval Ships' Technical Manual S9086-SN-STM-000/CH-541, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Mar 1982 with change 2, 01 Sep 1986.

Chapter 4

Air Department Standard Operating Procedures, COMNAVAIRPAC/COMNAVAIRLANTINST 3100.4A, Commander Naval Air Force, United States Atlantic Fleet, Norfolk, Virginia 23511-5188 and Commander Naval Air Force, United States Pacific Fleet, U.S. Naval Air Station, North Island, San Diego, California 92135, 02 Dec 1987.

Damage Control-Practical Damage Control, Naval Ships' Technical Manual, S9086-CN-STM-020/CH-079 V2, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, July 1977 with change 9, 01 Aug 1988.

Department of the Navy Pollution Control Reports; responsibilities and guidance on reporting of, NAVFACINST 6240.3A, Department of the Navy, Naval Facilities Engineering Command, 200 Stovall Street, Alexandria, Virginia 22332, 22 Oct 1981.

Environmental and Natural Resources Program Manual, OPNAVINST 5090.1A, Department of the Navy, Office of the Chief of Naval Operations, Washington DC 20350-2000, 02 Oct 1990.

Filter Separator (300 gpm), Technical Manual, NAVSEA S9550-AK-MMM-010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Nov 1981 with change C, 15 Sep 1991.

Filter Separator (2000 gpm), Technical Manual, NAVSEA S9550-AL-MMM-010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, Dec 1979.

Fuel Control System Consoles (Part Numbers 1000305, 1000306, and 1000308), Technical Manual, NAVSEA S9540-AE-MMO-010/DD 963-452K, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Jul 1983 with change A, 01 Aug 1987.

Gasoline and JP-5 Fuel Systems, Naval Ships' Technical Manual, S9086-SP-STM-010/CH-542, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 28 Sep 1990.

General Specifications for Ships of the United States Navy, NAVSEA S9AAO-AA-SPN-010/GEN-SPEC, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 02 Jan 1991.

JP-5 Tank Stripping Pump, Technical Manual, NAVSEA 0947-LP-156-6010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, Jun 1970 with change 2, 05 Dec 1983.

JP-5 *Fuel Service Pump,* Equipment Manual, NAVSEA 0947-LP-152-6010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, Nov 1974 with change 2, Jul 1983.

JP-5 Service Pumps, 5MMX5, Type ON, Maintenance Manual, NAVSEA S6225-T9-MMA-010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 15 Feb 1986 with change B, 01 Apr 1988.

JP-5 Transfer Pump, Equipment Manual, NAVSEA 0947-LP-154-6010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, Jun 1970 with change 3, 01 May 1987.

JP-5 Jet Fuel Centrifugal Purifier, Technical Manual, NAVSEA S9542-AB-MMO-010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Sep 1983 with change H, 15 Oct 1991.

Limitorque Valve Operators Types LT 130, LT 150, LT 550, Technical Manual, NAVSEA S6435-PB-MMA-010/52374, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 19 Aug 1986.

Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat, OPNAVINST 5100.19B, Department of the Navy, Office of the Chief of Naval Operations, Washington DC 20350-2000, 11 Apr 1989 with change 1, 23 Oct 1990.

Petroleum Fuel Storage, Use, and Testing, Naval Ships' Technical Manual S9086-SN-STM-000/CH-541, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Mar 1982 with change 2, 01 Sep 1986.

Piping Systems, Naval Ships' Technical Manual, S9086-RK-STM-010/CH-505, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 15 Apr 1988.

Pollution Control, Naval Ships' Technical Manual, S9086-T8-STM-010/CH-593, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Sep 1991.

Rotary Gear Motor Driven Transfer Pump, Maintenance Manual, NAVSEA S6226-CS-MMA-010/59180, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Nov 1987.

Tank Level Indicating and Control System (CVN 70), Technical Manual, NAVSEA S9540-AD-MMM-010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 15 Dec 1981.

Chapter 5

Air Department Standard Operating Procedures, COMNAVAIRPAC/COMNAVAIRLANTINST 3100.4A, Commander Naval Air Force, United States Atlantic Fleet, Norfolk, Virginia 23511-5188 and Commander Naval Air Force, United States Pacific Fleet, U.S. Naval Air Station, North Island, San Diego, California 92135, 02 Dec 1987.

Aircraft Fuel/Defuel Stations in CV and CVNs (CLA-VAL), Maintenance Manual, NAVSEA S9542-AL-MMM-010, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 15 Sep 1989.

Aircraft Refueling NATOPS Manual, NAVAIR 00-80T-109, Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 01 May 1992.

Aircraft Refueling Handbook, MIL-HDBK-844(AS), Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 20 Oct 1992.

CV NATOPS Manual, NAVAIR 00-80T-105, Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 01 Jun 1988.

Gasoline and JP-5 Fuel Systems, Naval Ships' Technical Manual, S9086-SP-STM-010/CH-542, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 28 Sep 1990.

Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat, OPNAVINST 5100.19B, Department of the Navy, Office of the Chief of Naval Operations, Washington DC 20350-2000, 11 Apr 1989 with change 1, 23 Oct 1990.

Petroleum Fuel Storage, Use, and Testing, Naval Ships' Technical Manual S9086-SN-STM-000/CH-541, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Mar 1982 with change 2, 01 Sep 1986.

Pressure Fuel Servicing Locking Nozzle (Part No. 6902), Technical Manual, NAVAIR 12-1CA-1, Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 15 Jul 1980.

Chapter 6

Cargo Fuels Operational Sequencing System (CFOSS) for LHA 2, Naval Ships' Technical Manual, S9086-SP-STM-010/CH-542, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 10 May 1991.

Gasoline and JP-5 Fuel Systems, Naval Ships' Technical Manual, S9086-SP-STM-010/CH-542, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 28 Sep 1990.

Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat, OPNAVINST 5100.19B, Department of the Navy, Office of the Chief of Naval Operations, Washington DC 20350-2000, 11 Apr 1989 with change 1, 23 Oct 1990.

Petroleum Fuel Storage, Use, and Testing, Naval Ships' Technical Manual S9086-SN-STM-000/CH-541, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Mar 1982 with change 2, 01 Sep 1986.

Chapter 7

Aircraft Refueling NATOPS Manual, NAVAIR 00-80T-109, Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 01 May 1992.

Aircraft Refueling Handbook, MIL-HDBK-844(AS), Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 20 Oct 1992.

Maintenance and Operation of Petroleum Fuel Facilities, NAVFAC MO-230, Department of the Navy, Naval Facilities Engineering Command, 200 Stovall Street, Alexandria, Virginia 22332, Aug 1990.

Pollution Control, Naval Ships' Technical Manual, S9086-T8-STM-010/CH-593, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 01 Sep 1991.

Chapter 8

Afloat Supply Procedures, NAVSUP Publication 485, Department of the Navy, Naval Supply Systems Command, Washington Dc 20376-5000, 15 Nov 1989 with change 4, 31 Aug 1991.

Air *Department Standard Operating* Procedures, COMNAVAIRPAC/COMNAV-AIRLANTINST 3100.4A, Commander Naval Air Force, United States Atlantic Fleet, Norfolk, Virginia 23511-5188 and Commander Naval Air Force, United States Pacific Fleet, U.S. Naval Air Station, North Island, San Diego, California 92135, 02 Dec 1987.

Aircraft Refueling NATOPS Manual, NAVAIR 00-80T-109, Department of the Navy, Naval Air Systems Command, Naval Air Systems Command Headquarters, Washington DC 20361, 01 May 1992.

Guide for User Maintenance of NAVSEA Technical Manuals, NAVSEA S0005-AA-GYD-030/TMMP, Department of the Navy, Naval Sea Systems Command, Washington DC 20362, 30 Sep 1988

INDEX

Assignment Questions

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

ASSIGNMENT 1

Textbook Assignment: "Afloat and Ashore Fuels Division Organization," "General Maintenance Equipment," and "Quality Surveillance," chapters 1, 2, and 3. pages 1-1 through 3-9.

1-1. The information contained In the ABF TRAMAN is written to provide minimum coverage of which of the following areas?

1. Examination subjects and military factors
2. Occupational standards
3. Practical and military factors
4. Knowledge factors

1-2. What publication contains occupational standards for the ABF rating?

1. List of Training Manuals and Correspondence Courses, NAVEDTRA 12061
2. Record of Practical Factors, NAVEDTRA 1414/1
3. Bibliography for Advancement Study, NAVEDTRA 12052
4. Advancement Handbook for Petty Officers, Aviation Boatswain's Mate (Fuels), NAVEDTRA 71201

1-3. The Quality Surveillance Laboratory is a branch of what work center?

1. Flight deck
2. Below deck
3. Flight deck repair
4. V-4 Division office

1-4. Which of the following watches is responsible for the security of the AvFuels system aboard ship?

1. Officer of the Deck
2. Junior Officer of the Deck (JOOD)
3. Air Department Integrity Watch
4. Aviation Fuels Security Watch

1-5. Which manual contains the PQS requirements for the ABF?

1. Air Department Standard Operating Procedures (COMNAVAIRPAC/LANTINST 3100-4)
2. CV NATOPS Manual (NAVAIR 00-8OT-105)
3. PQS for Air Department Aviation Fuels Afloat (NAVEDTRA 43426-4A)
4. Aircraft Refueling NATOPS Manual (NAVAIR 00-80T-109)

1-6. The Aviation Fuels Division ashore is a division of which department?

1. Supply Department
2. Air Department
3. Maintenance Department
4. Aircraft Intermediate Maintenance Department

1-7. What NAVEDTRA manual contains additional information on tools and their use?

1. 10015-B2
2. 12085
3. 10067-A
4. 16730-B1

1-8. When you use a standard screwdriver, the end of the screwdriver should fill at least how much of the screw slot to ensure proper fit?

1. 100%
2. 95%
3. 85%
4. 75%

1-9. When you use a Phillips screwdriver, at least how much of the screw cavity should be filled by the end of the blade to ensure a proper fit?

1. 100%
2. 95%
3. 85%
4. 75%

1-10. What advantage is there in using an adjustable wrench instead of an open-end wrench to tighten or loosen a nut?

1. An adjustable wrench will not damage hard-to-turn nuts
2. An adjustable wrench can be adjusted to fit odd-sized nuts or bolts
3. An adjustable wrench is less likely to be used improperly
4. Either jaw of an adjustable wrench may be adjusted to fit any size or shape nut or bolt

1-11. What important point should you remember when using a pipe wrench?

