TM 55-1925-273-SDC

This manual supersedes TM 55-1925-207-SDC, dated 16 August 1991

TECHNICAL MANUAL

SHIPBOARD DAMAGE CONTROL MANUAL
FOR
INLAND AND COASTAL LARGE TUG (LT)
NSN 1925-01-509-7013 (EIC XAG)

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY

30 NOVEMBER 2005

WARNING SUMMARY

FIRST AID

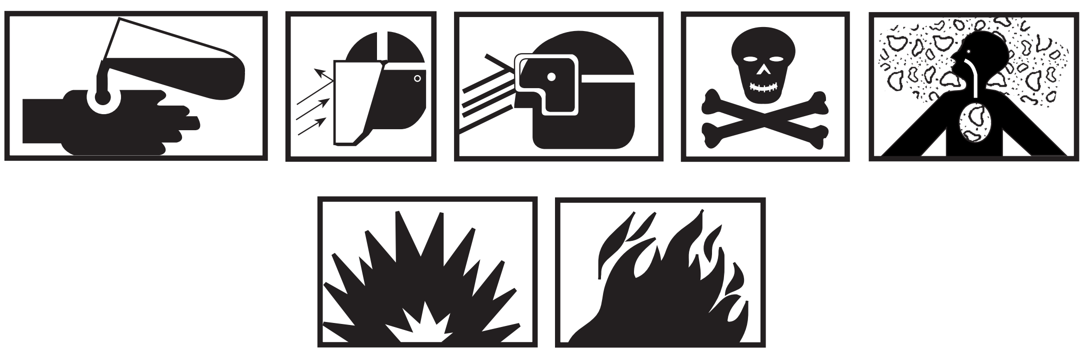
Although the 128' Large Tug is normally assigned a medic, first aid is still an important skill for all crewmembers. The ability to promptly administer first aid to another crewmember could mean the difference between life and death for that crewmember. First aid procedures for soldiers are contained in FM 4-25-11.

WARNING SUMMARY CONTENT

This warning summary contains general safety warnings and hazardous materials warnings that must be understood and applied during operation and maintenance of this vessel and its equipment. Failure to observe these precautions could result in serious injury or death to personnel. Also included are explanations of safety and of hazardous materials used within the technical manual.

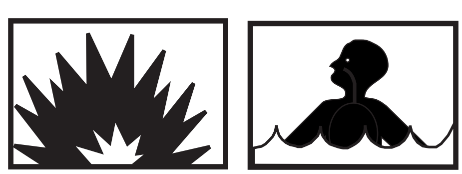
WARNING

Unauthorized modifications, alterations or installations of or to this equipment are prohibited and are in violation of AR 750-10. Any such unauthorized modifications, alterations or installations could result in death, injury or damage to the equipment.



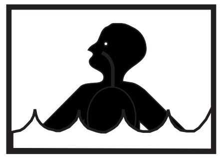
Dangerous chemicals are used in this equipment. Serious injury or death may result from failure to observe safety precautions.

Never work on energized electrical circuits. Serious injury or death may result if safety precautions are not observed.



Investigation of structural damage by visual examination presents many difficulties and dangers. To do a thorough job, it will often be necessary to open one or more watertight doors or hatches. It is unwise to open any such closures in the vicinity of damage, and it should be done only after a thorough investigation by means of soundings, and after obtaining permission from higher authority whenever the situation permits. Serious personal injury is possible.

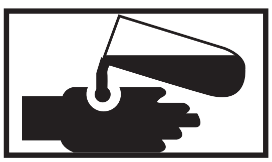
Crew members must wear Oxygen Breathing Apparatus (OBA) when entering compartments that have not been tested as safe to enter. Serious personal injury could result.



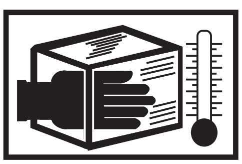
No watertight door, hatch, air fitting, oil fitting, cap, plug, scuttle, or manhole is to be opened until it is known definitely that the compartment on the other side is either completely dry, or so little flooded that opening the closure will not permit flooding to spread. Personal injury may result.

EXPLANATION OF SAFETY WARNING ICONS

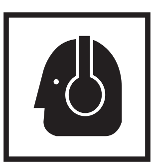
BIOLOGICAL - abstract symbol bug shows that a material may contain bacteria or viruses that present a danger to life or health.



CHEMICAL - drops of liquid on hand show that the material will cause burns or irritation to human skin or tissue.



CRYOGENIC - hand in block of ice shows that the material is extremely cold and can injure human skin or tissue.

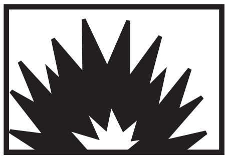


EAR PROTECTION - headphones over ears show that noise level will harm ears.

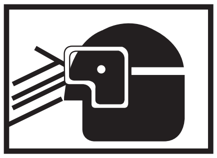
ELECTRICAL - electrical wire to arm with electricity symbol running through human body shows that shock hazard is present.

ELECTRICAL - electrical wire to hand with electricity symbol running through hand shows that shock hazard is present.

EXPLANATION OF SAFETY WARNING ICONS (continued)



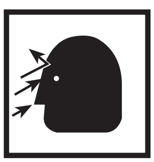
EXPLOSION - rapidly expanding symbol shows that the material may explode if subjected to high temperatures, sources of ignition, or high pressure.



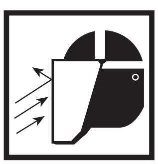
EYE PROTECTION - person with goggles shows that the material will injure the eyes.

FALLING PARTS - arrow bouncing off human shoulder and head shows that falling parts present a danger to life or limb.

FIRE - flame shows that a material may ignite and cause burns.



FLYING PARTICLES - arrows bouncing off face show that particles flying through the air will harm face.



FLYING PARTICLES - arrows bouncing off face with face shield show that particles flying through the air will harm face.

HEAVY OBJECT - human figure stooping over heavy object shows physical injury potential from improper lifting technique.

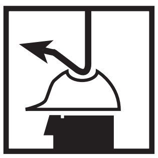
HEAVY PARTS - hand with heavy object on top shows that heavy parts can crush and harm.

HEAVY PARTS - foot with heavy object on top shows that heavy parts can crush and harm.

EXPLANATION OF SAFETY WARNING ICONS (continued)

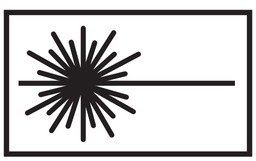
HEAVY PARTS - heavy object on human figure shows that heavy parts present a danger to life or limb.

HEAVY PARTS - heavy object pinning human figure against wall shows that heavy, moving parts present a danger to life or limb.

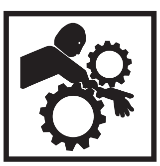


HELMET PROTECTION - arrow bouncing off head with helmet shows that falling parts present a danger.

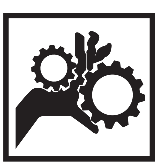
HOT AREA - hand over object radiating heat shows that part is hot and can burn.



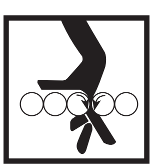
LASER LIGHT - laser light hazard symbol indicates extreme danger for eyes from laser beams and reflections.



MOVING PARTS - human figure with an arm caught between gears shows that the moving parts of the equipment present a danger to life or limb.



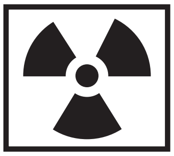
MOVING PARTS - hand with fingers caught between gears shows that the moving parts of the equipment present a danger to life or limb.



MOVING PARTS - hand with fingers caught between rollers shows that the moving parts of the equipment present a danger to life or limb.

POISON - skull and crossbones show that a material is poisonous or is a danger to life.

EXPLANATION OF SAFETY WARNING ICONS (continued)



RADIATION - three circular wedges shows that the material emits radioactive energy and can injure human tissue.

SHARP OBJECT - pointed object in hand shows that a sharp object presents a danger to limb.

SHARP OBJECT - pointed object in hand shows that a sharp object presents a danger to limb.

SHARP OBJECT - pointed object in foot shows that a sharp object presents a danger to limb.

SLICK FLOOR - wavy line on floor with legs prone shows that slick floor presents a danger for falling.

VAPOR - human figure in a cloud shows that material vapors present a danger to life or health.

LIST OF EFFECTIVE PAGES/WORK PACKAGES

NOTE: The portion of text affected by the changes is indicated by a vertical line in the outer margins of the page. Changes to illustrations are indicated by miniature pointing hands. Changes to wiring diagrams are indicated by shaded areas.

Date of original issue for this manual is:

Original 30 NOVEMBER 2005

TOTAL NUMBER OF PAGES FOR FRONT AND REAR MATTER IS 36 AND TOTAL NUMBER OF WORK PACKAGES IS 21, CONSISTING OF THE FOLLOWING:

Page/WP No.	* Change No.
Front Cover	0
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f blank	0
A	0
B blank	0
i-iv	0
Chp 1 title page	0
WP 0001 00 (2 pgs)	0
Chp 2 title page	0
WP 0002 00 (6 pgs)	0
Chp 3 title page	0
WP 0003 00 (16 pgs)	0
Chp 4 title page	0
WP 0004 00 (8 pgs)	0
WP 0005 00 (16 pgs)	0
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DA 2028	0
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* Zero in this column indicates an original page or work package

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 30 NOVEMBER 2005

TECHNICAL MANUAL

SHIPBOARD DAMAGE CONTROL MANUAL FOR INLAND AND COASTAL LARGE TUG (LT) NSN 1925-01-509-7013 (EIC XAG)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Submit your DA Form 2028 (Recommended Changes to Equipment Technical Publications) through the Internet on the Army Electronic Product Support (AEPS) Web site. The Internet address is https://aeps.ria.army.mil. The DA Form 2028 is located under the Public Applications section on the AEPS public home page. Fill out the form and click on SUBMIT. Using this form on the AEPS site will enable us to respond quicker to your comments and better manage the DA Form 2028 program. You may also mail, fax, or e-mail your letter or DA Form 2028 directly to: AMSTA-LC-LPIT / TECH PUBS, TACOM-RI, 1 Rock Island Arsenal, Rock Island, IL 61299-7630. The e-mail address is TACOM-TECH-PUBS@ria.army.mil. The fax number is DSN 793-0726 or Commercial (309) 782-0726.

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How to Use This Manual

USING THIS MANUAL

When using this manual, read and understand the entire action before performing that action. Also, read and understand all warnings, cautions, and notes as well as general safety precautions that apply to the action. The warning summary will inform personnel of hazards associated with the equipment to be worked on. However, the summary is not all inclusive and personnel should be aware at all times of hazardous conditions that may arise.

ACCESSING INFORMATION

Information is accessed by referring to the table of contents, located in the front of this manual, or by looking in the alphabetical index, located in the back of this manual.

To locate information using the table of contents, first scan the chapter titles to determine the general area in which your information will be contained. After locating the proper chapter, look beneath the chapter title to find the desired informational or procedural work package title. To the right of the work package title is a work package sequence number. This work package sequence number will direct you to the proper work package. Work packages are arranged in numerical order in this manual.

To locate information using the alphabetical index, look down the subject column on the left side of the page until you find the desired subject. To the right of the subject is the work package sequence number and page number. Go to the indicated work package and indicated page number to find the desired information.

LIST OF ABBREVIATIONS/ACRONYMS

Abbreviation/Acronym	Name
°C	Degrees Centigrade
°F	Degrees Fahrenheit
AFFF	Aqueous Film Forming Foam
AMS	Auxiliary Machinery Space
BII	Basic Issue Items
cm	Centimeter(s)
COEI	Components of End Item
COTS	Commercial Off the Shelf
CPC	Corrosion Prevention and Control
dc	Direct Current
DC	Damage Control
EDG	Emergency Diesel Generator
EOS	Enclosed Operating Station
ER	Engine Room
ERWWS	Engine Room Water Washdown System
ESD	Electrostatic Discharge
FF	Firefighting
FM	Fire Main
ft	Foot(feet)
ft^2	Square foot(feet)
ft^3/min	Cubic feet per minute

LIST OF ABBREVIATIONS/ACRONYMS (CONTINUED)

Abbreviation/Acronym	Name
HF	Hydrogen Fluoride
in	Inch(es)
in^3	Cubic Inch(es)
L	Liter(s)
LED	Light Emitting Diode
L/min	Liters per minute
lb	Pound(s)
lb-ft	Pounds Feet (torque)
LT	Large Tug
m	Meter(s)
mm	millimeter(s)
m^2	Square meter(s)
Nm	Newton Meter
ODS	Ozone Depleting Substance(s)
PMCS	Preventive Maintenance Checks and Services
PPE	Personal Protective Equipment
PPM	Parts Per Million
PSI	Pounds per Square Inch
SSDG	Ship's Service Diesel Generator
TM	Technical Manual
UV	Ultraviolet
Vac	Volts, Alternating Current
Vdc	Volts, Direct Current
WWS	Water Washdown System

Chapter 1

General Information
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) GENERAL INFORMATION

NOTE

Shipboard Damage Control (SDC) repairs and fixes shall be used only in combat or other emergency conditions and at the discretion of the vessel master. Damage will be permanently repaired by means of standard maintenance procedures as soon as practical.

PURPOSE

This Shipboard Damage Control (SDC) manual covers the assessment and repair of equipment failures that can occur under emergency conditions such as battle damage, fire, and flooding. Emergency repairs may limit system operation, because some components in the system may need to be bypassed or jury-rigged to function. The purpose of emergency repairs is not to restore the equipment to full operation, but rather to achieve a minimum operational condition for the vessel's major systems and equipment. Emergency conditions may require the use of alternative procedures to operate damaged systems at reduced capacity or in a minimum operating condition. After the emergency repair has been completed, the equipment should be tested for the purpose of damage assessment and for operational capability. If changes to normal operating procedures are necessary, the modified procedures must be provided to the operators.

SCOPE

Damage control includes the functional combination of all equipment, material, devices, and techniques designed to prevent, minimize, or restore wartime or peacetime damage. The damage control organization has the same objectives whether the country is at peace or at war. The vessel's ability to perform its mission and survive depends upon the effectiveness of its damage control organization. This includes passive defense for conventional, nuclear, biological, and chemical warfare, and all active defensive measures short of those designed to prevent successful delivery of enemy attack by military means or sabotage. The three primary areas of responsibility for damage control include the following:

1. The functional combination of all equipment, material, devices, and techniques that prevent and minimize damage and restore damaged equipment and structures. This damage can occur in wartime or peacetime.

2. The passive defense against conventional, nuclear, biological, and chemical warfare.

3. All active defense measures short of those designed to prevent successful delivery of an enemy attack by military means or sabotage.