1. The fixed jaw should provide the twisting force
2. The adjustable jaw should provide the twisting force
3. The fixed jaw should provide the pushing force
4. The adjustable jaw should provide the pushing force

1-12. What type of wrench should you use to loosen or tighten a screw with a recessed head?

1. Strap wrench
2. Socket wrench
3. Spanner wrench
4. Allen wrench

1-13. The size of the opening, for a nut or bolt, is the only factor considered in determining the size of a socket.

1. True
2. False

A. Speed handle

B. T-handle

C. Hinged handle

D. Ratchet handle

FIGURE 1-A

IN ANSWERING QUESTIONS 1-14 THROUGH 1-16, SELECT FROM FIGURE 1-A THE SOCKET HANDLE BEST SUITED FOR THE TASK IN THE STATEMENT.

1-14. Rapidly tighten or loosen nuts or bolts, using a series *of* partial turns .

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

1-15. Remove nuts or bolts that are loosened first with another wrench.

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

1-16. Apply the most leverage to break loose tight nuts, then remove the nuts rapidly.

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

1-17. What is the most commonly used chisel?

1. Cape chisel
2. Round nose chisel
3. Diamond point chisel
4. Flat cold chisel

1-18. What type of file is used to enlarge rectangular shaped holes or slots?

1. Square file
2. Rectangular file
3. Half round file
4. Triangular file

1-19. What tool is principally used for dressing over bruised or rusty threads on screws or bolts?

1. Hand tap
2. Rethreading die
3. Pipe die
4. Round split die

1-20. To remove a broken screw or tap with a spiral extractor. a hole must first be drilled in the screw or tap. How is the proper size of the hole determined? .

1. Visually
2. The drilled hole is to be of equal width as the shaft of tie broken screw or tap
3. The drilled hole is to be of equal width as the top of the broken screw or tap
4. The screw extractor will have the size hole required stamped on it

1-21. What chain hoist is most commonly used by the ABF?

1. Spur gear chain hoist
2. Lever operated chain hoist
3. Come-a-long
4. Ratchet chain hoist

1-22. Most water and aviation fuel lines can be easily repaired using the metallic pipe repair kit. When these repairs are made, in how many minutes can service be restored to the system?

1. 30
2. 45
3. 60
4. 75

1-23. When the resins and hardeners of a plastic patch are mixed together, a chemical reaction begins. “Kickover” will occur at or about what peak temperature?

1. 120°F
2. 135°F
3. 350°F
4. 400°F

1-24. When applying a simple pipe patch, the woven roving cloth should be wrapped around the void cover approximately how many times?

1. Between 2 and 3
2. Between 3 and 4
3. Between 4 and 5
4. Between 5 and 6

1-25. All Navy electrical power tools are required to have what safety feature?

1. Proper grounds
2. Automatic shut offs
3. Insulated handles
4. Built in shields

1-26. What indication does the micrometer setting type of torque wrench give when the desired amount of torque is reached?

1. The socket will disengage completely
2. The indicating needle or pointer will move
3. A click is given off, followed by the handle freely traveling for a short distance
4. The handle will lock

1-27. What term describes the movement between the spindle and the anvil of a micrometer?

1. Approximate distance
2. Set distance
3. Approximate range
4. Range

1-28. The size of a micrometer indicates

1. the size of the largest work it can measure
2. the size of the smallest work it can measure
3. if it requires calibration
4. how often it requires calibration

A. Inside micrometer
B. Outside micrometer
C. Depth gage
D. Dial indicator

FIGURE 1-B

IN ANSWERING QUESTIONS 1-29 THROUGH 1-31, SELECT FROM FIGURE 1-B THE MEASURING TOOL REQUIRED TO COMPLETE THE TASK IN THE STATEMENT

1-29. Measuring the depth of a slot in a pump shaft.

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

1-30. Measuring the inside diameter of a bushing.

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

1-31. Measuring the trueness of a pump shaft.

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

1-32. If you had to find the tightening sequence for the bolts on a pump casing, where should you look?

1. On the upper half of the casing
2. On the lower half of the casing
3. In the ABF TRAMAN
4. In the applicable technical manual

1-33. What does surface corrosion look like on painted aluminum?

1. White or gray powdery deposits
2. Grey or red powdery deposits
3. An indentation on the surface
4. The paint appears to lift off the surface

1-34. Why is intergranular corrosion more dangerous than other types of corrosion?

1. It spreads faster than other types of corrosion
2. It is not visible on the surface
3. It occurs only in the weaker metals
4. The powder it produces is toxic

A. Surface
B. Galvanic
C. Intergranular
D. Interior

FIGURE 1-C

IN ANSWERING QUESTIONS 1-35 THROUGH 1-37. SELECT FROM FIGURE 1-C THE TYPE OF CORROSION DESCRIBED IN THE STATEMENT

1-35. It spreads through the Interior of the metal.

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

1-36. Two different metals are connected and exposed to an electrolyte.

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

1-37. The atmosphere produces roughening, etching, or pitting.

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

1-38. When finding corrosion on equipment, what should be your first step in treatment?

1. Paint over it with a rust preventive type paint
2. Replace the entire unit
3. Remove the corrosion safely and completely
4. Remove the chips and burrs that collect corrosion residue

1-39. What is the most practical method of controlling metal corrosion?

1. Coat exposed metals with a light coat of grease or oil
2. When painting, apply at least three coats of paint
3. Sandblast metals before painting
4. Consistent preventive maintenance

1-40. Moving parts can be kept free of corrosion by which of the following actions?

1. Painting
2. Applying the proper lubricant
3. Removing the part when not in use
4. Wiping daily with an emery cloth

1-41. What NAVEDTRA manual contains more information on mechanical drawings?

1. 12364
2. 10067-A
3. 10085-B2
4. 10077-F1

1-42. To find the planned maintenance scheduled in your work center for today, you should look at what schedule?

1. Daily schedule
2. Weekly schedule
3. Quarterly schedule
4. Cycle schedule

1-43. Which of the following personnel signs the weekly schedule?

1. LPO
2. LCPO
3. Division officer
4. Department head

1-44. Which of the following forms should you submit to order a replacement maintenance requirement card (MRC)?

1. Feedback Report (category A)
2. Feedback Report (category B)
3. Technical manual deficiency/evaluation Report (TMDER)
4. NAVSEA 4160/1

1-45. For complete information on the 3-M Systems, you need to consult which manual?

1. OPNAVINST 4790.4
2. OPNAVINST 4790.2
3. 3-M-INST 2330.1
4. OPNAVINST 5100.19

1-46. Which manual provides the requirements for an effective QA program?

1. COMNAVAIRPAC/LANTINST 9090.1
2. COMNAVAIRPAC/LANTINST 3100.4
3. OPNAVINST 5100.19
4. OPNAVINST 5090.1

1-47. The quality assurance in-process inspection control document is the Controlled Work Package (CWP).

1. True
2. False

1-48. What OPNAVINST is the general reference for mandatory and advisory safety precautions?

1. OPNAVINST 2030.1
2. OPNAVINST 4790.2
3. OPNAVINST 5090.1
4. OPNAVINST 5100.19

1-49. Who is responsible for reporting any unsafe condition, equipment, material, or other hazards?

1. Commanding officer only
2. Division officer only
3. Work center supervisor only
4. All hands

1-50. How are petroleum fuels in liquid form compared to water?

1. They weigh the same as water at 60°F
2. They are heavier than water
3. They are lighter than water
4. They weigh the same as water at 70°F

1-51. Compared to air, petroleum fuels in vapor form have which of the following characteristics?

1. They weigh the same as air at 60°F
2. They are heavier than air
3. They are lighter than air
4. They weigh the same as air at 70°F

1-52. Petroleum fuel vapors remaining from a spill are extremely dangerous because of which factor?

1. They readily evaporate
2. They tend to remain close to the ground
3. They saturate the ground
4. They saturate porous materials

1-53. What is the NATO number for JP-5?

1. F-40
2. F-42
3. F-44
4. F-46

1-54. What is the minimum flash point of JP-5?

1. 128°F
2. 130°F
3. 140°F
4. 142°F

1-55. If rags or clothing become soaked with JP-5, the JP-5 becomes highly flammable. What term describes this action?

1. Saturation
2. Wicking
3. Candling
4. Soaking

1-56. Because of its high flash point, JP-5 is the only jet fuel authorized for fueling aircraft on Navy ships. When JP-4 or JP-8 is mixed with JP-5, what happens?

1. The flash point of the JP-4 or JP-8 is raised and it becomes safe for shipboard use
2. The flash point of the JP-5 is lowered and it becomes unsafe for shipboard use
3. A chemical reaction takes place that makes both fuels unusable
4. Based on the amount of each fuel in the mixture, either JP-6 or JP-7 is created

1-57. What two terms are generally used to measure volatility?

1. Vapor pressure and viscosity
2. Weight and distillation
3. Viscosity and weight
4. Vapor pressure and distillation

1-58. What is the minimum percentage of gasoline vapor, by volume, for it to burn or explode?

1. 1%
2. 3%
3. 5%
4. 6%

1-59. Because of the range of its vapor pressure, JP-4 almost always has an explosive mixture of vapors above the liquid.

1. True
2. False

1-60. Specific gravity determinations are correlated to what temperature according to ASTM Standard D1250-80?

1. 45°F
2. 60°F
3. 75°F
4. 100°F

1-61. What is the measure of a liquid’s resistance to flow called?

1. Volatility
2. Viscosity
3. Flash point
4. Solvency

1-62. Why is a fuel spill on an asphalt surface more damaging than a fuel spill on a concrete surface?

1. The vapors will spread faster on the asphalt surface
2. The asphalt surface will lose its color
3. The fuel will dissolve the asphalt surface
4. The asphalt will react to the fuel and spontaneously ignite

1-63. What term describes the lowest temperature at which a fuel vaporizes enough to form a combustible vapor?

1. Freezing point
2. Flash point
3. Auto-ignition temperature
4. Boiling point

1-64. What does the prolonged inhalation of fuel vapors cause?

1. Dizziness
2. Nausea
3. Death
4. All of the above

1-65. What is the NAVEDTRA number of the *Standard First Aid Training Course* that should be studied by personnel working with fuels?

1. 10018-B
2. 10081-D
3. 12081
4. 10085-A

1-66. From the standpoint of fire and explosion, which fuel is the safest?

1. MOGAS
2. JP-4
3. JP-5
4. JP-8

ASSIGNMENT 2

Textbook Assignment: "Quality Surveillance (continued)," and "JP-5 Afloat Below Deck Systems and Operations," chapters 3 and 4, pages 3-9 through 4-13.

2-1. To be acceptable for delivery to aircraft, jet fuels must not contain more than how much free water?

1. 5 ppm
2. 10 ppm
3. 2 mg/l
4. 5 mg/l

2-2. To be acceptable for delivery to aircraft, jet fuels must not contain more than how much particulate contamination?

1. 5 ppm
2. 10 ppm
3. 2 mg/l
4. 5 mg/l

2-3. What visual standards must jet fuel meet to be acceptable for delivery to aircraft?

1. Clean and bright
2. Clear and free of water
3. Clear and sparkling
4. Clean and colorless

2-4. Which of the following is NOT a form of water contamination found in fuels?

1. Dissolved
2. Hanging
3. Entrained
4. Free

2-5. Which of the following is a definition of entrained water?

1. Dissolved water that has not settled to the bottom
2. Free water that has not settled to the bottom
3. Undissolved water
4. A mixture of fresh and salt water

2-6. What are the most common types of sediment found in fuel?

1. Paint and rubber
2. Metal and rust
3. Rust and sand
4. Sand and metal

2-7. The division between course sediment and fine sediment is made at

1. 1,000 microns
2. 100 microns
3. 10 microns
4. 1 micron

2-8. Although invisible to the naked eye when separated, microscopic particles of foreign matter grouped together in a fuel sample may appear as a

1. speck or spot
2. slight haze
3. residue on the container
4. separate layer

2-9. Which of the following is a description of microbiological growth in fuel?

1. Dark colored, fibrous, and stringy
2. Dark colored, fibrous, and ball-shaped
3. Straw colored, mayonnaise-like, and stringy
4. Straw colored, mayonnaise-like, and ball-shaped

2-10. The development and growth of microorganisms in jet fuel is primarily caused by what contaminant?

1. Sand
2. Free water
3. Rust
4. Dissolved water

2-11. The most common emulsion is the water-in-fuel emulsion. What does it look like?

1. A light-to-heavy cloud
2. A heavy-to-light cloud
3. A dark, reddish haze
4. A brown haze

2-12. A surfactant in fuel causes the fuel and any water that contacts it to mix easier, and also makes it harder to separate.

1. True
2. False

2-13. Surfactants must be present for microbiological growth to occur.

1. True
2. False

2-14. A surfactant problem can usually be detected-by which of the following observations ?

1. Dark, red-brown, or black water in filter/separator sump drains, refueler sump drains, or pipeline low-point drains
2. Storage tanks not yielding a clear, bright fuel after the prescribed settling time
3. Triggering of fuel monitors in delivery systems, if installed
4. All of the above

2-15. What mechanical method. if any, is used to separate commingled fuels?

1. Settling
2. Filtering
3. Centrifuging
4. None

2-16. Commingled fuels are usually caused by

1. leaking valves
2. leaking tanks
3. carelessness during handling
4. intentional mixing

A.	**All-level**
B.	**Line**
C.	**Representative**
D.	**Composite**

FIGURE 2-A

IN ANSWERING QUESTIONS 2-17 THROUGH 2-20, SELECT FROM FIGURE 2-A THE TYPE OF FUEL SAMPLE ASSOCIATED WITH EACH STATEMENT.

2-17. Taken at *or* near the discharge point of a hose immediately before and during the first few minutes of pumping.

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

2-18. Consists of one container from a large stock of package fuel of the same grade and age.

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

2-19. Contains a blend of individual samples from several tanks that contain the same type of product being sampled.

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

2-20. Represents all fuel between the drawoff level and the top surface level of a tank.

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

2-21. Fuel sample containers used for sediment and water tests must be made of what construction?

1. Glass with a metal top
2. A nonmetallic material with glass linings
3. Glass with a nonmetallic top
4. Metal with glass linings

2-22. Which of the following is NOT a requirement for the identification of a sample?

1. The location and name of the activity submitting the sample
2. The location of the point where the sample was taken
3. The sample classification
4. Test results

2-23. A representative sampling of a large stock *of* packaged fuel revealed contamination sufficient to make the entire supply suspect. Further samples are taken, labeled, and sent to be tested. What were the first and subsequent samples taken?

1. A composite sample, and the others were routine samples
2. A routine sample, and the others were special samples
3. A routine sample, and the others were composite samples
4. A special sample, and the others were routine samples

2-24. When visually inspecting a fuel sample, What should be the first thing you check?

1. The color of the fuel sample
2. The aroma of the fuel sample
3. The presence of water
4. The presence of sediment

2-25. How should you visually check a fuel sample for sediment?

1. Shake it vigorously to break loose any previously undetected emulsion
2. Whirl it rapidly so the fine particles will be thrown to the outside of the sample container
3. Place the sample container on a level surface and allow the sediment to collect on the sides of the container
4. Swirl it to form a vortex that will draw the sediment to the center-bottom of the container

2-26. If contamination is found in a fuel sample, another sample should be drawn in a new, clean container and the visual inspection repeated.

1. True
2. False

2-27. The contaminated fuel detector (CFD/CCFD) employs which of the following principles?

1. Trapped solid contaminants increase the amount of light passing through the millipore filters
2. Trapped solid contaminants decrease the amount of light passing through the millipore filters
3. Solid contaminants increase the weight of the top millipore filter more than the color variation increases the weight of the bottom one
4. The weight of the solid contaminants trapped between the millipore filters is equal to the amount of solid contaminants in the sample

2-28. Why should two millipore filters be used when a sediment test is conducted?

1. To increase the speed of the filtration
2. In case one is ripped or torn during the filtration cycle
3. To allow the sediment to be trapped between the two
4. To eliminate any fuel color effect and increase accuracy

2-29. What size are the pores of the millipore filter?

1. .60 micron
2. .65 micron
3. .70 micron
4. .75 micron

2-30. When preparing to conduct a sediment test with the CFD/CCFD, you should fill the polyethylene bottle with how much fuel?

1. 500 ml
2. 600 ml
3. 700 ml
4. 800 ml

2-31. The light system of the CFD/CCFD should be warmed up for at least how many minutes before use?

1. 1 to 2
2. 2 to 3
3. 3 to 4
4. 4 to 5

2-32. The light intensity should be adjusted to what reading prior to measuring the millipore filter?

1. 6.0 milliamps
2. 0.6 milliamps
3. 0.06 milliamps
4. 0.006 milliamps

2-33. When measuring the millipore filters, the reading is taken in

1. tenths
2. hundredths
3. thousandths
4. ten thousandths

2-34. The light intensity on the CFD/CCFD is adjusted by use of a

1. thermostat
2. photovoltaic cell
3. hydrostat
4. rheostat

2-35. If adjustment of the light bulb holder is required, what position should the filament on the light bulb be in after the adjustment is made?

1. Up
2. Down
3. Horizontal
4. Vertical

2-36. Fuel with a known contamination measurement must be run through the Wratten filters when calibrating the CFD/CCFD.

1. True
2. False

2-37. In accordance with PMS, at least how often must CFD/CCFD be calibrated?

1. Monthly
2. Quarterly
3. Whenever a part is replaced
4. Both 2 and 3 above

2-38. What is the main function of the AEL Mk I and AEL Mk II?

1. To measure free water
2. To measure dissolved water
3. To detect salt water
4. To detect fresh water

2-39. *A* sample tested indicates that more than 20 ppm water is present. What additional test must you perform?

1. Test a second standard sample and double the results
2. Test another standard sample in the same manner to verify the accuracy of the first sample, then log the results
3. Test a second sample one-half the size of the standard sample and double the results
4. Test another standard sample and divide the results by 2

2-40. At least how often must the "standards" card in the free water detector be replaced in accordance with PMS?

1. Monthly
2. Quarterly
3. Semiannually
4. Annually

2-41. What range thermometer should you use to do a flash point test on JP-5?

1. 10°F to 230°F
2. 20°F to 230°F
3. 10°F to 700°F
4. 100°F to 200°F

2-42. When conducting a flash point test and the fuel to be tested has been heated within 30° to 50°F of the expected flash point. at what multiples should you begin applying the test flame?

1. 2°F
2. 3°F
3. 4°F
4. 10°F

2-43. What does FSII mean?

1. Fuel system initial installation
2. Fuel system internal instruments
3. Fuel system icing inhibitor
4. Fuel system internal inhibitors

2-44. What type of light source, if any, should you use when operating the refractometer?

1. Fluorescent or incandescent bulb
2. Natural sunlight
3. Ultra-violet
4. None

2-45. When the FSII test is conducted, how much fuel is taken from the graduated cylinder and poured into the separator funnel?

1. 2 ml
2. 80 ml
3. 120 ml
4. 160 ml

2-46. After adding 2 ml of water to the fuel for a FSII test, how long must the sample then be shaken?

1. 1 min
2. 2 min
3. 3 min
4. 4 min

2-47. What is the minimum use level for USN and USMC aircraft that require FSII?

1. .01%
2. .02%
3. .03%
4. .04%

2-48. Which of the following USN/USMC aircraft currently do NOT require the use of FSII?

1. s-3
2. US-3
3. SH-60
4. H-3

2-49. What instrument is used to measure the specific gravity of petroleum products?

1. Handimeter
2. Beaker
3. Gravity gage
4. Hydrometer

2-50. Which of the following is NOT considered a major pumping system?

1. Fill and transfer system
2. Stripping system
3. Jet test system
4. Service system

2-51. What is the primary use of a JP-5 storage tank?

1. Bulk stowage of JP-5
2. Amidship emergency tanks
3. Fuel for aircraft service
4. Fuel for only jet test use

2-52. What is the primary use of a JP-5 service tank?

1. To store bulk storage of JP-5
2. To store fue for aircraft servicing
3. To store fuel from the reclaim system
4. To receive fuel from flushing operations

2-53. What section of piping connects the filling connection on the main deck with the transfer main on the seventh deck?

1. Riser
2. Downcomer
3. Branch header
4. Suction header

2-54. What is the primary purpose of the transfer main?

1. To interconnect the forward and the aft storage tanks
2. To interconnect the forward and aft service tanks
3. To connect the designated contaminated tanks with the eductor
4. To interconnect the storage tanks to the service tanks

2-55. What valves are used to isolate the transfer system during secured conditions and to control the flow of JP-5 during various transfer and filling operations?