DAMAGE CONTROL OBJECTIVES

Shipboard damage control is designed to work towards the following three basic objectives:

1. Take all practicable preliminary measures to prevent damage. Incorporation of practical measures to prevent damage results from a conscientious effort of the crew to operate the vessel in a safe manner. Items include, but are not limited to the following:

    a. Maintaining adequate lookouts.

    b. Performing Preventive Maintenance Checks and Services (PMCS) correctly and in a timely fashion.

    c. Operating the vessel and its systems within design capabilities.

    d. Keeping the vessel clean and wastebaskets empty so as not to create fire hazards.

e. Not fouling access ways and doors so that watertight boundaries can be established in the event of flooding.

f. Conducting training and drills so that damage control information is known and emergency actions are practiced.

2. Minimize and localize damage as it occurs. It is vital that the crew always be prepared to combat casualties that may occur. The impact of a casualty may be lessened if preventative measures are in place. Every crewmember should know how to use permanent and portable dewatering pumps to remove water weight from the vessel (WP 0007 00). The small crew size of the LT makes it vitally important to maintain watertight boundaries at all times. Maintaining boundaries automatically localizes the flooding so that efforts to combat the casualty (WP 0016 00, WP 0017 00, and WP 0018 00) are better focused. Performing housekeeping actions, such as keeping passageways clear and proper stowage, allow unimpeded access to areas in the event of a casualty. Conducting training and drills on the use and methods of shoring (WP 0015 00) will lessen the time involved to make emergency repairs, and thus will minimize concurrent damage from flooding and possible injury to personnel.

3. Accomplish emergency repairs as quickly as possible, restore equipment to operation, and care for injured/wounded personnel. These are the textbook goals for responding to any situation that requires damage control efforts. In the event of a casualty, it is the primary goal to take the necessary actions to ensure the survivability of the crew. If the vessel can be saved, take every action to do so. The purpose for saving the vessel is to complete the mission and to provide a safe haven for the crew. If the vessel will remain a navigation hazard, crew hazard or will benefit the enemy if it is saved, then abandon it and save the crew. Calm, objective thinking in a crisis is imperative if both the crew and the vessel are to survive.

ATTAINMENT OF DAMAGE CONTROL OBJECTIVES

The damage control organization has the same objectives in peace and war, although the threat is accentuated in war. The vessel's ability to perform its assigned mission will depend upon the effectiveness of damage control. To attain these objectives, the crew must accomplish the following:

1. Preserve or establish stability, fume-tight and watertight integrity (buoyancy), maneuverability, and offensive power.

2. Maintain the operational capabilities of vital systems.

3. Prevent, isolate, combat, extinguish, and remove the effects of fire and explosion.

4. Detect, confine, and remove the effects of nuclear, biological, or chemical (NBC) contamination.

5. Prevent personnel casualties and administer first aid to the injured.

6. Make rapid repairs to correct structural and equipment damage.

END OF WORK PACKAGE

Chapter 2

Effects of Damage
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) EFFECTS OF DAMAGE

GENERAL

Knowing the types of damage and what emergency actions to take can save the vessel and its crew. The ability to repair the various types of damage will allow the vessel to continue the assigned mission, or depending on the severity of the damage, increase the chances of return to port for more extensive repairs. When planning and preparing for control of damage, it is important to understand that no two casualties are identical, nor will they require the same responses even though the cause of damage may be similar. Collisions, groundings, and storms have caused damage so severe that even very large ships were threatened. The nature of repairs that the vessel requires depends upon the type of damage, the type of vessel, and the location of the damage. The following are the general damage classifications:

1. Large holes in the underwater hull
2. Small holes and cracks in the underwater hull
3. Holes in the hull above the water
4. Punctured, weakened, buckled, or distorted bulkheads
5. Flooded machinery compartments or other vital spaces
6. Warped or sprung doors and hatches
7. Weakened or ruptured beams, supports, and other strength members
8. Ruptured or weakened decks
9. Wreckage, which interferes with equipment operation
10. Ruptured or cracked pipes
11. Severed electric cables
12. Broken or distorted foundations under machinery
13. Broken or pierced machinery units
14. Fire, with its attendant heat, smoke, and other damage

THE NATURE OF DAMAGE

In a casualty situation the first decision to be made is whether or not to stay with the vessel. This decision depends on the ability of the vessel to survive the casualty. The immediate need for this decision occurs at the outset of the casualty, and continues as the casualty situation is modified over time by changes that influence the ability of the vessel to survive. The most important of these factors are:

1. The ability to float and stay upright
2. The ability to control and extinguish fires
3. The ability to stay on mission and repel attack
4. The ability to reach a safe haven

The nature of the damage affects the survivability of the vessel and the crew. Flooding presents the greatest hazard to a vessel at sea, and every effort must be made to halt flooding as the first priority. Fire is also dangerous, and is often considered to be the Army mariner's worst enemy. While every effort must be made to stop flooding to the maximum extent possible, it is understood that other casualties may prevent this objective. Minor flooding can become a major problem when other casualties must be given a higher priority.

For example, blast damage can cause fragment holes, warped decks and bulkheads, sprung closures, and ruptured piping. Each of these casualty types alone may or may not be sufficient to produce an immediate danger, but the combined effects can be disastrous. These effects could lead to the inability to get to the leaks, loss of power and pumps, reduced watertight integrity, and the inability to dewater the vessel. After damage, the most important factor that determines the ability to survive is the ability of the crew to halt the flooding by making emergency repairs by means of plugging, patching, and shoring. Once the flooding is halted, the vessel should be able to handle any remaining casualties.

Self-inflicted damage is another concern. This type of damage mainly stems from a lack of preparation or even neglect. Other causes of this type of damage come from impaired stability due to excessive deck load, improper/unbalanced removal of ballast, overloading, free surface movement in the vessel's tanks or bilges, and design problems. Experience shows that after suffering damage that involves serious flooding, one of two situations usually take place. In the first situation, damage is so extensive that the vessel never stops listing, trimming or settling in the water, and sinks within a few minutes. In the second situation, the vessel stops heeling, changing trim, and settling in the water shortly after the initial damage. Experience shows that in the second case, the primary cause of sinking is directly traceable to progressive flooding that was ignored because higher priority was given to other casualties.

BELOW WATERLINE DAMAGE

Underwater damage may be from battle damage or from collision damage caused by contact with another vessel or by underwater obstacles, fixed or floating. Below waterline damage to a hull resulting from collision, explosive device, or grounding might not cause a vessel to immediately sink or require abandonment, but the following can occur:

1. List
2. Flooding with seawater and/or fuel oil
3. Impairment of vital operating systems in damaged area
4. Fire

Complete flooding of a compartment or flooding to sea level, generally will indicate that the compartment is open to the sea. Flooding to a lesser height may indicate that the puncture is relatively small and that progressive flooding is occurring. Progressive flooding can be verified by soundings. Isolated or concealed seawater lines leading through a closed or unmanned compartment may rupture, causing the compartment to flood. This condition is more dangerous than penetration of the hull. In time, the pressure within the compartment may increase, causing undamaged bulkheads to collapse. It must be remembered that the stress on the vessel's girder (keel), is increased by the weight of floodwater added. The increase in stress depends on the amount and the location of the water.

The list of the vessel can be presumed to be due to off-center weight. If the vessel is underway when damaged, and the probability of receiving additional underwater damage is possible, prompt removal of the list is the prime consideration. List has many undesirable effects:

1. Impaired speed due to increased propulsion resistance, increased difficulty in operating the main propulsion plant, and possible improper immersion of propellers
2. Impaired maneuverability

3. Impaired overall stability due to list and improper trim

4. Increased difficulty in servicing and operating deck equipment

5. Increased risk of swamping or sinking

A combat hit, which strikes the vessel's side below the waterline, which can cause all the effects outlined above, may seriously decrease hull strength. A hit near the stern may damage or carry away one or both propellers, and can render inoperative or destroy the rudder and steering gear. Damage causing total flooding of tanks or void spaces below the waterline may have a beneficial effect on stability if there is no list and sufficient freeboard exists. The amount of such flooding that the vessel can withstand depends upon the ballast and cargo distribution before the damage occurs. New ballasting figures must be calculated using the methods described in the Stability and Loading Data booklet to ensure that a safe amount of reserve buoyancy remains.

If an underwater weapon explodes on contact with the hull, a hole is torn in the hull, and the interior of the vessel is subjected to blast and fragment attack, followed by a violent inrush of water. Surrounded by a liquid medium, underwater weapons do not depend upon their casing for fragment attack, but instead, tear loose large chunks of the vessel's structure and hurl them into the vessel with projectile-like violence. Blasts and fragments may sever wiring circuits. Severed and grounded cables will interrupt power and can short the entire electrical system. If the damaged area is amidships, machinery spaces will be flooded. The power plant may be affected, propulsion may be lost.

Underwater damage depends mainly on the weight of the bursting charge. Because of the large amounts of explosive used in modern underwater weapons, the holes opened in the hull of the vessel will be very large. Flame from incandescent gases created by explosion can spread through the affected area. Hot fragments can also cause fires. Acrid smoke and toxic gases from the explosion and fire will necessitate the use of the Oxygen Breathing Apparatus (OBA). When a vessel sustains underwater damage, violent shock may break or derange electronic radio, radar or navigation equipment. Brittle materials such as valve bodies or castiron base plates under machinery can be fractured. Shock frequently opens circuit breakers. Violent heaving of decks can cause personnel injury to those who are standing at the time of impact.

Watertight integrity below the main deck of the LT is provided by the installation of athwart ships bulkheads at frames 6, 14, 21, 44, 54, and 56. The bulkheads at frames 21 and 44 are fitted with hand operated sliding watertight doors. At or above the main deck, watertight doors protect compartments. On the main deck a watertight hatch at frame 59 and a watertight door at frame 21 protect the damage control locker, the boatswain's storeroom, and the berthing and messing spaces. The 01 level watertight doors lead to the emergency generator room at frame 32, and to the officers' berthing spaces at frames 33 and 47 port and starboard.

FIRE

In any casualty that causes structural damage, fire is almost certain to follow. Unless the fire is extinguished speedily and effectively, more serious damage than that caused by the initial problem will result. Many vessels have been lost to fire. Experience indicates that steel vessels can become floating furnaces, fed by the combustible and flammable materials carried on board. Some vessels have become blazing infernos that had to be abandoned and sunk by our own forces because fires got out of control. Fire may cause the loss of a vessel after other damage has been repaired or minimized. There is a substantial amount of combustible material on board the LT. Fire must be considered a potential hazard requiring every effort to eliminate, control, and extinguish.

CORRECTIVE MEASURES FOR CONTROL OF DAMAGE

The following steps are provided to cover the basic procedures and techniques for preventing and minimizing vessel damage in the event of a casualty.

1. Keep the bridge informed: The timeliness and accuracy of all reports to the bridge will have a direct bearing upon the speed and success attained in correcting the damage. The bridge must be continually informed of progress in correcting damage, particularly of a deteriorating situation. A continual flow of information to the bridge must be maintained by the most efficient and rapid means available. Excess reporting is better than too little.

2. Initial report: Reporting known or suspected damage is an all-hands responsibility. The speed with which the bridge is informed of damage and the accuracy and thoroughness of the report will be key factors in reducing damage caused by material casualties. Anyone aware of damage (fire, flooding, etc.) shall immediately report the incident to the bridge by the fastest means possible. The initial report should include the following:

    a. Type of damage (if known)

    b. Location (compartment noun name, frame, deck, port/starboard side, etc.)

    c. Estimate of extent of damage (if known)

    d. Name of the individual reporting the damage

There will be cases which should be corrected "on the spot" by the individual discovering the damage. However minor it may seem, it is important to report the damage before attempting to correct it. All damage, no matter how minor, shall be reported to the Vessel Master. Attempts to correct problems may be made once the initial reports are made.

3. Battle Dress: When the general alarm is sounded, the appropriate battle dress will be promptly donned. Long sleeved shirts, the firefighting ensemble, survival suit, safety shoes, helmets, life jackets, weapons, and protective masks are examples of battle dress. The Vessel Master determines the battle dress. Relaxing of full battle dress may be authorized by the Vessel Master in spaces where it restricts necessary personnel movement (for example, on the bridge, and in main engineering spaces). In these cases, those items will be available within arm's reach of the personnel involved. Personal clothing will be adjusted to cover maximum body area to prevent flash burns.

4. Investigating and Reporting Damage: Any crewmember discovering damage will report it to the bridge. The damage control team will respond. When damage is reported or suspected as a result of any outside influence, an immediate investigation shall be conducted to determine the type and extent of the damage. Prompt investigation and accurate reporting will allow the chief engineer to evaluate the damage, and make effective repairs. The bridge will be informed of the extent of damage, the corrective action in progress or recommended, and the status of vessel's stability and maneuverability. While the need for immediate investigation of the damage is stressed, the need for caution on the part of the investigators remains paramount.

WARNING

Investigators will wear oxygen-breathing equipment when entering the damaged area. They will work in pairs, and maintain communications with assistants outside the damaged area. When the situation permits, no closed space or void will be entered until the area has been cleared by the Chief Engineer. Should fire, flooding, or other factors prevent the clearing of the area by the Chief Engineer, the investigators will continue, but they will assume that hazardous conditions exist. Failure to consider the presence of flammable, explosive or toxic fumes, and/or that the atmosphere of the space cannot sustain life, can lead to the death or serious injury of personnel.

5. Preliminary Investigation of Damage: The degree of investigation required after a vessel has suffered damage depends upon the location, the extent of the damage, and the type of damage. Certain information as to the extent of damage will be available almost immediately. Heavy shock and whipping of the hull structure may indicate a major underwater explosion. A decided or progressive change in trim or list indicated by clinometers will also provide information. Additional information will come from the damage control team near the scene of the damage.

Examples of damage reports might include the bridge reporting that steering control has been lost. Engineering may report that water is coming through a certain bulkhead. The information may be preliminary, but the combined reports from topside and below-decks personnel aid in locating the damage. Also, a better picture of the extent of the damage is provided. On the other hand, there may be few, if any, obvious signs of damage. Items such as a minor loss of power, a slight smell of smoke, a dropping pressure gauge, an unusual temperature change, or a slight seeping of liquid at a seam can be indications of major problems. All of these separate indications should be investigated thoroughly because the combined symptoms are signs of a very dangerous condition. Reporting these minor problems to the bridge provides the vessel a means of collating information that may indicate a major casualty. This enables the Vessel Master to initiate the prompt remedial action necessary to ensure the survivability of the vessel.

Vessels have been lost or suffered unnecessary damage because investigating crew members neglected one or more of the following principles:

a. The investigation should be thorough

b. The investigation should be conducted with caution

c. All reports should be accurate

d. Investigations should be repeated to guard against overlooking progressive damage

6. Compartments Adjacent To the Damaged Areas: Major damage is often more extensive than preliminary examination might indicate. The investigation should cover all spaces, systems, and structures in every compartment adjacent to the damaged area. This is to locate any additional damage and to establish gas, flooding, and fire boundaries around the damaged areas.