1. Downcomer valves
2. Bulkhead cutout valves
3. Service pump suction valves
4. Riser cutout valves

2-56. Transfer main branch headers connect the transfer main to

1. storage tank manifolds
2. the opposite transfer main
3. stripping pump suction headers
4. service tank manifolds

2-57. What devices are arranged in the transfer pump’s discharge header to enable both purifiers to operate simultaneously using any two of the three transfer pumps?

1. Two one-way check valves
2. Two transfer pump bypass lines
3. Two cutout valves
4. T-lines

2-58. Valve arrangement in the transfer pump’s discharge header is designed to allow two different transfer operations to be performed at the same time.

1. True
2. False

2-59. The common suction and discharge headers of the transfer pumps are interconnected with the suction and discharge headers of the service pumps. What is the purpose of these two systems being interconnected?

1. To pump fuel directly from the storage tanks to the flight deck for servicing aircraft
2. To use the higher capacity service pumps to pump fuel through the reclamation system quicker
3. To bypass the service filters
4. To use the service pumps for off-loading fuel

2-60. What system provides the capability to reclaim JP-5 received from hose flushings, tank stripping operations, and the initial flow from a FAS?

1. Stripping system
2. Service system
3. Recirculation system
4. Reclamation system

2-61. What is/are the primary use(s) of the motor-driven stripping system?

1. Remove settled water and solids from tanks
2. Completely empty tanks
3. Remove wash water from tanks
4. All of the above

2-62. What is the required height from the bottom of a tank for the motor-driven stripping tailpipe?

1. 1 in.
2. 1 1/2 in.
3. 2 in.
4. 2 1/2 in.

2-63. What is the required height from the bottom of a service tank for the hand-operated stripping tailpipe?

1. 1/4 in.
2. 1/2 in.
3. 3/4 in.
4. 7/8 in.

2-64. What system is designed to deliver clean, clear, and bright JP-5 from the service tanks to aircraft?

1. Transfer system
2. Jet test system
3. Auxiliary system
4. Service system

2-65. The service system is typically designed to be isolated into how many parts?

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

2-66. The service tank suction tailpipes should be at least how many inches above the tank bottoms?

1. 24
2. 18
3. 12
4. 10

2-67. The service tank recirculating line terminates how far and in what position from the bottom of the tank?

1. 18 inches vertically
2. 18 inches horizontally
3. 24 inches vertically
4. 24 inches horizontally

2-68. The orifice in the service pump recirculation line allows what percent of the pump's rated capacity to recirculate back into the tank from which suction is being taken?

1. 5%
2. 10%
3. 12%
4. 15%

2-69. What is the purpose of recirculating fuel through the service pumps?

1. To lubricate the pump
2. To maintain a positive suction
3. To ensure the pump does not exceed its rated capacity
4. To keep the pump cool when no fuel is being drawn topside

2-70. From where does the jet test system receive its fuel?

1. The service pump suction header
2. The transfer main
3. The service filter discharge line
4. The aft, port quadrant distribution riser

2-71. What system provides JP-5 to small boat filling stations?

1. Jet test system
2. Stripping system
3. Auxiliary system
4. Filter drain system

ASSIGNMENT 3

Textbook Assignment: "JP-5 Afloat Below Deck Systems and Operations (continued)," chapter 4, pages 4-13 through 4-65.

3-1. The centrifugal pump used in the JP-5 service system is rated at what capacity?

1. 20 gpm
2. 150 gpm
3. 1,100 gpm
4. 1,500 gpm

3-2. The centrifugal pump casing is divided into how many chambers?

1. One discharge and two suction
2. One suction and two discharge
3. Two discharge and two suction
4. One discharge and one suction

3-3. The centrifugal pump has four wearing rings. Two wearing rings are installed in the pump casing between the suction and discharge chambers. Where are the other two wearing rings installed?

1. On the pump shaft
2. In the discharge chamber
3. In the suction chamber
4. On the impeller

3-4. What is the purpose of wearing rings?

1. To act as bearings for the pump shaft
2. To minimize leakage between the suction and discharge chambers
3. To allow for the wear created between the impeller and pump casing
4. Both 2 and 3 above

3-5. The centrifugal pump impeller is centered and secured in the pump casing by what devices?

1. Shaft sleeves and wearing rings
2. Shaft sleeves and shaft nuts
3. Bearing caps and shaft nuts
4. Bearing caps and shaft sleeves

3-6. What devices prevent fuel from leaking out of the pump case around the pump shaft?

1. Mechanical seals
2. Shaft collars
3. Flinger rings
4. All of the above

3-7. Mechanical seals are used because of their durability and will not often break, even if they are dropped on a hard surface.

1. True
2. False

3-8. The ball bearings on the centrifugal pump shaft are lubricated by what means?

1. The circulating JP-5
2. Self-priming oil pump
3. Grease fittings
4. Oil reservoir

3-9. Rotary vane pumps used for stripping are designed to pump approximately how many gallons per minute and at what pressure?

1. 50 gpm at 25 psi
2. 50 gpm at 50 psi
3. 200 gpm at 25 psi
4. 200 gpm at 50 psi

3-10. Rotary vane pumps used for transferring are designed to pump approximately how many gallons per minute at what pressure?

1. 50 gpm at 25 psi
2. 50 gpm at 50 psi
3. 200 gpm at 25 psi
4. 200 gpm at 50 psi

3-11. On a rotary vane pump, which component houses the ball bearings and mechanical seals?

1. Cylinder
2. Cylinder heads
3. Rotor and shaft assembly
4. Cylinder bore

3-12. To allow for the escape of liquid between the vanes and-slots of the rotor, the vanes have relief grooves on the

1. forward faces
2. rear faces
3. outside tips
4. inside tips

A.	Rex chain
B.	Direct drive
C.	Falk type-F steelflex
D.	Lovejoy

FIGURE 3-A

IN ANSWERING QUESTIONS 3-13 THROUGH 3-15, SELECT FROM FIGURE 3-A THE TYPE OF PUMP COUPLING DESCRIBED IN THE STATEMENT.

3-13. The coupling halves are cushioned by a formed rubber spider.

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

3-14. A flexible gridmember engages the teeth in the hubs to transmit power.

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

3-15. It resembles small bicycle sprockets placed side by side with a double wide chain connecting the two.

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

3-16. Which type of valve is most commonly used for throttling fuel flow?

1. Globe
2. Gate
3. High performance butterfly
4. Rotary plug

3-17. What valve design allows no metal-to-metal contact during regular operations?

1. A globe
2. A gate
3. A high performance butterfly
4. A rotary plug

3-18. What valve should be used where a straight flow with a minimum amount of restriction is desired?

1. A globe
2. A gate
3. A high performance butterfly
4. A modified globe

3-19. What component on the limitorque valve operator operates the OPEN and CLOSE position indicator lights for the valve?

1. The handwheel
2. The console relay switch
3. The valve stem
4. The limit switches

3-20. If a one-way check valve has no directional flow arrow, how can You identify which end is the inlet?

1. It will have female threads
2. It will have male threads
3. It will have the hinge pin
4. It is the side without the hinge pin

3-21. Valve manifolds are made up of what type of modified valve?

1. Globe
2. Gate
3. One-way check
4. Rotary plug

3-22. What device ensures the disk is centered into the base of the valve body in a manifold?

1. Valve stem
2. Gate guide
3. Plug guide
4. Disk guide

3-23. What device prevents leakage around the valve stem of a manifold?

1. O-ring
2. Gasket
3. Packing
4. Plug

3-24. On a manifold, what is the name of the pipe connecting the mainside valve to the tankside valve?

1. Nozzle
2. Coupler
3. Flange joint
4. Tube

3-25. When tanks are ballasted, what must be done to the tankside valve?

1. It must be pinned closed
2. It must be bolted closed
3. It must be locked closed
4. It must be tagged closed

3-26. What type of manifold should be used for the tanktop valves in the stripping system?

1. Double-valved manifold
2. Single-valved manifold
3. Flood and drain manifold
4. Sliding gate manifold

3-27. Which of the following is NOT a function of the flood and drain manifold?

1. Stripping
2. Transferring
3. Ballasting
4. Deballasting

3-28. What device on the flood and drain manifold allows only one valve to be opened at a time?

1. A rotating hook locking device
2. A pinning device
3. A latch-type locking device
4. A sliding bar locking device

3-29. What are the three chambers inside the fuel filter?

1. Sump, separator, and outlet
2. Sump, separator, and inlet
3. Inlet, sump, and outlet
4. Inlet, fallout, and outlet

3-30. What components are inserted in the threaded holes that are symmetrically arranged over the surface of the tube sheets?

1. Coalescer elements
2. Filter element mount assemblies
3. Separator elements
4. Vent lines

3-31. Leakage is prevented at the ends of the filter elements by the

1. smooth surface of the end caps forming a tight seal with rubber gaskets on the elements
2. fiber washers on the elements forming a tight seal against the knife edges on the end caps
3. end caps of the elements being assembled with fiber washers to form a tight seal
4. knife edges on the end caps projecting into the synthetic rubber gaskets on the elements

3-32. In what direction does fuel flow through the coalescer element?

1. Outside to inside
2. Inside to outside
3. Top to bottom
4. Bottom to top

3-33. Separator elements are considered permanent elements and are not replaced unless they become damaged.

1. True
2. False

3-34. When fuel flows from the coalescer elements to the separator elements, the coalesced water falls out of the fuel by gravity. In which chamber does this take place?

1. Outlet
2. Inlet
3. Fallout
4. Water receiving sump

3-35. The manhole cover installed on the side of the filter allows entrance to which chamber?

1. Outlet
2. Inlet
3. Fallout
4. Water receiving sump

3-36. Fuel passing from the fallout chamber to the outlet chamber must go through the

1. coalescer elements
2. separator elements
3. sump
4. water drain valve

3-37. The separator elements have the capability to only filter solid contaminants larger than how many microns?

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

3-38. The rotary control valve is bolted to what part of the filter?

1. Inlet chamber
2. Fallout chamber
3. Outlet chamber
4. Water receiving sump

3-39. What devices are provided to determine the pressure drop across the filter elements?

1. Air gates
2. Pressure gages
3. Sight glasses
4. Flow indicators

3-40. What is the rated capacity of the service fuel filter?

1. 1,100 gpm
2. 2,000 gpm
3. 2,100 gpm
4. 2,400 gpm

3-41. What is the typical pressure drop limit on the fuel filter?

1. 10 psi
2. 15 psi
3. 17 psi
4. 20 psi

3-42. Filter samples should be taken at the start of the initial flow and at what intervals thereafter?