Inspect the entire vessel. If an underwater explosion occurs close to the side of the vessel, all voids, tanks, and lower compartments must be investigated for damage by taking samples of the oil and testing them for water. Likewise, potable and feed water tanks should be tested for salinity. There shall be a sounding team in each damage control team, and all crewmembers should know where and how to sound oil tanks in their own and adjacent areas.

SAFETY MEASURES

Investigation of structural damage by visual examination presents many difficulties and dangers. To do a thorough job, it is often necessary to open one or more watertight doors or hatches. It is unwise to open any such closures in the vicinity of the damage. Open closures only after a thorough investigation and only after obtaining permission from the Vessel Master or Chief Engineer. Opening a door or hatch to a flooded space will result in additional rapid flooding and changing of the list and trim. Opening a door or hatch that is hot to the touch can cause rapid spreading of fires or explosions.

Watertight doors, hatches, scuttles, and manholes will not be opened until it is known definitely that the compartment on the other side is completely dry or that flooding is minimal enough that opening the closure will not allow the flooding to spread. When a compartment is equipped with a sounding tube, the existence of flooding can be determined by slowly loosening the sounding tube cap. Air escaping under pressure followed by a stream of water indicates that the compartment is completely flooded. Air only indicates a partially flooded compartment.

CAUTION

Investigators will take no action that causes the loss of control of watertight integrity. All compartments will be secured after leaving them. Failure to do so creates a hazard to the survival of the vessel.

Many compartments are not provided with air escapes, but there are other ways to investigate. Tapping on a bulkhead with a hammer will often disclose the presence of water on the other side. The exact height of the water in the flooded compartment may be judged by the variation of the tones produced when the bulkhead is struck with a metal object. Mistakes caused by tapping a hidden frame can be avoided by tapping the bulkhead in several locations along the height of the bulkhead. A dangerous, but often necessary, method of testing a compartment for flooding is to back off slowly on some of the dogs that hold a hatch or a door closed. The correct procedure is to slack off slightly on the dogs adjacent to the hinges where there is a slight amount of clearance around the hinge pins. Never loosen the dogs on the edge of the door away from the hinges. This will result in the door buckling or flying open. Personnel at the door will be seriously injured, and another compartment will be needlessly flooded. As the dogs are loosened, any water present will trickle between the gasket and the knife-edges on the hinge side of the watertight door or hatch. Control of the watertight closure is still maintained by the hinges and the opposite dogs. This method cannot be used with quick acting doors or scuttles where the hatch dogging devices are interconnected.

As in the case of progressive flooding through damaged or improperly maintained fittings, fire, gas, and smoke may be spread in a similar manner. Open flues such as trunks and ventilation ducts are potential sources of trouble. Ventilation ducts are especially dangerous, because they can contain flammable dust. When not properly secured, they will carry fire to other parts of the vessel. Fire has been known to travel along electrical cables. The heat transferred by metal bulkheads has caused fires in parts of ships distant from the original source. It is necessary to inspect a wide area around the scene of a fire in order to completely localize damage. Overheating ammunition stowage areas must be avoided. Care should be exercised when opening watertight hatches or scuttles into the compartments suspected of containing fire. There is a distinct possibility that the heat within the compartment may build an overpressure within the space, blow the hatch, and belch fire and smoke when the dogs are loosened.

INITIAL STEPS OF CONTROL

After the initial investigation, steps shall be taken to localize and control the damage. An investigation for hidden potential damage should be conducted. A damage control team provided with protective equipment, lighting, ventilating facilities, and other required tools should take the following general steps:

1. If fire is present, the firefighting team must begin operations immediately.

2. Electrical circuits in the damaged area should be secured, preferably by removing fuses or securing load center distribution panels in a compartment at a distance from the scene of fire.

3. Pipelines in the damaged area may be ruptured and valves may be destroyed. If the lines are so badly damaged that they cannot be repaired at once by soft patches or similar methods, the damaged section must be isolated at the first intact valve outside the damaged area.

4. The air in a damaged area may be fouled with smoke, fumes, and gases. A compartment may get so hot that the damage control team cannot remain in it. It may be necessary to provide fresh air. Hot compartments can be cooled by spraying them with water, using fog nozzles.

5. If there is no fire in the compartment and it is necessary to employ spark-producing equipment in the area to make repairs, fire extinguishers will remain at the scene, and the air will be tested for toxic or explosive gases and for lack of oxygen before repair work is commenced.

6. When the initial steps of damage control are completed and the situation permits, steps will be initiated to restore the vessel to the desired readiness condition to the maximum extent possible.

END OF WORK PACKAGE

Chapter 3

Ventilation
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) VENTILATION

Ventilation systems are a potential means of flooding, and they can also contribute to the spread of fire and dangerous fumes. The duct work openings of the ventilation supply and exhaust systems, the bulkhead and deck penetrations, the supply and exhaust fans, and other components in the ventilation system present many opportunities for progressive flooding and the spread of fire, smoke, and toxic fumes. The continuous demand on the ventilation system for large volumes of air for habitability and equipment requires careful consideration from the damage control point of view. Ventilation ducting can provide a path for water to flow from one compartment to the next. It can also provide a route for gas, smoke, or fire to enter and move throughout the vessel. A 10-foot x 18-foot (3 meter x 5.5 meter) compartment of average deck height will completely flood in about five minutes through a 6-inch (15 cm) diameter hole when submerged under 10 feet (3 meters) of water.

SETTING OF CLOSURES

During flooding or collision, it is important to secure all watertight closures. Ventilation ducts, which pierce watertight bulkheads or decks below the main deck level, are fitted with watertight closures at the penetrations called dampers. In most cases where the ventilation ducts pierce decks, the ducts are watertight up to the main deck level. Vessel design prevents penetration of the main transverse bulkheads below the main deck level. In the event of a Nuclear, Biological, or Chemical (NBC), attack all ventilation fans and blowers must be secured in order to prevent contaminants from entering the interior of the vessel. Ventilation should not be restored until the vessel is clear of the contaminated area and has been properly decontaminated.

VENTILATION DAMPER OPERATION

Ventilation dampers are located in the ventilation ductwork throughout the vessel. They serve to balance the amount of air provided to various compartments. In the event of a fire, the dampers must be CLOSED to prevent fresh air from getting to the fire. The following procedure is provided for closing and opening the ventilation dampers.

CLOSE DAMPER

1. Remove the locking pin (figure 1, item 1).
2. Move the damper lever (figure 1, item 2) in the SHUT direction as indicated on the lever guide (figure 1, item 3).
3. Install the locking pin (figure 1, item 1).

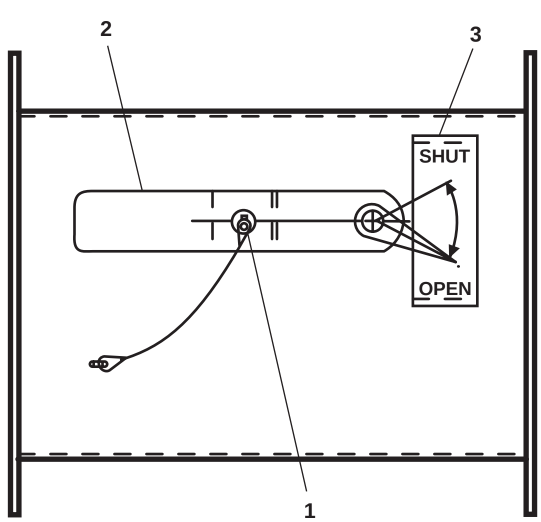


Figure 1. Fire Damper Operation

OPEN DAMPER

1. Remove the locking pin (figure 1, item 1).

2. Move the damper lever (figure 1, item 2) in the OPEN direction as indicated on lever guide (figure 1, item 3).

3. Install the locking pin (figure 1, item 1).

AIR QUALITY

Personnel entering a compartment to investigate after a casualty must certify the air to be breathable unless the investigators are wearing approved breathing protection. This requirement is in effect whether or not the FM-200 system was activated. If a flooded space was dewatered using the eductors it is possible that a sufficient volume of air was removed from the space to decrease the overall oxygen content. Compartments which are not under continuous natural or mechanical ventilation may not have sufficient oxygen to support life, or may contain toxic or explosive gas(es). Follow the appropriate procedures to certify that the atmosphere within the space is safe to enter. This procedure is outlined in FM 55-502.

FM-200 FIRE SUPPRESSION SYSTEM PROTECTED SPACES

The Large Tug (LT) contains spaces that are protected by a fixed FM-200 Fire Suppression System. These spaces are in the hold level, and they consist of the engine room and AMS 1. When FM-200 is released, the ventilation system and closures serving these spaces should be secured as quickly as possible. The ventilation supply and exhaust systems are equipped with interlocking switches that shut down the fans when the FM-200 system is actuated. Activation of the FM-200 system will also shut down the ship service diesel generators, auxiliary engines, and fuel oil transfer pumps. These features serve to prevent the dilution or removal of the FM-200 gas from the protected spaces and prevent spread of the fire. Additionally, activation of the FM-200 system actuates visual yellow beacons and a pressure-actuated siren in the protected spaces prior to the spaces being flooded with FM-200 gas.

The FM-200 system operates in conjunction with the Engine Room Water Washdown System (ERWWS). The ERWWS cools the space, and the FM-200 extinguishes the fire. In the event of a fire in the engine room the following sequence should be performed in order to ensure crew safety and successful fire suppression.

1. Sound the alarm

2. Evacuate all personnel from the engine room and AMS 1.

3. Close the watertight doors between the engine room, AMS 1, and AMS 2.

4. Align fire and general service pump 1 as the online fire pump (TM 55-1925-273-10).

CAUTION

FM-17 and/or FM-15 supplies raw water to various shipboard systems including the refrigeration plant, the air conditioning plant, and the water maker. Failure to secure power to these systems prior to closing the valves will cause damage to the equipment.

5. CLOSE the following valves:

   a. FM-17, FIRE/G.S. PMP NO. 1 DISCH TO G.S. (figure 2, item 1).

   b. FM-15, FIRE/G.S. PMP NO. 2 DISCH TO G.S. (figure 2, item 2).

6. OPEN WWS-1 (figure 3, item 1), located in the main deck vestibule, starboard side, to activate the Engine Room Water Washdown System (ERWWS).

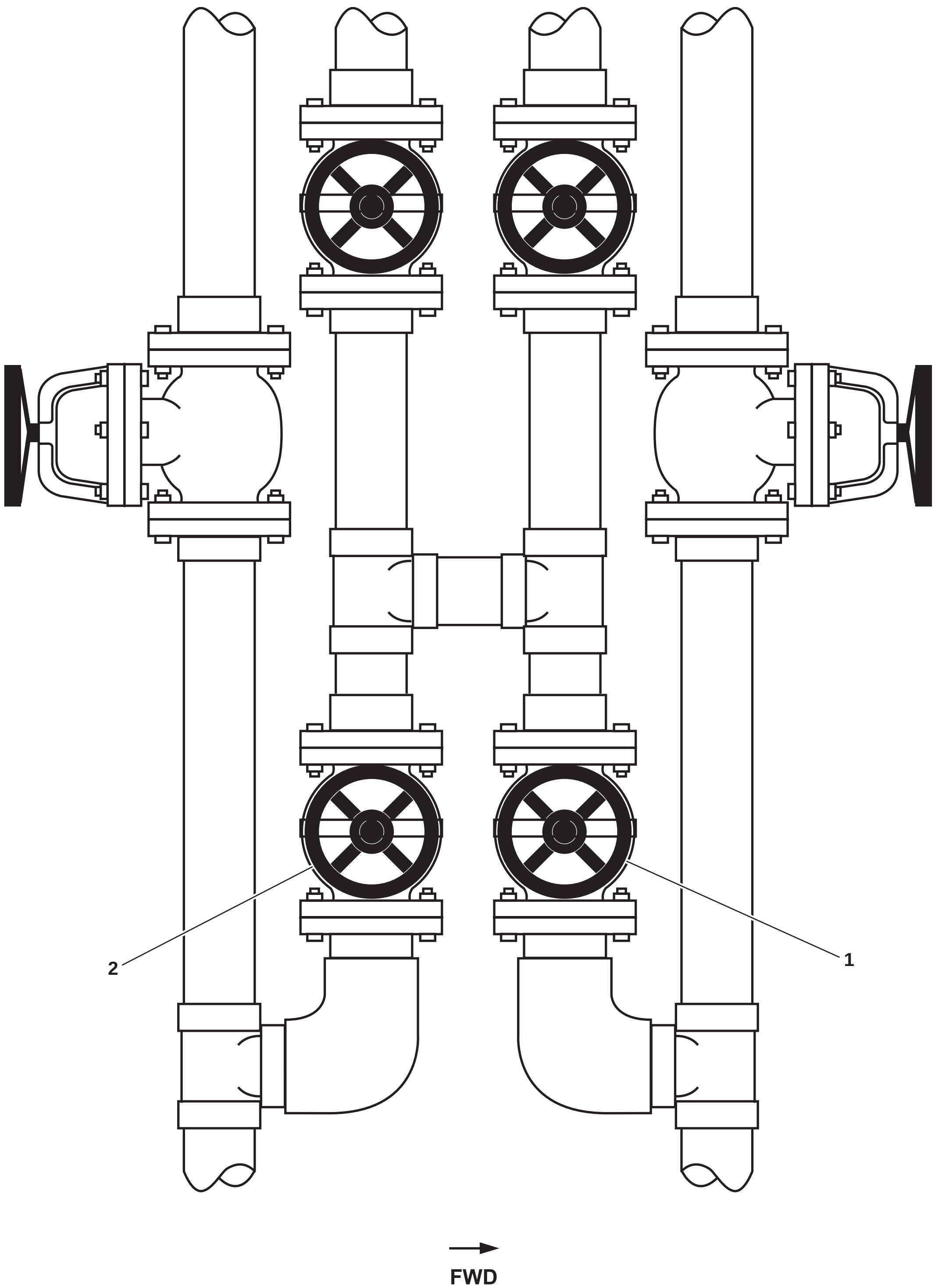


Figure 2. Engine Water Washdown System Station

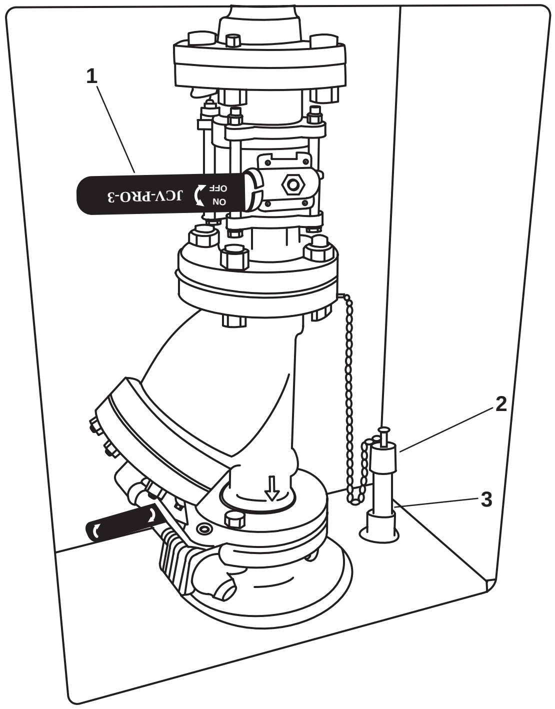


Figure 3. Engine Room Water Washdown Station

7. CLOSE the following:

   a. Port engine room supply fan intake damper (figure 4, item 1) located on the forward side of the port stack.

   b. Port engine room exhaust fan outlet damper (figure 4, item 2) located on the forward side of the port stack.

   c. Starboard engine room supply fan intake damper (figure 5, item 1) located on the forward side of the starboard stack.

   d. Starboard engine room exhaust fan outlet damper (figure 5, item 2) located on the forward side of the starboard stack.