1. Every 10 minutes
2. Every 15 minutes
3. Every 30 minutes
4. Every 60 minutes

3-43. What provides a cushioning effect when the automatic shutoff valve is opened by the filter discharge pressure acting under the valve seat?

1. A tension spring in the lower valve chamber
2. A tension spring in the upper valve chamber
3. Fuel pressure acting on the bottom of the diaphragm
4. Fuel pressure acting on the top of the diaphragm

3-44. When the eductor causes a decrease in fuel pressure on top of the diaphragm of the shutoff valve, how will the shutoff valve be affected?

1. The filter discharge pressure will open the valve
2. The filter discharge pressure will close the valve
3. The tension spring will close the valve
4. The increase in filter discharge pressure applied to the top of the diaphragm will open the valve

3-45. What causes the automatic shutoff valve to close when the pilot valve closes?

1. Fuel pressure acting on the bottom of the diaphragm in the automatic shutoff valve
2. Fuel pressure being directed through the eductor suction line to the top of the cover chamber of the automatic shutoff valve
3. Fuel pressure being directed to the top of the diaphragm in the automatic water drain valve
4. Fuel pressure being directed to the bottom of the diaphragm in the automatic water drain valve

3-46. What are the operating positions of the rotary control valve?

1. Down and up only
2. Down and horizontal only
3. Horizontal and up only
4. Down, horizontal, and up

3-47. What valve directs filter pressure through its ports to the tops of the diaphragms of the pilot and automatic water drain valves?

1. The pilot valve
2. The automatic shutoff valve
3. The rotary control valve
4. The automatic water drain valve

3-48. When there is little to no water passing through the fuel filter and the ball float is in the DOWN position, the rotary control valve directs filter pressure to. and vents it to, which valves?

1. Directs to the top of the water drain valve and vents the top of the pilot valve
2. Directs to the bottom of the water drain valve and vents the top of the pilot valve
3. Directs to the top of the water drain valve and vents the bottom of the water drain valve
4. Directs to the top of the automatic shutoff valve and vents the top of the water drain valve

3-49. When all valves of the filter hydraulic system are open and coalesced water is draining from the sump, in what position will the ball float be?

1. Down
2. Vertical
3. Horizontal
4. Up

3-50. Under which of the following conditions will the pilot and automatic shutoff valves be closed?

1. The float is in the DOWN position with no water drainage required
2. The float is in the HORIZONTAL position and the accumulated water is draining
3. The float is in the UP position and the accumulated water is not draining fast enough
4. During normal operations

3-51. Which of the following is often the most likely cause of a filter hydraulic control system failing to operate properly?

1. Manually operated valves improperly aligned
2. The tubing has obstructions or is dented
3. The automatic valves are improperly installed
4. Too much water in the fuel

3-52. During centrifugal purifier operations, where will the solid contaminants be collected after they are separated from the fuel?

1. In the heavy phase outlet
2. On the underside of the disks
3. On the outer edge of the disks
4. On the inside bowl wall

3-53. What part of the purifier acts as a pump?

1. The tubular shaft
2. The paring disk
3. The intermediate disks
4. The distribution holes in the intermediate disks

3-54. What are the ideal operating pressures of the centrifugal purifier?

1. 9 psi inlet and 25 psi outlet
2. 9 psi inlet and 30 psi outlet
3. 9 psi inlet and 35 psi outlet
4. 30 psi inlet and 9 psi outlet

3-55. When the purifier bowl has to be cleaned, which components allow the cover assembly to be rotated open without disconnecting the piping?

1. The cover hinge, inlet, and outlet assembly
2. The feed tube assembly and cover hinge
3. The feed tube assembly and ratchet hook
4. The cover hinge and ratchet hook

3-56. During purifier operations, impure JP-5 is directed into the bowl and purified JP-5 is directed out of the bowl by what force or component?

1. The seal water inlet valve
2. Centrifugal force
3. The feed tube assembly
4. The regulating tube

3-57. What part of the purifier is the shaft for the paring disk?

1. Regulating tube
2. Feed tube
3. Tubular shaft
4. Drive shaft

3-58. The feed tube screws into what device?

1. The feed tube assembly
2. The outlet tube
3. The paring disk
4. The tubular shaft

3-59. What device(s) prevent(s) the purifier from rotating during disassembly and assembly?

1. Spring-loaded handle
2. Three handwheel cover clamps
3. Lock screws
4. Ratchet hook catch

3-60. What component acts as a shock absorber to absorb vertical thrust of the spindle shaft when the purifier is started?

1. Horizontal spring
2. Vertical spring
3. Horizontal ball bearing
4. Vertical ball bearing

3-61. A total of how many sets of ball bearings support the spindle assembly?

1. Five
2. Two
3. Three
4. Seven

3-62. What components help reduce vibration in the operating purifier?

1. Four vertical springs
2. Six vertical springs
3. Four horizontal springs
4. Six horizontal springs

3-63. If the bowl of the purifier is rotating at 4100 rpm, what should the rpm of the speed counter be?

1. 100 to 130
2. 146 to 150
3. 41
4. 410

3-64. What force or device moves the oil in the oil lubrication compartment to supply lubricating oil to the bearings and gears?

1. An oil pump
2. The worm wheel gear
3. A flinger ring
4. A slinger

3-65. What parts of the tubular shaft keep it off the bowl shell and give circular motion to the feed inlet liquid?

1. 6 outer slots
2. 12 outer holes
3. 12 inner spacers
4. 3 unequal pins

3-66. How are the holes in the intermediate disks aligned vertically in the bowl shell?

1. The notch on the inward lip at the top of each disk interlocks with the key on the tubular shaft
2. The notch on the outer lip at the bottom of each disk interlocks on the tubular shaft
3. The notch on the top on each disk is interlocked with a key on the feed tube assembly
4. The notch at the top of the tubular shaft interlocks with a key on each disk

3-67. What is the normal number of intermediate disks in the disk stack?

1. 127
2. 145
3. 147
4. 150

3-68. Which of the following is the only disk not having holes around its base?

1. Disk #1
2. Disk #127
3. Bottom disk
4. Top disk

3-69. Which disk provides a rotating casing for the centripetal pump?

1. Top disk
2. Coupling disk
3. Intermediate disk
4. Paring disk

3-70. The disk stack is compressed to the correct tension by tightening the

1. spindle nut
2. coupling nut
3. coupling ring
4. discharge ring

3-71. What unique characteristic does the feed tube assembly, coupling ring, and coupling nut all have?

1. Light in weight
2. Each has a serial number to match it to a specific purifier
3. Left-handed threads
4. Right-handed threads

3-72. Each purifier is furnished with seven discharge rings. The inside diameters range from

1. 220 millimeters to 280 millimeters in 10 millimeter increments
2. 220 centimeters to 250 centimeters in 5 centimeter increments
3. 220 millimeters to 250 millimeters in 5 millimeter increments
4. 220 millimeters to 227 millimeters in 1 millimeter increments

3-73. When starting the purifier, it should come up to operating speed within how many minutes

1. 5
2. 7
3. 9
4. 11

3-74. When the purifier is in the standby mode, how often should you check the inlet-outlet housing and bowl cover to make sure they are cool to the touch?

1. Every 5 minutes
2. Every 7 minutes
3. Every 10 minutes
4. Every 15 minutes

3-75. The purifier must be cleaned before the wet cake (accumulated solids) exceeds 30 pounds or what thickness?

1. 1/4 in.
2. 1/2 in.
3. 1 1/4 in.
4. 1 1/2 in.

ASSIGNMENT 4

Textbook Assignment: "JP-5 Afloat Below Deck Systems and Operations (continued)," and "JP-5 Afloat Flight Deck Systems and Operations," chapters 4 and 5, pages 4-65 through 5-16.

4-1. What type of gage is normally installed on the suction side of a pump?

1. Simplex
2. Compound
3. Differential
4. Duplex

4-2. Which type of tanks, located between voids, are an integral part of the ship's underwater protective system?

1. Wing
2. Deep centerline
3. Double-bottom
4. Peak

4-3. Why are twin wing tanks emptied and filled as a unit?

1. The rate of flow is increased
2. To preserve the list and trim of the ship
3. The rate of flow is decreased
4. To lessen the chance of contamination

4-4. The top of a double-bottom tank is also the

1. outer shell of the ship
2. vertical bulkhead of the pumproom
3. inner skin of the ship
4. deck of the bilge

4-5. The JP-5 storage tanks are used for bulk storage of JP-5. What is the difference, if any, in JP-5 in a service tank compared to JP-5 in a storage tank?

1. It passed through a filter or centrifugal purifier
2. It was filled directly from the refueling station downcomer
3. It contains clean JP-5 defueled from defueled aircraft
4. None

4-6. What device prevents air pressure from building up or a vacuum from forming in a JP-5 tank when the tank is being emptied or filled?

1. A service suction pipe
2. A transfer suction pipe
3. An air escape riser
4. An overflow line

4-7. Why should you be concerned about ship's side cleaners spray painting near tank air escape vents?

1. The paint could get in the line and contaminate the fuel
2. The paint will mix with the JP-5 and lower its flash point
3. The paint could clog the flame arrester and block the flow of air
4. The paint will dissolve the grease applied during PMS

4-8. What device is installed in the overflow line to prevent overflow from the overflow tank going into another storage tank?

1. Globe valve
2. One-way check valve
3. Gate valve
4. Butterfly valve

4-9. Which of the following fittings is installed at the lower end of a sounding tube?

1. Brass vortex plate
2. Striker plate
3. Brass non-vortex plate
4. Bellmouth fitting

4-10. Which of the following devices is/are installed in the tank at the end of a fill and suction tailpipe?

1. Splash plate
2. Nonvortex fitting
3. Both 1 and 2 above
4. Striker plate

4-11. What is the specified fill rate of JP-5 storage tanks?

1. 500 gpm
2. 200 gpm
3. 300 gpm
4. 400 gpm

4-12. What tanks are the first to be emptied when transferring fuel internally and the last to be filled when receiving fuel aboard?

1. Overflow tanks
2. Service tanks
3. Contaminated tanks
4. Peak tanks

4-13. Where do overflow tanks overflow to when they are full?

1. Other overflow tanks
2. The contaminated tank
3. Overboard
4. Bilge sump tank

4-14. The service tank fill and suction tailpipes are exactly the same as the fill and suction tailpipes for storage tanks.

1. True
2. False

4-15. Each service tank has a recirculating line installed horizontally in the opposite end from the suction tailpipe. How far off the bottom of the tank is the recirculating line installed?

1. 12 in.
2. 18 in.
3. 24 in.
4. 26 in.

4-16. Before you enter any JP-5 tank for inspection or cleaning, the tank must be certified safe for entry by whom?

1. The below decks CPO
2. V-4 division LCPO
3. V-4 division officer
4. The gas-free engineer

4-17. The GEM TLI transmitter mounted vertically within the tank is comprised of magnetic reed switches. At what intervals are the switches capped into the transmitter?

1. 1 in.
2. 2 in.
3. 3 in.
4. 4 in.

4-18. The calibrate potentiometer in the primary receiver is adjusted to what amount of power supply output?

1. 10 volts ac
2. 10 amps ac
3. 10 volts dc
4. 10 amps dc

4-19. What operates the tap switches in the transmitter?

1. Current in the potentiometer
2. The cable system
3. The slosh dampener
4. A magnet in the float

4-20. The tap switches are arranged so voltage drops are read at the receiver after how much float travel ?

1. Every 1/4 in.
2. Every 1/2 in.
3. Every 3/4 in.
4. Every 7/8 in.

4-21. Included in the primary receiver housing are the dc power supply, electrical slosh dampening control, all alarm controls, and the

1. secondary receiver
2. indicating meter
3. ac power supply
4. sounding gage

4-22. After calibration, the toggle switch is held in the FULL REF position and a full-scale meter reading is observed. What should this reading indicate?

1. A ground in the transmitters
2. A ground in the receivers
3. Bad electrical connections
4. Cables and electrical connections are good

4-23. Why is a capacitor connected across the indicating meter?

1. To prevent meter fluctuation caused by sloshing in the tank
2. To prevent a power surge from damaging the indicating meter
3. To indicate a low power supply
4. To indicate high voltage

4-24. The alarm control system (SENS PAK) is normally used for indicating what factor(s) in the tanks?

1. High level
2. Low level
3. Both 1 and 2 above
4. Overflow

4-25. Which SENS PAK alarm control adjustment substitutes the float simulator circuit for the transmitter in the indicating meter circuit for alarm adjustment?

1. Normal simulate switch
2. Float simulator potentiometer
3. High alarm potentiometer
4. Low alarm potentiometer

4-26. On the mimic diagram of the control console, what color is used to indicate the stripping system?

1. Purple
2. Green
3. Red
4. Black

4-27. What manual contains the JP-5 systems operating procedures for a specific ship?

1. Technical Manual for Shipboard Aviation JP-5 Fuel Systems
2. Aviation Fuels Operational Sequencing System (AFOSS)
3. NAVSEA Technical Manual, Chapter 542, Gasoline and JP-5 Systems
4. Aircraft Refueling NATOPS Manual

4-28. What copy of AFOSS would be found in a filter room?

1. Division officer’s copy
2. Work center copy
3. Workstation copy
4. Master copy

4-29. What devices are used to completely empty JP-5 and ballast tanks that have been ballasted before receiving fuel?

1. Main eductors
2. Transfer pumps
3. Auxiliary pumps
4. Stripping pumps

4-30. Before fuel can be pumped Into any tank in a nest of storage tanks, what condition must be met?

1. The service tanks must be full
2. The fuel must be purified
3. The overflow tank for that nest must be empty
4. All other tanks in that nest must be empty

4-31. Typically, what is the minimum number of tanks that should be open when receiving fuel?

1. Six
2. Two
3. Eight
4. Four

4-32. Which of the following is NOT a consideration when you are determining the duration of a receiving operation?

1. Speed of the ship
2. Amount to be received
3. Pumping rate of the tanker
4. Maximum receiving rate

4-33. Underway refueling stations should be manned at least how many minutes before the fueling time?

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

4-34. Which tanks are normally filled first during a refueling operation?

1. Double-bottom
2. Wing
3. Service
4. Overflow

4-35. Where is the initial flow of JP-5 directed during an underway replenishment?

1. Service tanks
2. Peak tank
3. Contaminated settling tanks
4. Overboard

4-36. Overflow mains leading into overflow tanks are designed to allow what flow rate of overflow into overflow tanks?

1. 1,000 gpm
2. 1,500 gpm
3. 2,000 gpm
4. 2,500 gpm

4-37. After the initial samples are obtained, how often are samples taken when on-loading fuel?

1. Every 15 min
2. Every 20 min
3. Every 30 min
4. Every 60 min

4-38. A fuel sample fails to meet the cleanliness requirements during a refueling operation. Who makes the final decision on acceptance or rejection of the fuel?

1. The person taking the sample
2. The quality surveillance lab supervisor
3. The division officer
4. The commanding officer

4-39. To obtain maximum settling time, it is standard procedure to purify into the in-use service tank.

1. True
2. False

4-40. What is the settling time for JP-5 per foot of height?

1. 1 hr
2. 6 hr
3. 3 hr
4. 12 hr

4-41. When underway, JP-5 service tanks are stripped daily and what other times?

1. Every 3 hours
2. Every 6 hours
3. Just before use
4. Just before pulling inport

A. Stripping main valves to the stripping pump suction header

B. Flood and drain manifold valve to the stripping main

C. Single-valved stripping manifold valve to the tank to be stripped

D. Stripping pump discharge valve

E. Cutout valve from the discharge header to the contaminated storage tank

F. Stripping pump inlet valve

IN ASWERING QUESTION 4-42, REFER TO FIGURE 4-A.

FIGURE 4-A

4-42. Select the sequence in which you should open the valves before starting-the storage tank stripping pumps.

1. B, C, A, D, F, E
2. C. B, A, E, F, D
3. C, B, A, F, D, E
4. A, B, C, F, D, E

4-43. The pipe capacity is 120 gallons and the pump capacity is 50 gallons a minute. Approximately how many minutes must elapse after the stripping operation has started on the next storage tank before a conclusive sample of JP-5 can be taken?

1. 5
2. 2
3. 3
4. 4

4-44. How should you minimize vibration when starting the purifier with a dirty bowl?

1. By admitting seal water immediately after pressing the START button
2. By filling the purifier with fuel from the transfer pumps
3. By starting the transfer pumps before you start the purifier
4. By pumping out the sump tank to make sure all the fuel in the purifier has drained out

4-45. The motor-driven stripping pump is used to consolidate the last 24 inches remaining in the storage tanks. The pump’s discharge header is aligned so that this fuel is discharged into the

1. stripping tailpipes
2. overflow tank
3. transfer main
4. contaminated settling tank

A. Service tank

B. Downcomer

C. Service pump discharge header

D. Transfer main

E. Transfer pump discharge header

F. Filling connection

G. Service pump

IN ANSWERING QUESTION 4-46. REFER TO FIGURE 4-B

FIGURE 4-B

4-46. Select the correct sequence of flow when off-loading JP-5 from a service tank.

1. A, G, C, E, D, B, F
2. A, C, G, E, D, B, F
3. A, G, C, E, B, D, F
4. A, C, G, B, E, D. F

4-47. Which of the following operations requires flushing the entire JP-5 service system?

1. Shipyard overhaul
2. Major rework on the system
3. Drainback for maintenance
4. Each of the above

4-48. Where are samples of JP-5 obtained when flushing the service system?

1. From a test connection on the pressure fueling nozzle
2. From the telltale valve on the double-valved manifold
3. From the sample connection in the aft-service pump discharge header
4. Both 2 and 3 above

4-49. What is the Navy's largest pollution problem?

1. Air pollution
2. Noise pollution
3. Dioxin pollution
4. Oil pollution

4-50. Which of the following is an incorrect statement about the functions of the Cla-Val fuel/defuel valve?

1. It acts as an emergency shutoff valve
2. It evacuates the entire piping system
3. It maintains a constant discharge pressure
4. It relieves discharge pressure rising above a predetermined level

4-51. In the main valve, the fueling valve and defueling valve each uses a well supported and reinforced diaphragm as its operating means. Normally each valve is in what position?

1. The fueling valve is spring-loaded open and the defueling valve is held open by its weight
2. The fueling valve is spring-loaded closed end the defueling valve is held open by its own weight
3. The fueling valve is held closed by its own weight and the defueling valve is spring-loaded open
4. The fueling valve is held open by its own weight and the defueling valve is spring-loaded closed

4-52. Which valve in the Cla-Val unit controls the delivery pressure when the main valve is in the fueling mode?

1. Fueling pressure relief control valve
2. Defueling pressure relief control valve
3. Pressure reducing control valve
4. Hytrol valve

4-53. Spring action holds which of the following valves open?

1. Fueling pressure relief control valve
2. Defuellng pressure relief control valve
3. Defueling main valve
4. Pressure reducing control valve

4-54. Which valve shifts the Cla-Val unit from the defuel to the fuel mode of operation, and from the fuel to the defuel mode of operation?

1. SOPV
2. Hytrol valve
3. Defueling valve
4. Pressure reducing control valve

4-55. Which valve prevents the fuel hose from charging too quickly by controlling the reaction time of the fueling valve?

1. Flow control valve
2. SOPV
3. Fueling pressure relief control valve
4. Pressure reducing control valve

4-56. When there is an increase in the downstream pressure that is high enough to overcome the force of the spring in the defueling pressure relief control valve, which of the following valves will open?

1. The SOPV, both relief valves, and the defueling valve
2. The defueling pressure relief control valve and the defueling valve
3. The pressure reducing control valve and both pressure relief control valves
4. The flow control valve

4-57. When adjusting the delivery pressure on the Cla-Val station, what pressure should you adjust the pressure reducing control valve to first?

1. 10 psi higher than the desired delivery pressure
2. 10 psi lower than the desired delivery pressure
3. At the desired delivery pressure
4. 0 psi

4-58. When the final adjustment on the Cla-Val is made, at what pressure will the fueling valve's pressure relief control valve be set?

1. 10 psi higher than the delivery pressure
2. 7 1/2 psi higher than the delivery pressure
3. 5 psi higher than the delivery pressure
4. 2 1/2 psi higher than the delivery pressure

4-59. In a swing joint, what device connects the continuity wire to the spider assembly?

1. An amphonel gasket
2. A spider joint
3. A nylon collar
4. An amphonel stud

4-60. What device prevents the hose reel from moving when it is not in use?

1. A gear chain
2. A manual brake
3. A locking pin
4. An automatic catch

4-61. What is the standard length for a completely assembled 2 1/2-inch collapsible hose?

1. 20 ft
2. 25 ft
3. 40 ft
4. 50 ft

4-62. After cutting back and pressure testing a fuel hose, which of the following actions must you take before fueling aircraft with that hose?