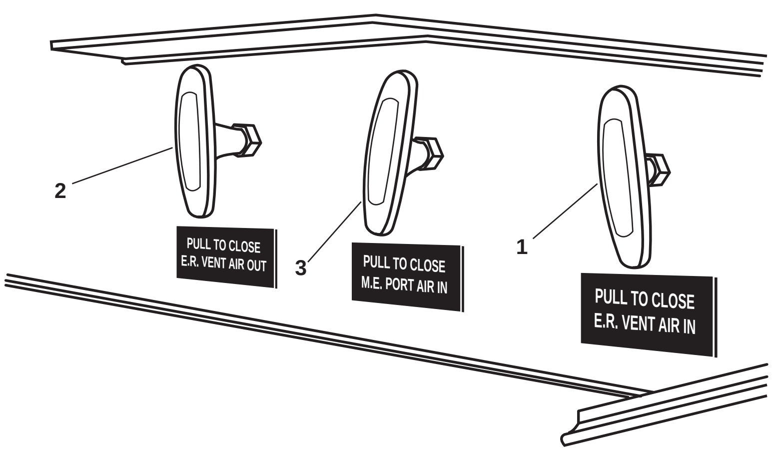


Figure 4. Port Engine Room Fire Flap Quick Release T Handles

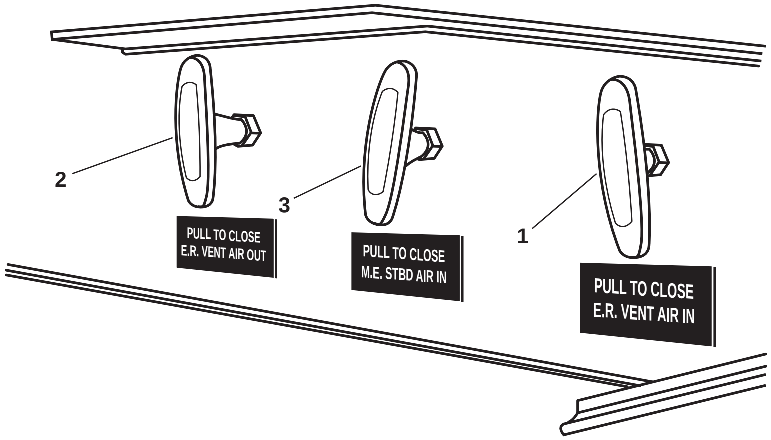


Figure 5. STBD Engine Room Fire Flap Quick Release T Handles

e. AMS 1 supply fan intake hinged cover (figure 6, item 1) located on the foredeck.

f. AMS 1 exhaust hinged cover (figure 7, item 1) located on the foredeck.

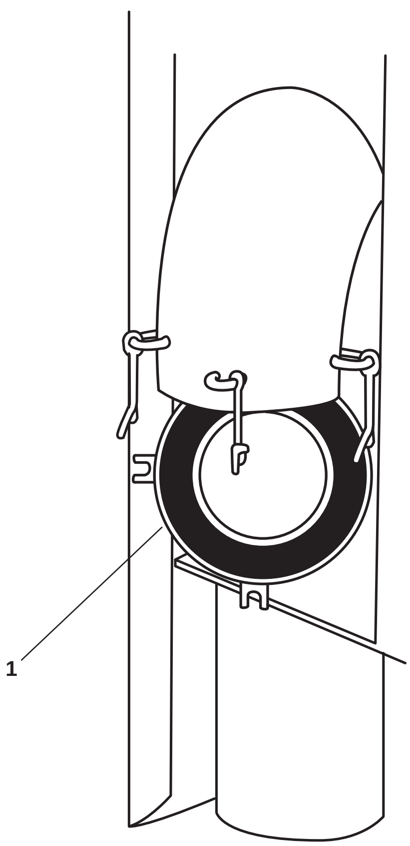


Figure 6. AMS 1 Supply Fan Intake Hinged Cover

Figure 7. AMS 1 Exhaust Hinged Cover

g. Engine room entrance door located in the main deck vestibule (figure 8, item 1).

h. EOS emergency escape scuttle between EOS and the main deck passageway (figure 9, item 1).

i. AMS 1 emergency escape scuttle between AMS 1 and the damage control center (figure 10, item 1).

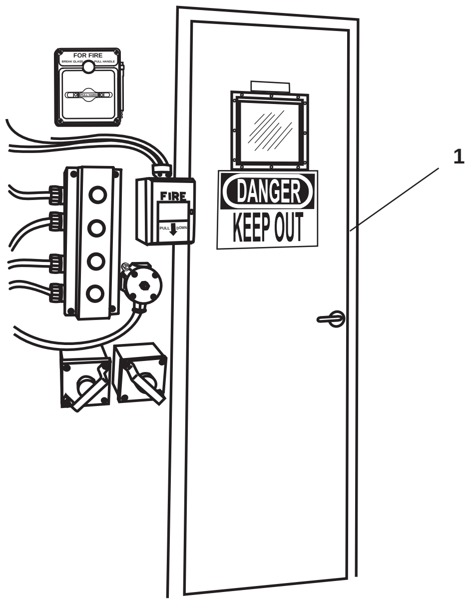


Figure 8. Engine Room Entrance Door

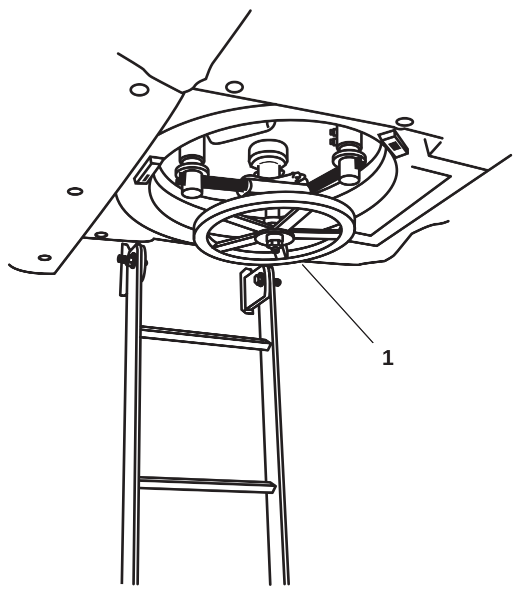


Figure 9. EOS Emergency Escape Scuttle

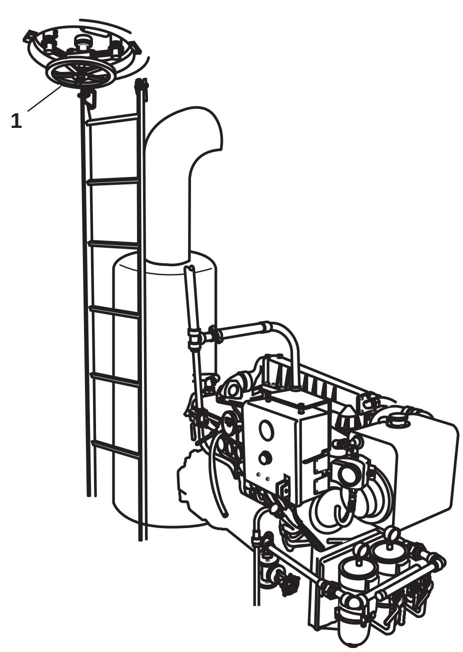


Figure 10. AMS 1 Emergency Escape Scuttle

NOTE

The ERWWS will shut down once the FM-200 system has been activated. Restart fire and general service pump 1 remotely (pilothouse), once the emergency generator has come online.

8. Break the glass on the FM-200 manual pull box (figure 11 or 12). FM-200 manual pull boxes are found in the following locations:

   a. Engine room vestibule, main deck, 01 level, frame 23

   b. Main deck, on the weather deck, starboard of the engine room vestibule entrance door, frame 21

9. Pull the handle (figure 11 or 12, item 1) to actuate the FM-200 system. The handle is designed to require less than 40 pounds (18.14 kg) force and 14 inches (35.6 cm) of pull to operate. If the FM-200 system fails to actuate, proceed to the FM-200 cylinder location, AMS 2, frame 22, and follow the emergency discharge instructions posted at the FM-200 cylinder location and in WP 0006 00. Enter and evacuate AMS 2 using the emergency escape scuttle.

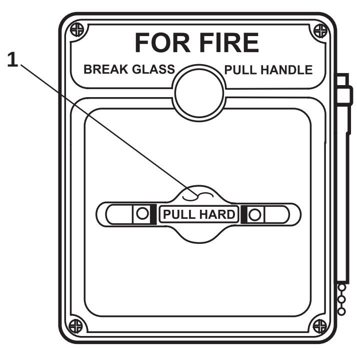


Figure 11. Interior FM-200 Manual Pull Box

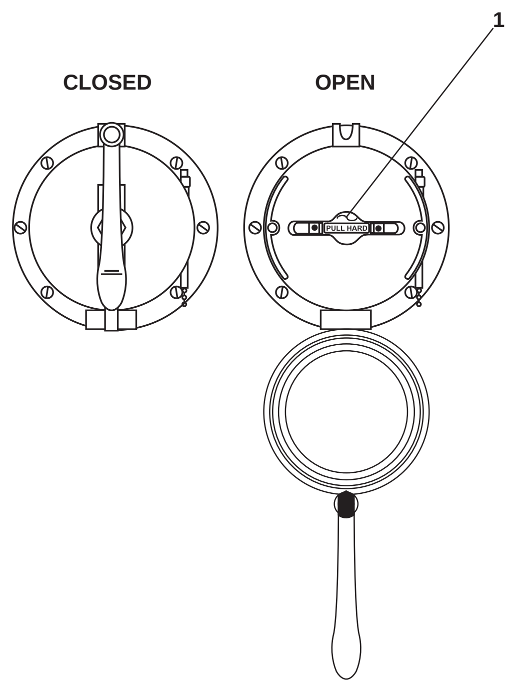


Figure 12. Exterior FM-200 Manual Pull Box

10. Verify that the emergency generator has come online and start fire and general service pump 1 at the remote start located in the pilothouse.

11. Actuation of the FM-200 fire suppression system will result in the automatic shutdown of the auxiliary engines and ventilation fan motors affecting the protected spaces. Verify that the following fans, engines, and pumps are shut down:

a. Fan Motors:

(1) Port engine room supply fan

(2) Port engine room exhaust fan

(3) Starboard engine room supply fan

(4) Starboard engine room exhaust fan

(5) AMS 1 supply fan

b. Engines:

(1) SSDG 1

(2) SSDG 2

(3) Pump drive engine

(4) Bow thruster engine

c. Pumps:

(1) Fuel oil transfer pump 1

(2) Fuel oil transfer pump 2

12. Wait a minimum of fifteen minutes after FM-200 system actuation before initiating reentry procedures. The water washdown system should be allowed to operate continuously during this time. Allow no one to enter the protected spaces until reentry procedures are complete and permission is granted to do so.

REENTRY PROCEDURES

WARNING

Following a fire and actuation of the engine room fire suppression system, the engine room may contain a dangerous level of Hydrogen Fluoride (HF) gas, which is dangerous to humans. Do not reenter the engine room until the post-fire re-entry procedure has been performed. Death or serious injury can result from unprotected entry into this space prior to completion of the post-fire re-entry procedure.

1. Wait at least 15 minutes after extinguishing the fire before performing this procedure. The natural decay rate for Hydrogen Fluoride (HF) gas is approximately 15 minutes after a fire is extinguished.

2. Perform HF gas sampling as follows:

a. Remove the cap (figure 3, item 2) from the HF sampling port (figure 3, item 3) located in the main deck vestibule.

b. Zero the stroke counter (figure 13, item 1).

c. Install the rubber hose (figure 13, item 2) on the pump by sliding one end of the rubber hose over the tube holder (figure 13, item 3).

d. Break off both tips (figure 13, item 4) of the detector tube (figure 13, item 5) using the breaker (figure 13, item 6) on the bottom of the sampling pump (figure 13, item 7).

e. Install the detector tube (figure 13, item 5) into the rubber hose (figure 13, item 2) with the arrow on the detector tube pointing toward the sampling pump (figure 13, item 7)

f. Insert the detector tube (figure 13, item 5) into the HF sampling port (figure 3, item 3). Ensure all of the rubber hose (figure 13, item 2) is inserted into the HF sampling port.

NOTE

Determine the number of strokes required for a proper sample by checking the detector tube instructions that are in the box of detector tubes or the detector tube itself. The tube will be labeled as n=(number of strokes).

g. With all four fingers on the handle (figure 13, item 8), fully press the knob (figure 13, item 9) with the palm of the hand until the stroke counter (figure 13, item 1) changes number.

h. Release the knob (figure 13, item 9).

i. Verify that the end of stroke indicator (figure 13, item 10) has turned a high visibility yellow. Once the pump has consumed 100cc of the sample, the end of stroke indicator will return to its black color.

j. Repeat steps f, g, h and i until the proper number of strokes has been preformed.

k. Remove the detector tube (figure 13, item 5) from the HF sampling port (figure 3, item 3).

l. Install the cap (figure 3, item 2) on the HF sampling port (figure 3, item 3).

m. Observe the color of the detector tube, read the scale printed on the detector tube and record the reading.

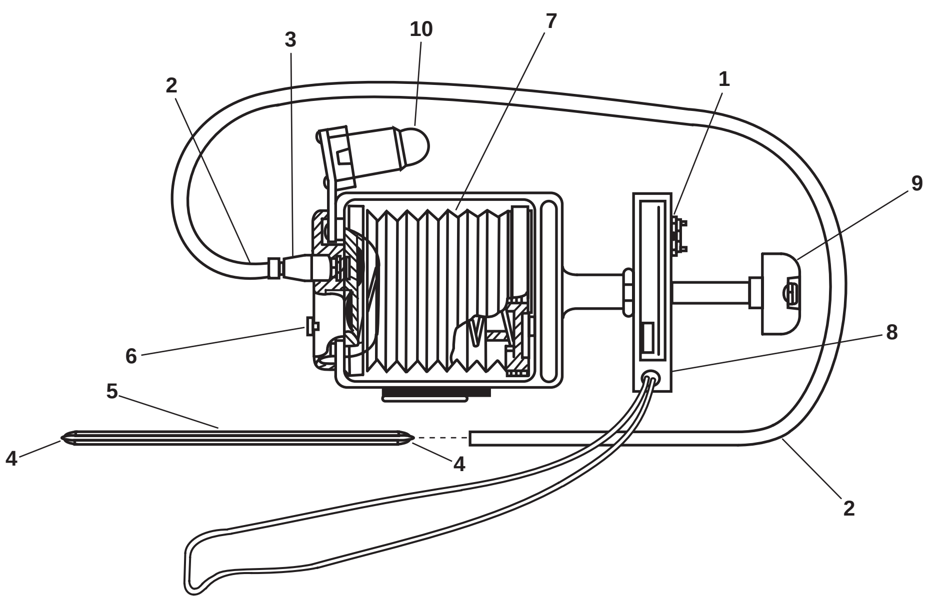


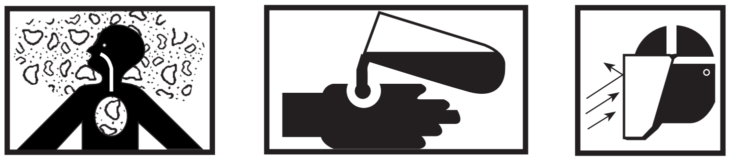
Figure 13. Sampling Pump

n. Remove the detector tube (figure 13, item 5) from the hose (figure 13, item 2).

o. Wait two minutes and repeat steps a-m above with a new detector tube.

p. When three consecutive readings of 3 parts per million (ppm) are obtained, the engine room is safe for reentry.

WARNING



Residue from FM-200 fire suppression is a minor irritant to the skin, the eyes, and the respiratory tract. All personnel who may come in contact with this residue must wear Personal Protective Equipment (PPE), which prevents the FM-200 residue from contacting the skin, eyes, and/or respiratory tract.

3. After ensuring that no reflash risks exist, the engine room must be ventilated in accordance with the following procedure:

a. If explosive or flammable gases are present, desmoke using the water-driven blower. Desmoke using the water-driven blower until no flammable gases are detected.

b. If no explosive or flammable gases are present, desmoke using the ventilation exhaust fans in high speed.

c. When the smoke has cleared, restart the ventilation supply fans in high speed.

d. When all smoke is cleared and air quality is at normal levels, return all ventilation fans to their normal operating speed.

e. Ventilate the engine room for at least 15 minutes before proceeding to the cleanup phase.

4. After the engine room has been ventilated and has cooled down, wash down the engine room interior and all equipment with fresh water.

NOTE

Bilge water which has been exposed to FM-200 fire extinguishing agent in extinguishing a fire shall be classified and treated as hazardous waste.

5. Use the oily water collection system to remove all contaminated bilge water from the engine room. Discharge this contaminated water only to a suitable treatment facility.

6. Return the equipment to the desired readiness condition.

FIRE FLAP ASSEMBLIES

The LT is outfitted with a main engine combustion air fire flap assembly (figure 14, item 1). This arrangement upgrades the previous blanking plate arrangement that was used to secure the main engine intake if a catastrophic casualty required shutdown of a main engine. The main engine combustion air fire flap assemblies are rectangular in shape, and their quick release T handles (figures 4 and 5, item 3) are located at the front of the stacks on the 02 level. Access to the main engine combustion air fire flap assembly is gained by entering the manhole cover on the stacks at the 01 level.

The LT is outfitted with an engine room ventilation supply fire flap assembly (figure 15, item 1). The engine room ventilation supply fire flap assemblies are of the louver type, and their quick release T handles (figures 4 and 5, item 1) are located at the front of the stacks on the 02 level. Access to the engine room ventilation supply fire flap assembly is gained by entering the watertight hatch on the stack at the 01 level. Additionally, the LT is outfitted with an engine room ventilation exhaust fire flap assembly (figure 16, item 1). The engine room ventilation exhaust fire flap assemblies are circular in shape and their quick release T handles (figures 4 and 5, item 2) are located at the front of the stacks on the 02 level. Access to the engine room ventilation exhaust fire flap assembly is gained by entering the watertight hatch on the stack at the 02 level and entering the manhole cover inside the stack.

In addition to the main engine combustion air fire flap assembly and the engine room ventilation supply and exhaust fire flap assemblies, the LT is also outfitted with Emergency Diesel Generator (EDG) room fire flap assemblies. These assemblies are located on the inboard (figure 17, item 1) and outboard (figure 17, item 2) ventilation louvers. The EDG room fire flap assemblies are actuated by pulling T handles (figure 17, item 3) located on the aft bulkhead of the EDG room, inboard.

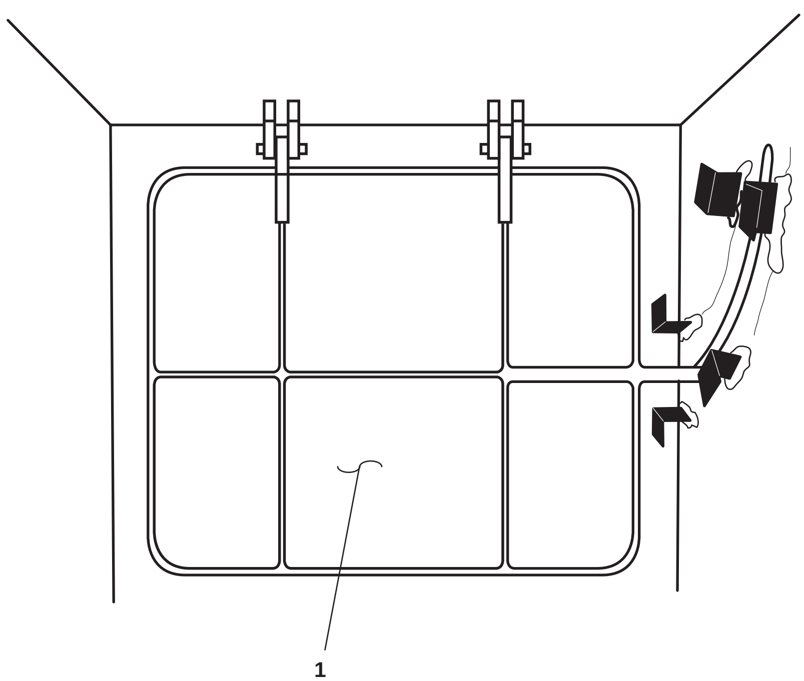


Figure 14. Main Engine Combustion Air Fire Flap Assembly

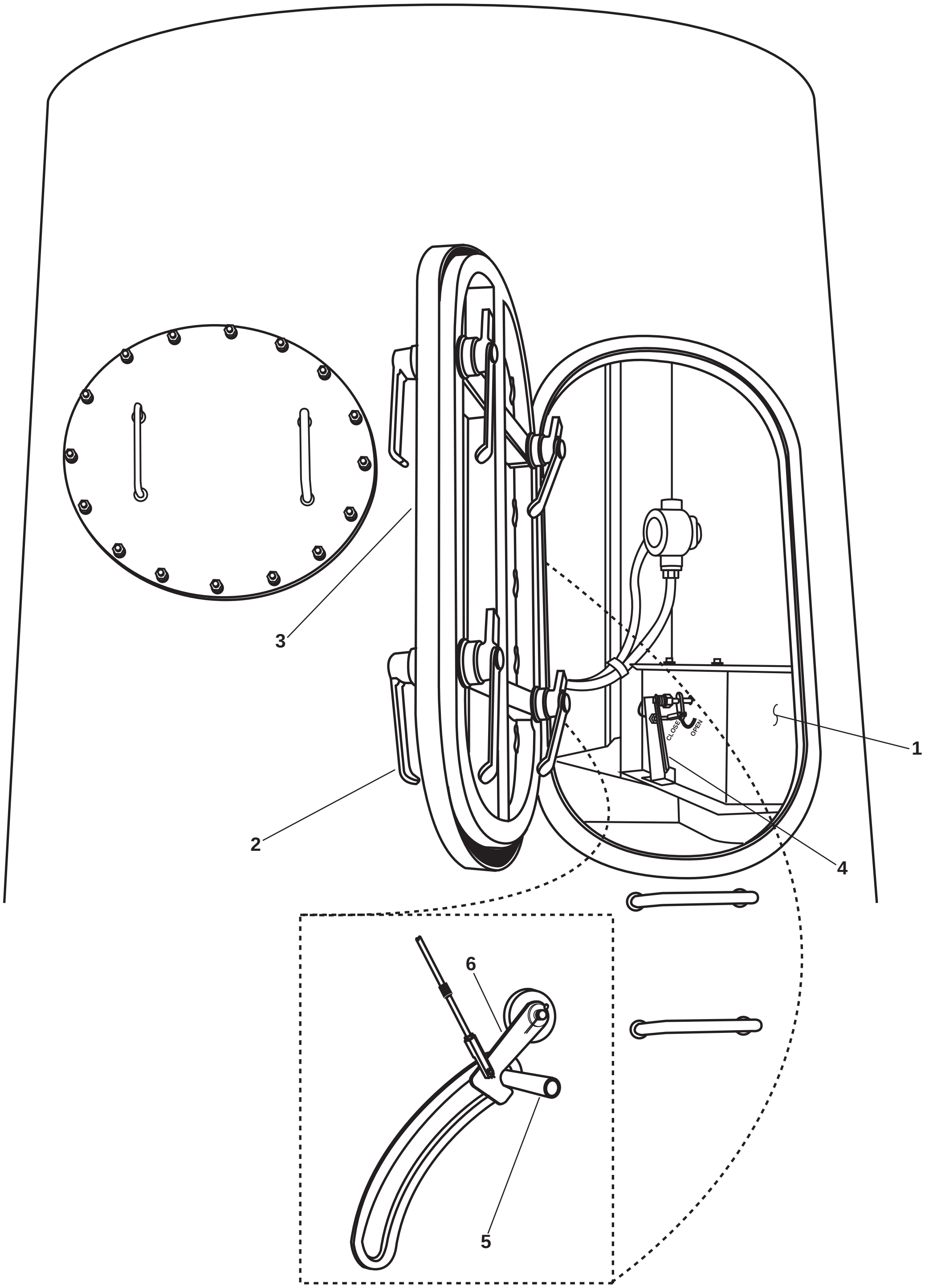


Figure 15. Engine Room Ventilation Supply Fire Flap Assembly

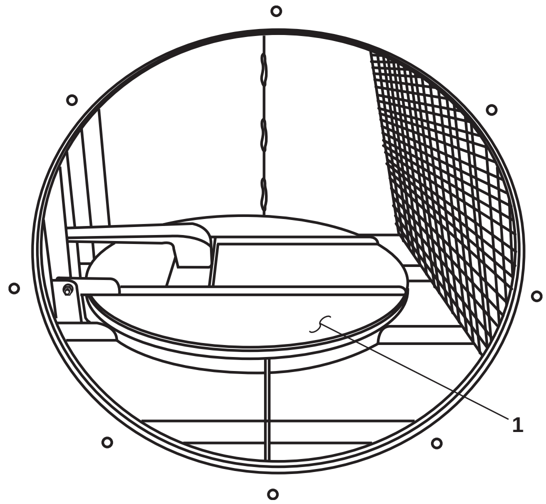


Figure 16. Engine Room Ventilation Exhaust Fire Flap Assembly

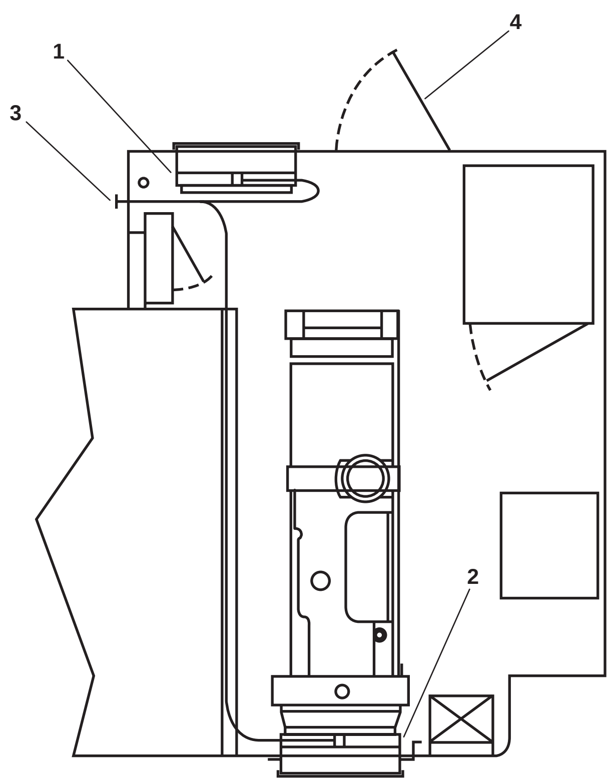


Figure 17. EDG Room Fire Flap Assemblies

CLOSE ENGINE ROOM VENTILATION AND MAIN ENGINE COMBUSTION AIR FIRE FLAPS

NOTE

If propulsion is required, do not CLOSE the main engine combustion air fire flap assemblies.

1. Pull the T handles (figures 4 and 5 items 1, 2, and 3) to their fully extended position. This CLOSES the main engine combustion air fire flap assembly (figure 14, item 1), the engine room ventilation exhaust fire flap assembly (figure 16, item 1) and CLOSES the engine room ventilation supply fire flap assembly lovers (figure 15, item 1).

2. Repeat step 1 on the opposite stack for the remaining fire flaps.

OPEN ENGINE ROOM VENTILATION AND MAIN ENGINE COMBUSTION AIR FIRE FLAPS

ENGINE ROOM EXHAUST FIRE FLAP ASSEMBLY

1. Gain access to the inside of the stack on the 02 level by loosening the four dogs (figure 18, item 1) on the watertight hatch (figure 18, item 2) and opening it.

2. Remove the eight bolts (figure 18, item 3) and eight flat washers (figure 18, item 4) from the manhole cover (figure 18, item 5).

3. Remove the manhole cover (figure 18, item 5) from the engine room exhaust fire flap assembly housing (figure 18, item 6).