1. Flush the hose
2. Sample the hose
3. Test the sample on the CFD to see if it is acceptable
4. Each of the above

4-63. The quick-disconnect has female threads on one end to accept the hose coupling. What device(s) is/are used to connect the other end to the male end of the nozzle adapter?

1. 3/8-inch nuts and bolts
2. A female ball bearing quick release
3. A pie flange
4. Swedge locks

4-64. What part of the pressure refueling nozzle houses the operating linkage?

1. Collar assembly
2. Nose seal assembly
3. Body
4. Poppet

4-65. Gravity fueling nozzles are blocked open when being used on the same station as pressure refueling nozzles.

1. True
2. False

4-66. Portable defuel pumps are operated by what force?

1. The service system riser pressure
2. The power take-off (PTO) of a tow tractor
3. The ship's low pressure air
4. The ship's high pressure air

4-67. What will happen to the solenoid on the Cla-Val if continuity is broken in any place?

1. It will reenergize with a 5-second delay
2. Its warning buzzer will emit an audible alarm
3. It will immediately reenergize
4. It will remain energized until the toggle switch on the nozzle is placed in the OFF position

4-68. If a hose ruptures while you are fueling and the continuity circuit is not broken, what, if anything, will happen?

1. The hose will shift into the defuel mode
2. The defuel pump on the station will automatically shut off causing the Cla-Val to shift to the defuel mode
3. The fuel hose will self seal
4. Nothing

ASSIGNMENT 5

Textbook Assignment: "JP-5 Afloat Flight Deck Systems and Operations (continued)," "Afloat MOGAS and Lube Oil Systems and Operations," and "Ashore Systems and Operations," chapters 5, 6, and 7, pages 5-16 through 7-8.

5-1. The checker requests the fuel load from an aircraft.The pilot responds with four fingers held vertically followed by three fingers held horizontally. How much fuel is in the aircraft?

1. 4,300 gallons
2. 4,300 pounds
3. 4,800 pounds
4. 430 pounds

5-2. What is the minimum number of personnel required to fuel an aircraft?

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

5-3. If you are fueling an aircraft in the hanger bay and there is no roving fire-fighting equipment manned, you must have a portable fire extinguisher nearby. What other equipment on the flight deck normally satisfies this requirement?

1. The flight deck sprinkler system
2. The catapult steam smothering system
3. The flight deck AFFF stations
4. The flight deck P-16

5-4. What is the maximum time a fuel hose can go without sampling and testing and still be used to fuel aircraft?

1. 12 hr
2. 24 hr
3. 26 hr
4. 32 hr

5-5. The grounding wire connecting sequence for the pressure fueling nozzle is from the

1. deck to the aircraft
2. aircraft to the deck
3. deck to the nozzle
4. nozzle to the deck

5-6. Since most personnel in a refueling crew are experienced, squadron personnel are not required to be present when fueling aircraft.

1. True
2. False

5-7. The flow control handle of the pressure refueling nozzle must be placed in the FULLY OPEN or FULLY CLOSED position. Why is the handle not allowed to "float" when refueling?

1. To prevent excessive wear on the aircraft adapter and the nozzle poppet
2. To ensure the station will go into the defuel mode if an emergency occurs
3. The time it takes to refuel the aircraft will double
4. The possibility of contamination is increased

5-8. Who is responsible for ensuring the aircraft is fueled to the correct fuel load?

1. Crewleader
2. Yellow shirt
3. Air Boss
4. Plane captain

5-9. Which of the following statements is/are correct concerning hot refueling?

1. No static samples can be taken
2. Pilot-in-command changes are not permitted
3. The aircraft cannot be refueled if it fails precheck
4. All of the above

5-10. To defuel an aircraft, a written request must be submitted to and approved by whom?

1. V-4 Division Officer
2. Air Boss
3. Aircraft Handling Officer
4. Control talker

5-11. Prior to defueling an aircraft, a sample must be drawn and tested for which of the following?

1. Flash point
2. Free water
3. Sediment
4. All of the above

5-12. All personnel directly involved in fueling or defueling operations must wear the proper safety gear. This gear includes a cranial, goggles, jersey, gloves, and life vest. However, when the ship is not at flight quarters, only goggles are required.

1. True
2. False

5-13. Whose job is it to check the fuel loads on incoming aircraft?

1. Crewleader
2. Flight deck chief
3. Nozzleman
4. Checker

5-14. The aviation lube oil system is operated according to what system?

1. ALOSS
2. LOOSS
3. DLOSS
4. CFASS

5-15. When taking on lube oil, the tanks should not be filled beyond what capacity?

1. 80%
2. 85%
3. 90%
4. 95%

5-16. What is used to determine the frequency of maintenance required on the lube oil pump?

1. MDC
2. PMS
3. IRS
4. PQS

5-17. The MOGAS system is operated according to what system?

1. CFOSS
2. EOSS
3. AFOSS
4. ALOSS

5-10. The fundamental law of hydraulics is that any pressure or force applied to a confined liquid will be transmitted equally and undiminished in all directions regardless of the size of the container.

1. True
2. False

5-19. Why does gasoline float on water?

1. Unit by unit, gasoline weighs less than water
2. Unit by unit, gasoline weighs more than water
3. Atmospheric pressure has more of an effect on water
4. Water is lighter than gasoline

5-20. Gasoline systems are designed to be full at all times to prevent what occurrence?

1. The gasoline from overflowing
2. Over-pressurizing the tanks
3. The buildup of contaminants
4. Explosive mixtures forming in air pockets

5-21. A saddle-type gasoline storage tank is actually a combination of how many tanks?

1. One tank and two cofferdams
2. Two tanks and one cofferdam
3. Two tanks and two cofferdams
4. One tank and one cofferdam

5-22. What device connects the outer tank to the draw-off tank?

1. A sluice pipe
2. A diffuser
3. A cross connect
4. The outer tank service riser

5-23. What gasoline tank is the first to be filled and last to be emptied of MOGAS?

1. Outer tank
2. Cofferdam
3. Service tank
4. Draw-off tank

5-24. What is the cofferdam normally filled with for protection?

1. Water
2. Gasoline
3. CO_2 or N_2
4. JP-5

5-25. When cofferdams are charged with nitrogen, what percentage of inertness must be maintained?

1. 25%
2. 50%
3. 75%
4. 85%

5-26. When cofferdams are charged with carbon dioxide. what percentage of inertness must be maintained?

1. 25%
2. 30%
3. 35%
4. 50%

5-27. The pressure-relief valve in the bypass line of the air escape riser is set at what psi?

1. 1 psi
2. 2 psi
3. 3 psi
4. 4 psi

5-28. When the gasoline storage tanks are 100% full of seawater, what will the differential pressure gage read?

1. 100
2. 2
3. 0
4. 4

5-29. What is unique about the float used in a MOGAS system TLI?

1. It sinks in water
2. It sinks in fuel
3. It does not contain a magnet

5-30. What device ensures back-pressure is maintained on the tanks to force gasoline to the suction side of the gasoline pumps?

1. A priming pump
2. An elevated loop in the overboard discharge line
3. A venturi installed in the discharge line
4. The downsized discharge piping

5-31. What device is designed to break the syphoning effect of the overflow loop?

1. A swing check valve
2. A sight glass
3. A spectacle flange
4. A vent line

5-32. To what pressure is the outer jacket of the double-walled piping pressurized with inert gas?

1. 12 psi
2. 15 psi
3. 3 psi
4. 5 psi

5-33. What device is provided in the bellows of the double-walled piping to inspect for fluid inside the double-walls?

1. A bolted manhole cover
2. An easy-open hatch
3. Sight glasses
4. Drain plugs

5-34. Constant pressure is maintained in the automatic pressure regulating system by balancing the spring tension in the pilot valve against what pressure?

1. The spring pressure in the main valve
2. The ejector strainer spring pressure
3. The venturi throat pressure
4. The station discharge pressure

5-35. What device prevents chatter of the main valve in the pressure regulating system?

1. The venturi
2. The ejector strainer assembly
3. The recirculating line
4. The reinforced diaphragm in the main valve

5-36. What is the function of the control valve in the automatic pressure regulating system?

1. To control discharge pressure
2. To reduce the violence with which pump pressure is admitted to the main valve cover chamber
3. To close the main valve during a sudden buildup in downstream pressure
4. To direct fuel flow to the venturi

5-37. A recirculating line on the delivery side of the venturi tube returns what percent of the capacity of the booster pump?

1. 3%
2. 5%
3. 7%
4. 10%

3-36. Why is a metal bellows used instead of fiber packing in the sylphon packless globe valve?

1. The fiber packing shrinks or deteriorates
2. The metal bellows never requires replacement
3. The fiber packing will hold a static charge
4. The metal bellows will not corrode

5-39. The pressure relief valve for the cofferdam is set at what psi?

1. 7 psi
2. 10 psi
3. 14 psi
4. 50 psi

5-40. How long after the fixed CO_2 system is activated will the CO_2 actually be discharged?

1. 5 sec
2. 10 sec
3. 15 sec
4. 30 sec

5-41. When the CO_2 flooding system is activated, which of the following actions will NOT automatically happen?

1. A warning bell will ring in the space
2. A visual alarm will show outside the space
3. The electrically operated hatches will open
4. The ventilation motors will stop

5-42. What is the maximum allowable capacity of MOGAS that can be brought onboard when the ship is alongside a pier?

1. 75%
2. 80%
3. 85%
4. 95%

5-43. What is the normal maximum allowable tanktop pressure when filling the MOGAS tank?

1. 3 psi
2. 23 psi
3. 25 psi
4. 45 psi

5-44. The MOGAS transfer pump is NOT to be started if the temperature in the discharge header exceeds how many degrees?

1. 75°F
2. 90°F
3. 95°F
4. 100°F

5-45. How many changes of seawater are required to ensure proper flushing of the MOGAS tanks?

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

5-46. The filter/separator used on shore activities is designed to remove what percent of solid and water contaminants ?

1. 98% of all solids and 98% of all water
2. 100% of all solids and 98% of all water
3. 98% of all solids and 100% of all water
4. 100% of all solids and 100% of all water

5-47. The manual water drains on the filter/separator are connected to what component(s)?

1. A recirculation line going back into the tank
2. A recovery system
3. The shore activity's sewer drain lines
4. The fuel monitor

5-48. Which of the following locations requires a filter/separator?

1. The suction side of transfer pumps
2. The storage tank to storage tank transfer lines
3. The water drain line
4. The supply piping from the storage tanks to aircraft refueler truck fill stands

5-49. Fuel quality monitors have fuses installed inside. What part of the fuse absorbs water?