4. Remove the gasket (figure 18, item 7) from the manhole cover (figure 18, item 5). Discard the gasket.

5. Push the quick release T handle (figure 18, item 8) all the way in.

6. Have one crewmember push the engine room exhaust fire flap handle (figure 18, item 9) down, raising the engine room exhaust fire flap (figure 18, item 10) up, while a second crewmember secures it in the OPEN position with the quick release latch (figure 18, item 11).

7. Install a new gasket (figure 18, item 7) on the engine room exhaust fire flap assembly housing (figure 18, item 6).

8. Install the manhole cover (figure 18, item 5) and secure it with the eight flat washers (figure 18, item 4) and the eight bolts (figure 18, item 3).

9. Close the watertight hatch (figure 18, item 2) and tighten the dogs (figure 18, item 1).

10. Perform steps 1 through 9 for the engine room exhaust fire flap assembly on the opposite stack.

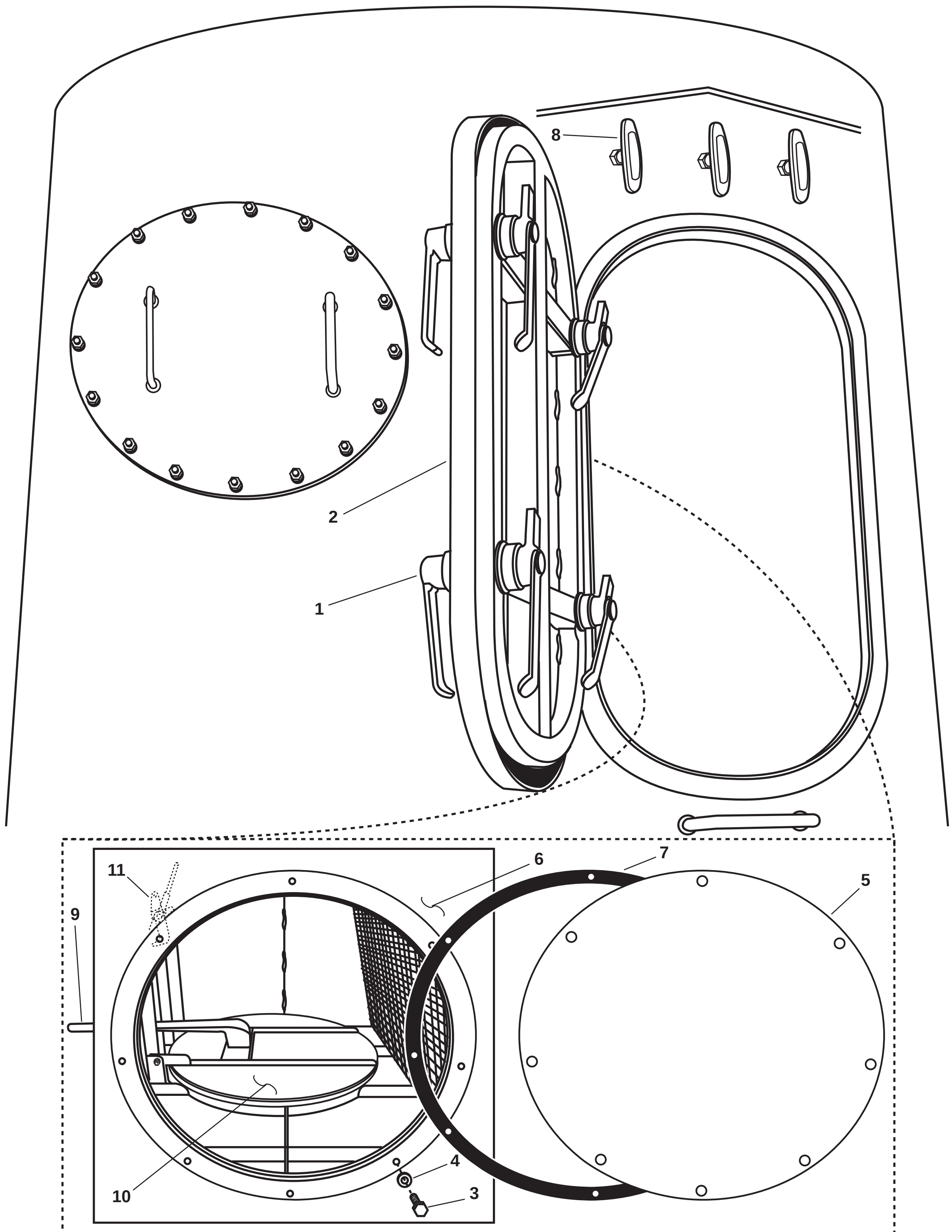


Figure 18. Access to Engine Room Ventilation Exhaust Assembly Fire Flap

ENGINE ROOM VENTILATION SUPPLY FIRE FLAP ASSEMBLY

1. Gain access to the inside of the stack on the 01 level by loosening the four dogs (figure 15, item 2) on the watertight hatch (figure 15, item 3) and opening it.

2. Have one crewmember push the quick release T handle (figures 4 and 5, item 1) all the way in while a second crewmember moves the engine room ventilation supply fire flap assembly handle (figure 15, item 4) to the OPEN position.

3. Close the watertight hatch (figure 15, item 3) and tighten the dogs (figure 15, item 2).

4. Perform steps 1 through 3 for the engine room ventilation supply fire flap assembly in the opposite stack.

MAIN ENGINE COMBUSTION AIR FIRE FLAP ASSEMBLY

1. Gain access to the inside of the stack on the 01 level by loosening the four dogs (figure 15, item 2) on the watertight hatch (figure 15, item 3) and opening it.

2. Have one crewmember push the quick release T handle (figures 4 and 5, item 3) all the way in while a second crewmember lifts up on the main engine combustion air fire flap assembly handle (figure 15, item 5) and secures it in the OPEN position with the quick release latch (figure 15, item 6).

3. Close the watertight hatch (figure 15, item 3) and tighten the dogs (figure 15, item 2).

4. Perform steps 1 through 3 for the engine room ventilation supply fire flap assembly in the opposite stack.

CLOSE EDG ROOM FIRE FLAP ASSEMBLIES

1. Ensure that all personnel are clear of the EDG room.

2. Secure the watertight door (figure 17, item 4) to the EDG room.

3. Pull OUT on both T handles (figure 17, item 3) to deploy the EDG room fire flaps (figure 17, items 1 and 2).

4. Notify the pilothouse of the fire condition.

OPEN EDG ROOM FIRE FLAP ASSEMBLIES

1. Ensure that the fire is out and that the proper command authority has authorized entry into the space.

2. After the space has been ventilated, and appropriate damage control measures have been completed, the EDG room fire flaps (figure 17, items 1 and 2) may be reset.

3. Reset the EDG room fire flaps (figure 17, items 1 and 2) by pulling UP from the bottom. The sections (figure 19, item 1) of the EDG room fire flap should fold up like a fan as they are raised. Once the EDG room fire flaps are fully raised, the latch assembly (figure 19, item 2) will automatically latch them into place.

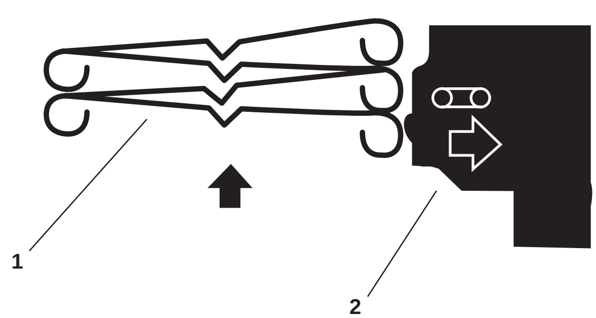


Figure 19. Opening the EDG Room Fire Flaps

END OF WORK PACKAGE

Chapter 4

Damage Control Equipment
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) INTRODUCTION

The damage control equipment and tools are used to make emergency repairs in the event of a casualty that causes damage to the vessel. Damage control equipment and tools are not to be used for any purpose other than to effect emergency repairs in the event of a casualty. Any piece of damage control equipment used in combating an emergency must be inspected for serviceability after use, and all damage control equipment and tools must be restored to original operating condition and location. The safety of the vessel and the personnel on board depend upon the specified equipment being properly stowed and ready for use at all times. It is important that all crewmembers be familiar with the location and uses of the various pieces of damage control equipment and tools.

DAMAGE CONTROL EQUIPMENT DESCRIPTION

Damage control equipment and tools consist of firefighting gear, extinguishers, fire stations, fire axes, the FM-200 Fire Suppression System, firefighter's ensembles, Oxygen Breathing Apparatus, life jackets, life rafts, life rings, shoring, portable pumps, and portable tool kits. The damage control equipment and tools are located in the damage control equipment locker. The damage control locker is located on the main deck just aft of the boatswain's storeroom. The LT is outfitted with the following damage control equipment as indicated in table 1:

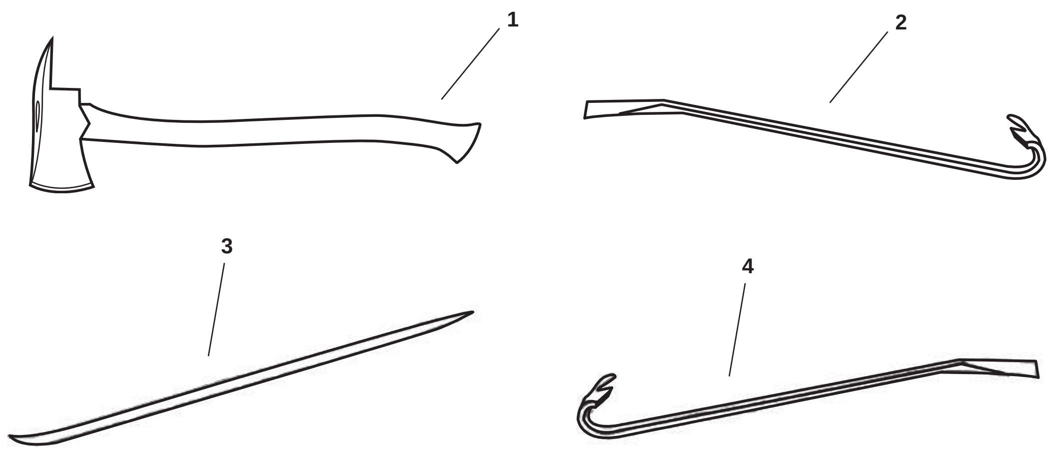


Table 1. Damage Control Equipment

Illustration Number	Nomenclature	Description	Quantity
1	Axe, fire, pick head	Used to gain quick access to a given area. This ax has a steel head with a cutting blade on one end and a spike-like extension on the other.	6
2	Bar, wrecking 60" Bar, wrecking 36" Bar, wrecking 30"	Wrecking bars are steel tools used to lift and move heavy objects, and to pry where leverage is needed. They can be used to open heavy crates and to do wrecking work.	1 each
3	Pinch bar	The pinch bar is used for light ripping and prying jobs	1
4	Bar, gooseneck claw, ¾" dia, 26" long	The claw crowbar is used for heavy prying and for moving heavy objects short distances.	1

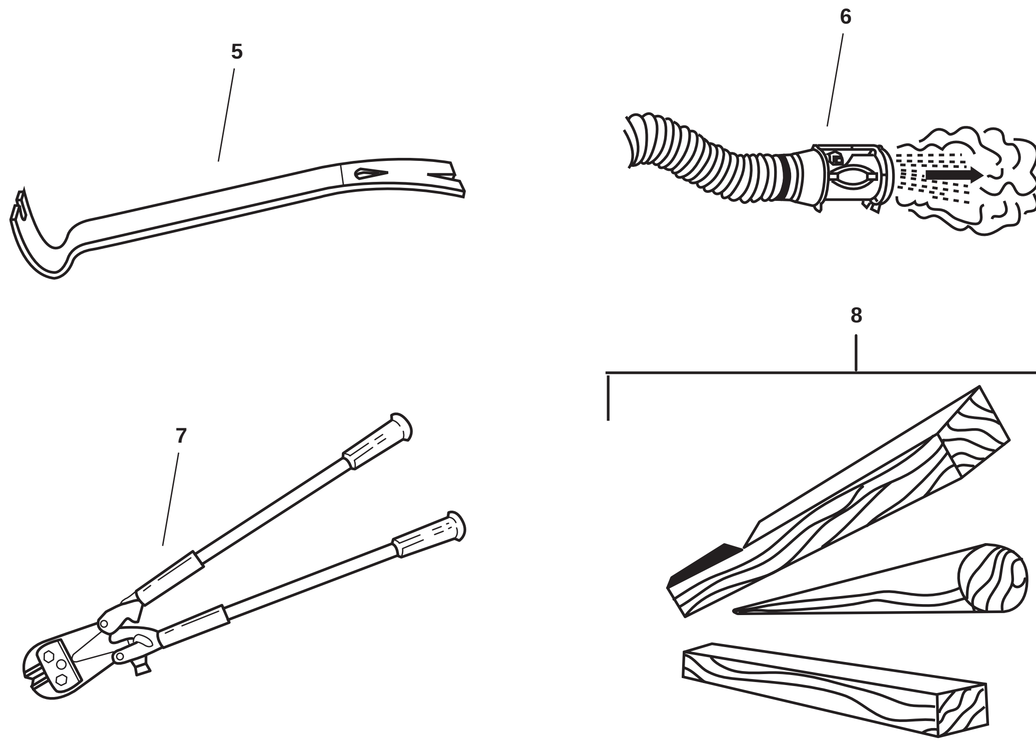


Table 1. Damage Control Equipment (continued)

Illustration Number	Nomenclature	Description	Quantity
5	Bar, pry, offset: 3/4" dia, 26" long 3/8" dia, 30" long	The pry bar is an all-purpose combination pry and scrape bar for rugged heavy duty service. It is used to pry, pull, cut, scrape, lift, and pound nails. The slim tapered blades are easily inserted for prying and lifting. It also has beveled nail slots.	2 each
6	Blower, ventilating portable	Portable blowers are designed to blow fresh air into a compartment through a collapsible hose, or out of a compartment by means of a non-collapsible hose.	2
7	Cutter, bolt, 36"	Bolt cutters are shaped like giant shears with short blades and long handles. The cutters are at the end of extensions, which are jointed in such a way that the inside joint is forced outwards when the handles are closed. This forces the cutting edges together with great force. They are used to cut mild steel bolts and rods up to ½" in diameter.	2
8	Damage control kit (contains plugs and wedges)	Contains various wooden wedges and plugs needed to plug holes or fasten shoring during casualties.	12

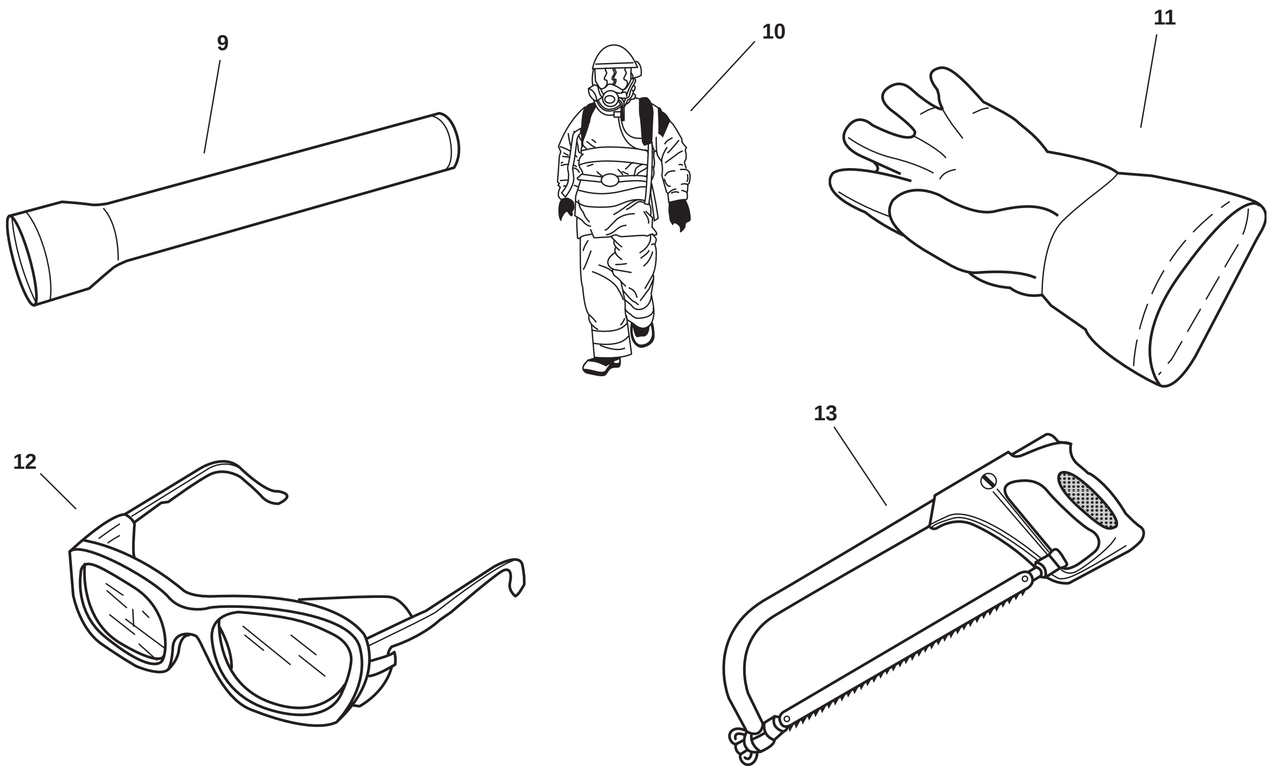


Table 1. Damage Control Equipment (continued)

Illustration Number	Nomenclature	Description	Quantity
9	Flashlight, 3 cell, watertight	Provides a source of portable emergency lighting for areas of the vessel that may be without power.	3
10	Firefighter’s Ensemble	Additional protective clothing that provides greater resistance to heat and enables the wearer longer exposure times in hot compartments during casualties.	7
11	Gloves, welders	Flameproof gloves that provide extra protection for the wearer during casualties. They are capable of protecting the wearer during gas and electric welding and limit the danger to the wearer from flames and hot objects.	2 pair
12	Goggles, industrial safety	Provide the wearer eye protection from flying objects such as sparks and other hot flying objects.	8
13	Hacksaw, hand 10" Hacksaw, hand 12"	Designed to cut almost any size or shape of metal object. The blade is designed to cut on the pushing (downward stroke).	1 each

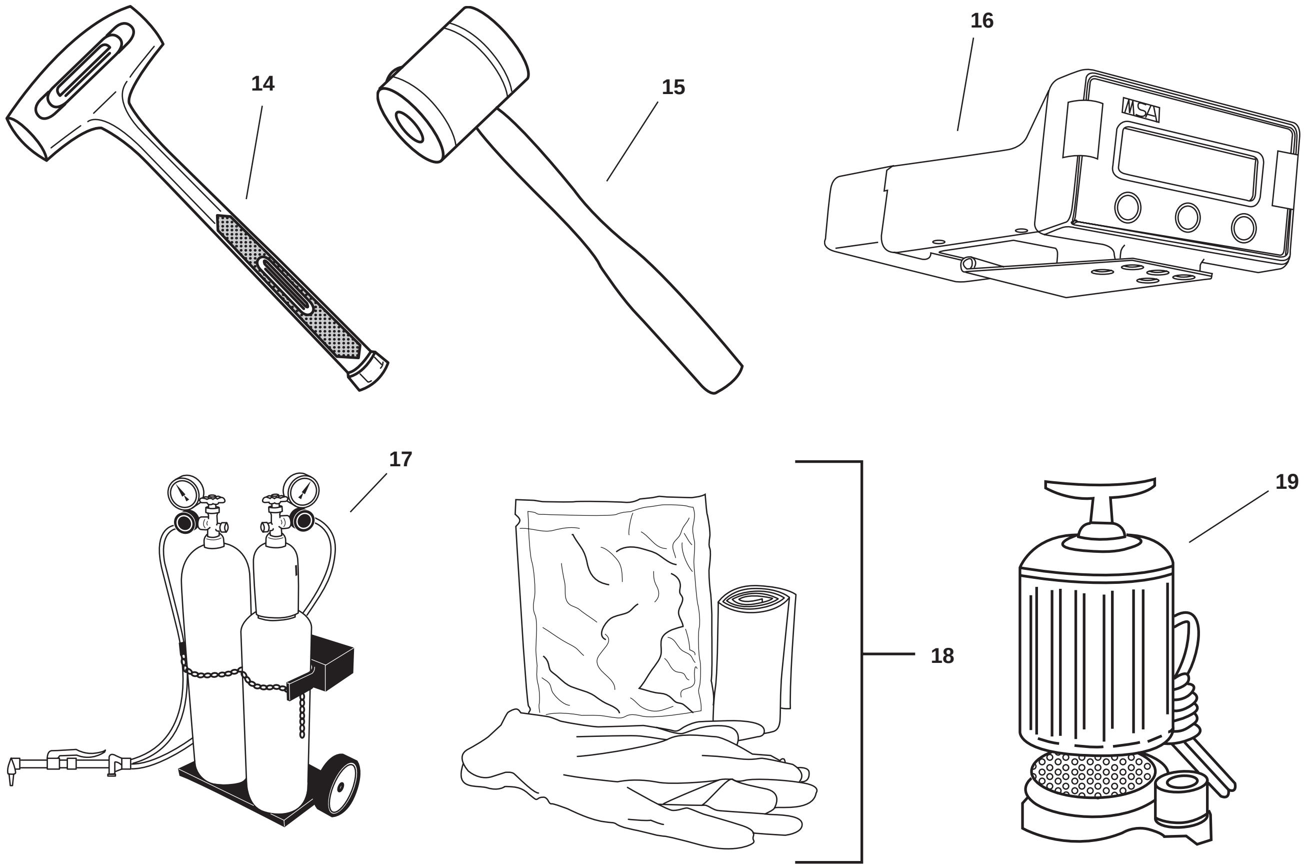
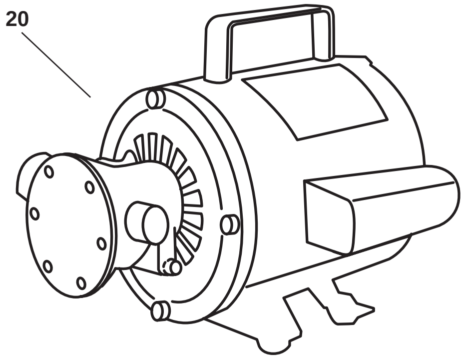
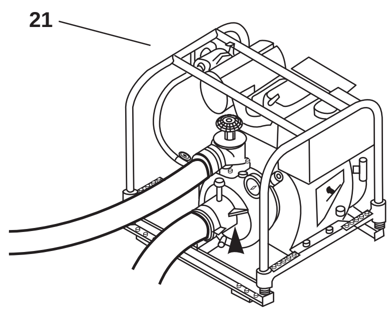
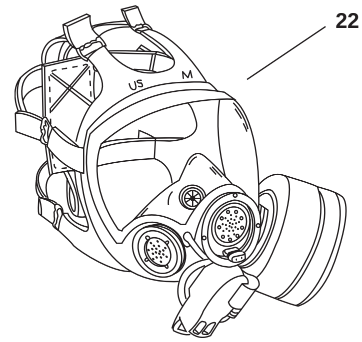


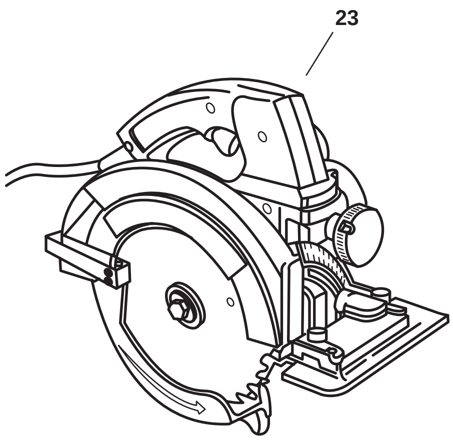
Table 1. Damage Control Equipment (continued)

Illustration Number	Nomenclature	Description	Quantity
14	Hammer, sledge, 20 lbs.	Used for striking and setting timbers during emergency shoring operations.	1
15	Maul, 5 lbs.	A maul has a cylindrical head and is used to drive wooden posts and shims into position during emergency shoring operations.	1
16	Meter, for gas monitoring	Samples the atmosphere for oxygen, carbon dioxide, carbon monoxide, and hydrogen.	2
17	Oxygen and acetylene cutting torch outfit	Used to braze together or to cut apart ferrous metals.	1
18	Pipe repair kits	Contains materials needed to patch and repair piping.	12
19	Pump, electric submersible	Portable electric pump used to dewater flooded compartments.	1









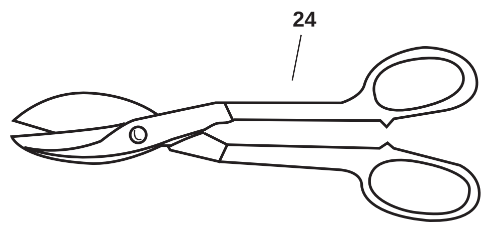


Table 1. Damage Control Equipment (continued)

Illustration Number	Nomenclature	Description	Quantity
20	Pump unit, centrifugal	Portable electric pump used to dewater flooded compartments.	1
21	Pump, diesel operated, dewatering and firefighting P-100	Portable small engine-operated pump used for emergency dewatering and firefighting purposes.	1
22	Respirator, air filtering	Self contained air filtering device capable of removing particulate and smoke from breathable air. It does not provide its own oxygen nor does it remove carbon dioxide or carbon monoxide.	2
23	Saw, circular, portable: electric and pneumatic	Used to cut studding and other boards and planks to length during emergency shoring operations.	1 each
24	Shears, metal cutting straight cut	Designed for cutting sheet metal and steel of various thickness and shape. Used to cut straight lines or curves in locations that are easily reached.	1

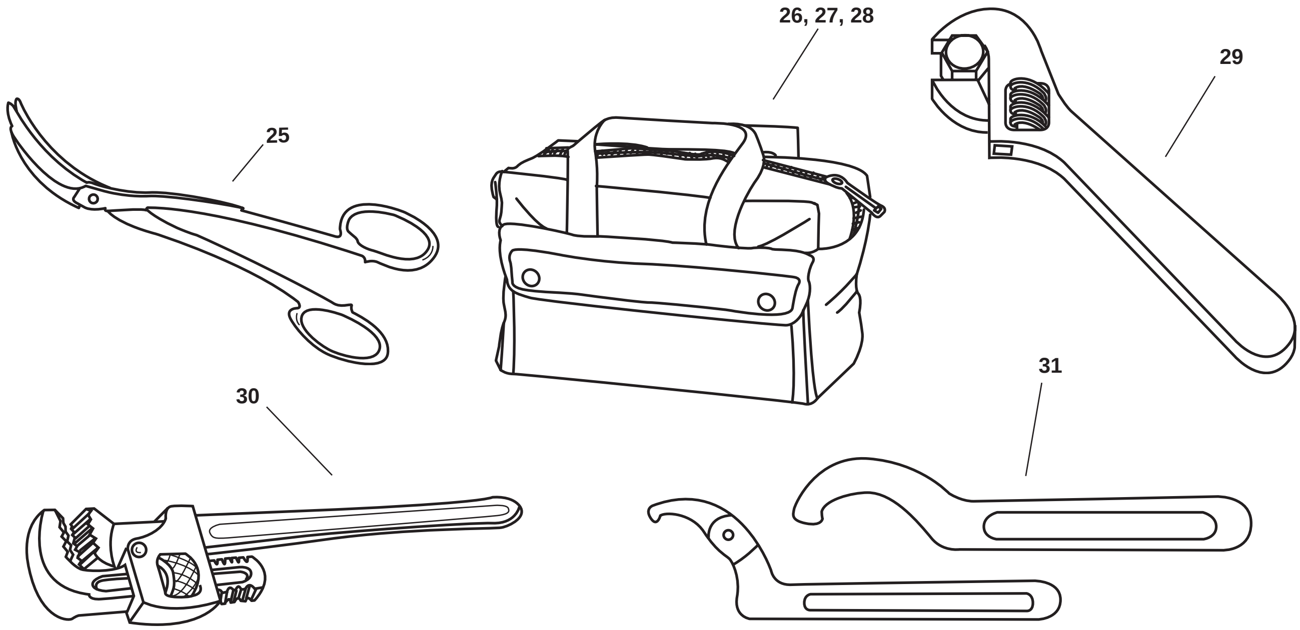


Table 1. Damage Control Equipment (continued)

Illustration Number	Nomenclature	Description	Quantity
25	Shears, metal cutting combination cut	Made especially for cutting short straight lines or curves. They are also used for cutting out small intricate designs in locations where it is necessary to keep the handles from contacting the metal stock.	1
26	Tool kit, carpenter's	Contains tools needed for emergency shoring operations.	1
27	Tool kit, electrician's	Contains tools needed to conduct emergency electrical work.	1
28	Tool kit, general mechanic's	Contains the necessary tools to conduct most other major mechanical repairs.	1
29	Wrench, open-end adjustable 6",10", 24"	Tools designed to tighten or loosen nuts, bolts, studs, and pipes. Adjustable wrenches are used at times when the correct size wrench or socket is not available, such as during a casualty.	1 each
30	Pipe wrench, heavy duty 10", 14", 18", 36"	Used to connect or break pipe joints or to turn cylindrical parts. Adjustment is made by turning a knurled adjusting screw, which moves the jaw. Always tighten the pipe fitting with the fixed jaw on top. The serrated jaws of the wrench will mar soft metal pipes and will crust PVC.	1 each
31	Spanner Wrench	Used to tighten fire hoses or similar couplings, which have a protruding lip. Spanner wrenches are special purpose wrenches and are to be used only for their intended purpose.	11

LIFE JACKETS

Life jackets (figure 1) are placed in various locations throughout the LT. Locations are indicated in table 2.