1. The paper pleat
2. The sensing washers
3. The fiberglass core
4. The paper plug

5-50. At least how long must fuel maintain contact with the metal walls of a relaxation chamber?

1. 1 min
2. 5 min
3. 30 sec
4. 45 sec

5-51. All hoses used on shore activities should meet which of the following requirements?

1. Collapsible
2. Non-collapsible
3. 25 feet in length
4. Equipped with a continuity wire in the center of the hose

5-52. The hose end pressure regulator installed with the nozzle assembly is set for what maximum psi?

1. 45 psi
2. 50 psi
3. 55 psi
4. 60 psi

5-53. The loading systems on a loading rack are approved for multiproduct use.

1. True
2. False

5-54. Above-ground tanks must be surrounded by an enclosure capable of holding the entire capacity of the tank, plus how much freeboard?

1. 1 ft
2. 2 ft
3. 5 ft
4. 7 ft

5-55. The transfer line on a shore activity is 8 inches in diameter. The letters identifying the product are required to be what size?

1. 1 in.
2. 2 in.
3. 3 in.
4. 4 in.

ASSIGNMENT 6

Textbook Assignment: "Ashore Systems and Operations (continued)," and "Administration," chapters 7 and 8, pages 7-8 through 8-10.

6-1. Aircraft direct refueling systems are normally used for what function?

1. To defuel aircraft
2. To fuel support equipment
3. To hot refuel aircraft
4. To fill refueler trucks

6-2. Mobile refuelers are normally used for what function?

1. To hot refuel aircraft
2. To act as a recovery system
3. To cold-refuel aircraft
4. To load barges

6-3. The bottom loading equipment of a mobile aircraft refueler must be capable of receiving at least how many gallons per minute?

1. 300 gpm
2. 600 gpm
3. 900 gpm
4. 1,200 gpm

6-4. Vehicles used for fueling aircraft must have how many fire extinguishers installed?

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

6-5. Which of the following markings is used to identify a refuel and defuel truck?

1. JP-4 Jet Fuel F-40
2. JP-5 Jet Fuel F-44
3. Contaminated
4. Jet Fuel/JP

6-6. Refueler/defuelers and defuelers have a maximum defuel rate of

1. 50 gpm
2. 75 gpm
3. 100 gpm
4. 1,000 gpm

6-7. In a refueler and defueler, the hose evacuation system is used for defueling.

1. True
2. False

6-8. Daily checks on aircraft fueling equipment are good for a maximum of how many hours?

1. 12
2. 24
3. 3
4. 4

6-9. During the daily inspection of a refueler, water is found when the low points are trained. What action should you take?

1. Notify the air operations officer and have all aircraft fueled with that refueler recalled
2. Flush the refueler
3. Redrain the low points until a clear sample is obtained
4. Reclassify the fuel as contaminated

6-10. Fuel trucks that are more than half full are limited to a recirculation time of how many minutes?

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

6-11. Weekly checks are performed weekly and when a piece of equipment is being returned to service after being down for more than how many hours?

1. 12 hr
2. 24 hr
3. 48 hr
4. 72 hr

6-12. When are engine spark checks performed?

1. Every week
2. In the morning
3. In the afternoon
4. At night

6-13. Unless element problems require an earlier change, how often are filter and monitor elements changed?

1. Every 6 months
2. Every year
3. Every 3 years
4. Every 5 years

6-14. Filter and monitor elements require changing if the pressure drop across either unit reaches what total use?

1. 15 psi
2. 20 psi
3. 25 psi
4. 30 psi

6-15. Filter and monitor elements require changing if the pressure drop across both units reaches what total psi?

1. 15 psi
2. 20 psi
3. 25 psi
4. 30 psi

6-16. What problem may be indicated by a significant drop in differential pressure?

1. An element rupture
2. A leak in the downstream side from the filter or monitor
3. Clogged elements
4. Excessive water in the feed fuel

6-17. Which of the following operations must be immediately terminated if a spill or leak of any size occurs?

1. Sampling
2. Hot refueling
3. Cold refueling
4. Refueling support equipment

6-18. Large spills require handling by the Spill Response Team. What size spill is/are considered a large spill?

1. More than 10 square feet
2. Greater than 10 feet in any direction
3. More than 50 square feet
4. Both 2 and 3 above

6-19. What is the minimum number of personnel required when cold refueling aircraft at a pit?

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

6-20. Which of the following is a characteristic of deadman controls?

1. They are normally blocked open to allow the operator to perform other duties
2. They are never blocked open
3. They are used only in pits
4. They are used only when hot refueling aircraft

6-21. Before being filled from a truck fill stand, completely empty trucks must have approximately how many gallons of fuel pumped into them at a low flow rate from another truck?

1. 100 to 1,000
2. 250 to 500
3. 500 to 1,000
4. 100 to 500

6-22. What is the closest a truck may get to an aircraft?

1. 10 ft
2. 20 ft
3. 25 ft
4. 50 ft

6-23. Refuelers and refueler/defuelers are NEVER left pointing toward any part of an aircraft.

1. True
2. False

6-24. What is the minimum number of personnel required to fuel an aircraft by truck?

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

6-25. Why should a window be open when the engine of a truck is idling?

1. To prevent carbon monoxide building up in the cab
2. To allow the operator to hear refueling commands
3. So the operator can reach the power take off
4. So the operator can get out in case of a fire

6-26. When refueling with a truck, who is responsible for making sure the fire-fighting equipment is manned before starting the refueling operation?

1. Nozzleman
2. Refueling operator
3. Coordinator
4. Director

6-27. If a refueler operator has to leave his truck unattended. what is the first action taken?

1. Chock the wheels
2. Set the parking brakes
3. Stop the engine
4. Drive the truck clear of aircraft

6-28. Why are pantographs preferred over hoses for hot refueling operations?

1. Pantographs are easier to stow
2. Pantographs are less likely to be run over
3. Pantographs are less likely to rupture
4. Pantographs are easier to repair

6-29. When hot refueling, it is acceptable for the hose or pantograph to pass under the aircraft as long as the fueling coordinator is aware of the situation.

1. True
2. False

6-30. What special safety precaution must be followed if you are hot refueling a helicopter by truck without using a pantograph?

1. Two fire-fighting units must be manned
2. An extra length of hose must be added to the truck
3. The rotor blades must be disengaged

6-31. Piggyback refueling is conducted only with properly configured vehicles and under the direct supervision of whom?

1. Fuels division LPO
2. Fuels division LCPO
3. Fuels maintenance officer
4. Commanding officer

6-32. Who maintains a list of squadron personnel authorized to request a defuel?

1. Fuels division LPO
2. Fuels division LCPO
3. Fuels maintenance officer
4. Executive officer

6-33. When defueling aircraft on shore activities, the aircraft being defueled must be at least how far away from other structures and aircraft?

1. 10 ft
2. 25 ft
3. 50 ft
4. 100 ft

6-34. Defueled fuel containing leak detection dye is considered contaminated and cannot be reissued to aircraft.

1. True
2. False

6-35. During a defuel operation, the pump starts to lose prime or cavitates. At least how much time must pass before the supervisor authorizes a restart?

1. 1 min
2. 3 min
3. 5 min
4. 10 min

6-36. What is the first choice in disposing nonsuspect fuel defueled from an aircraft?

1. Use it to refuel aircraft from the same squadron of the defueled aircraft
2. Sell it
3. Issue it to aircraft scheduled for immediate sea duty
4. Use it to refuel helicopters

6-37. If a mobile refueler carrying JP-4 is changed to carry JP-5, what procedures must be followed?

1. Drain and fill with JP-5
2. Drain, flush with JP-5, drain again, and fill with JP-5
3. Drain, steam clean, dry, and fill with JP-5
4. Drain, gas free, and fill with JP-5

6-38. If a mobile refueler carrying JP-5 is changed to carry JP-4, what procedures must be followed?

1. Drain and fill with JP-4
2. Drain, flush with JP-4, drain again, and fill with JP-4
3. Drain, steam clean, dry, and fill with JP-4
4. Drain, gas free, and fill with JP-4

6-39. Smoking, spark or flame producing items, and open flames or hotwork are not permitted within how many feet of a refueling operation?

1. 50
2. 75
3. 100
4. 500

6-40. Aircraft refueling/defueling operations are not allowed to be conducted within how many feet of ground radar equipment?

1. 300
2. 500
3. 700
4. 1,000

6-41. Fuel vapors will collect in pits. sumps, and open sewers because the vapors are

1. lighter than air
2. heavier than air
3. warmer than air
4. cooler than air

6-42. Technical publication libraries serve what function?

1. A place to submit 3-M feedback reports
2. A central storage area for outdated but useful manuals
3. A central source of up-to-date technical information for personnel
4. A place to turn in parts for technical inspection

6-43. What type of manual contains a description of a system and instructions for its effective use?

1. 3-M manual
2. Maintenance manual
3. Operational manual
4. MRCs

6-44. Which of the following is an example of a maintenance manual containing a description of individual systems for the purpose of maintenance and repair?

1. Aircraft Refueling NATOPS Manual
2. Ship's Maintenance Material Management Manual
3. COMNAVAIRPAC/LANTINST 3100.4, Air Department Standard Operating Procedures
4. Maintenance Manual for Motor Driven JP-5 Transfer Pump, Type TG3DBCX-337

6-45. Technical/Maintenance manuals do NOT contain which of the following?

1. Theory of operation
2. Preventive maintenance procedures
3. Parts breakdown and numbers
4. Operating and design limits

6-46. Which of the following documents contains the provisions for its own cancellation?

1. An instruction
2. A Naval Ships Technical Manual
3. A maintenance requirement card
4. A notice

6-47. If a change is issued for a publication in your technical library, when should that change be made?

1. Immediately upon receipt
2. Within 7 days of receipt
3. Within 30 days of receipt
4. The next time the publication is required for use

6-48. Checklists can be tailored to fit specific equipment, but what requirements MUST be met in any checklist?

1. Tools required
2. Man-hours required
3. Preventive maintenance required
4. Intended use of the equipment

6-49. What is the purpose of checker cards?

1. To account for fuel issued to each aircraft
2. To check which fueling has been sampled
3. To tell how much fuel is in the service tanks
4. To check which aircraft has been sampled

6-50. A casualty is an equipment malfunction that reduces the unit's ability to perform its primary mission because it cannot be repaired within a maximum of how many hours?

1. 6
2. 12
3. 24
4. 48