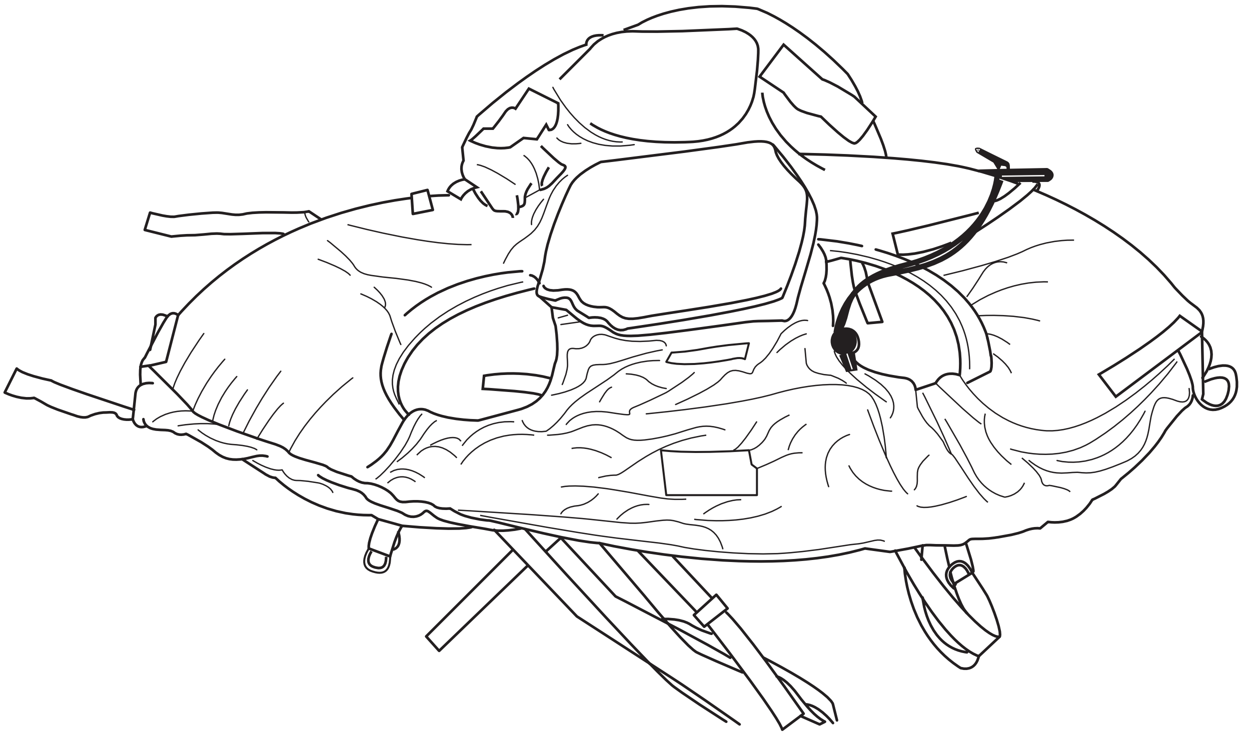


Figure 1. Life Jacket

Table 2. Life Jacket Locations

Location	No. Jackets
Life jacket locker	26
Engine Room	2
Workboat	3
Stowage racks in each stateroom	1 per bunk
Pilothouse	4
EOS	1

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) COMMUNICATION AND ALARM SYSTEMS

SOUND POWERED TELEPHONES

GENERAL

The purpose of the sound powered phone system is to ensure good, reliable communication during normal operations, special evolutions, and emergencies. An emergency on board the vessel is a real everyday possibility, and communications are of vital importance to any shipboard organization. Without this system to exchange accurate, up to date information, the vessel would not be able to function properly. Reliable information leads to good decisions. Sound powered telephone talkers are the nerve centers of the vessel. Without phone talkers, the vessel cannot operate efficiently or safely. The quality of the information transmitted depends entirely on how well the phone talker performs his or her job.

Sound powered communication is available at the following locations:

Station Number	Location
1	PilothouseTop
2	Pilothouse
3	Port Bridge Wing
4	Starboard Bridge Wing
5	Forward Bridge Wing
6	Aft Bridge Wing
7	Foredeck
8	Chief Engineer’s Stateroom
9	Captain's Stateroom
10	Officer Stateroom No. 1
11	Officer Stateroom No. 2
12	Emergency Generator Room
13	Aft Control & Machine Gun
14	Damage Control Locker
15	Crew’s Mess
16	Galley
17	Fantail
18	Bow Thruster Compartment
19	Enclosed Operating Station
20	Emergency Steering Gear Station
21	Radio Room

Sound powered telephones are just what the name implies. They are powered by the sound pressure of the speakers voice rather than by an electrical source. In a properly working phone, a strong clear voice generates the current necessary to carry the sound to the other phones on the circuit. Speaking into the mouthpiece causes the sound waves generated by the voice to vibrate a diaphragm. The sound vibrations are transferred from the diaphragm through a drive rod to an armature centered in a wire coil. The coil generates a current that is then transmitted to a receiver (the earpiece), where the process is reversed.

The sound powered telephone system consists of individual sound powered telephone circuits. Each circuit operates without any external source of electrical power. These features are important to remember if a failure occurs during a casualty. This is also important to remember because an earpiece turned away from the head will transmit distracting noises to other stations. The earpiece, though shaped differently from the mouthpiece, contains a diaphragm, an armature, and a coil. The earpiece and the mouthpiece can be used interchangeably. If the mouthpiece is damaged, the earpiece can be used as a microphone. The mouthpiece can be used as a speaker if it becomes necessary.

SOUND POWERED HANDSET

Sound powered handsets (figure 1, item 1) are usually permanently connected to their station by means of a coiled cord with terminal connectors (figure 1, item 2). A holder (figure 1, item 3) is provided for each handset, and the handset should be in the holder at all times when not actually in use. Handsets are used primarily for communication between two stations. The handset is provided with a normally open, spring returned switch in the handle (figure 1, item 4). When pressed, the switch closes the circuit to connect both the transmitter and receiver in parallel across the line. When the switch button is released, both transmitter and receiver are disconnected.

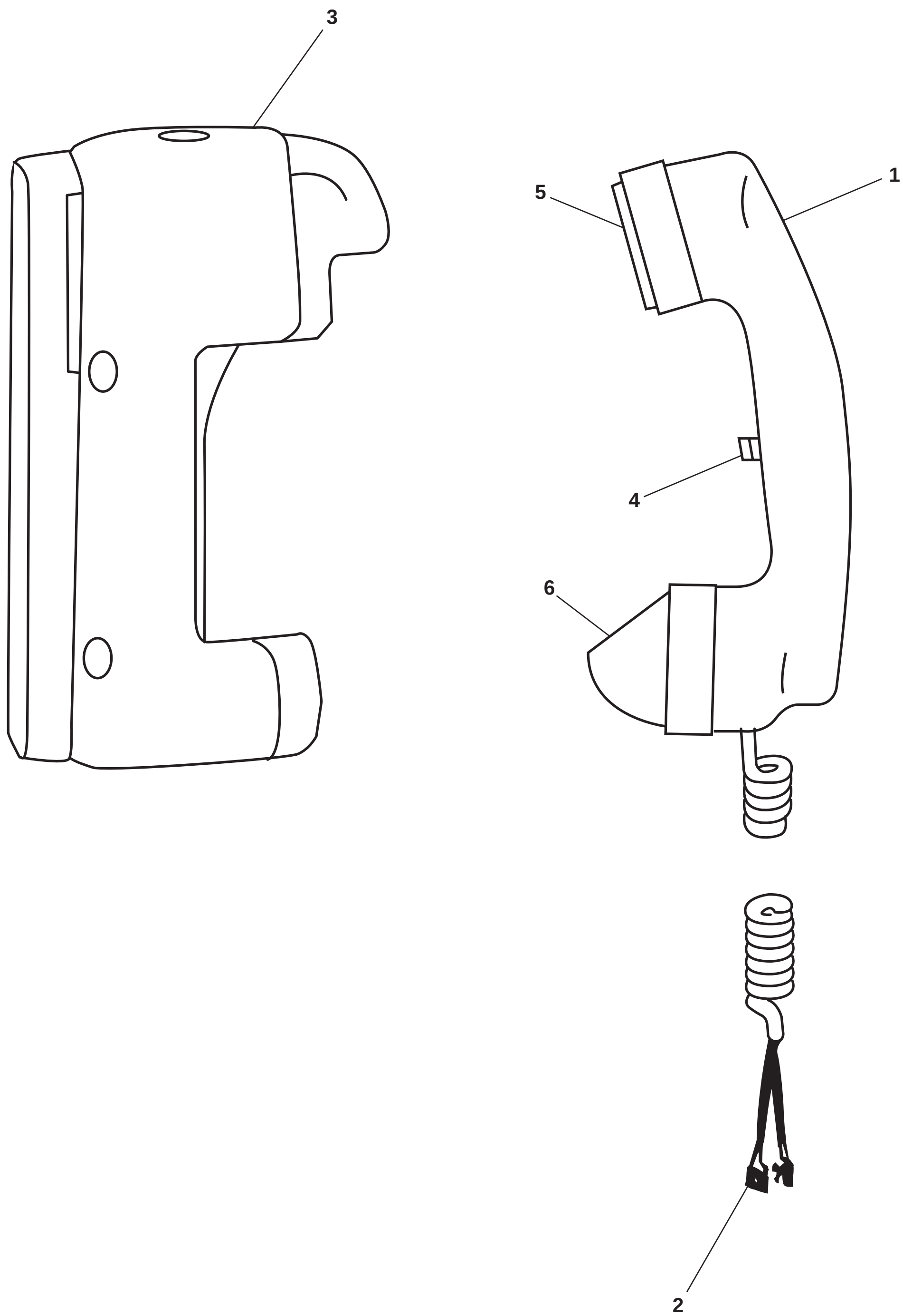


Figure 1. Sound Powered Handset

To operate the sound powered handset, hold the handset in one hand with the receiver (figure 1, item 5) over one ear and the transmitter (figure 1, item 6) in front of your mouth. You must push down the normally open, spring returned switch (figure 1, item 4) for talking as well as listening. Sound powered handsets are generally permanently wired into their call stations. Handset holders are installed in interior spaces, and handset stowage cabinets (figure 2) are installed at stations exposed to the weather. When placing the handset in its holder, be sure it is secured so that it cannot fall to the deck and be damaged.

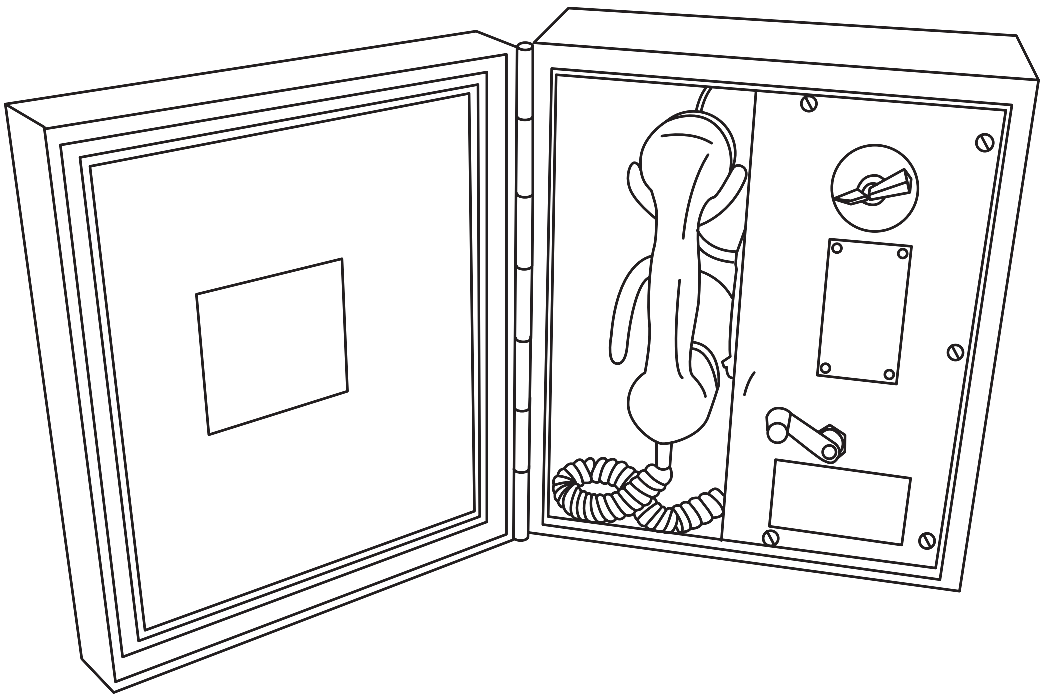


Figure 2. Exterior Handset Cabinet

THE HEADSET-CHESTSET

The purpose of the headset-chestset is to maintain continuous communication between stations for extended periods of time. Headset-chestsets should also be used when communicating between more than two stations. Maintaining continuous communications between stations is commonly referred to as “manning the phones.” It is necessary to man the phones during special evolutions such as getting the vessel underway or refueling. The phones are also manned during casualties such as fire, collision, and flooding.

Headset-chestsets are to be treated as emergency damage control equipment, and they operate in the same fashion as handsets. They are powered by the sound pressure of the speaker’s voice, and the receiver button must be pushed to talk. However, the button does not have to be pushed to listen. The mouthpiece and earpieces contain components that enable each to be spoken into and listened from.

The transmitter mouthpiece (figure 3, item 1) of the headset is suspended from a yoke (figure 3, item 2). The yoke is attached to a metal chest plate (figure 3, item 3). The earphones (figure 3, item 4) are the receiver and are connected to an adjustable headband (figure 3, item 5). The mouthpiece and earphones are connected by wire (figure 3, item 6) to a junction box (figure 3, item 7) that is mounted on the chest plate. A push to talk spring returned switch (figure 3, item 8) is mounted on top of the transmitter mouthpiece. The switch, receiver, and transmitter are wired together inside the chest plate mounted junction box. The wires in the junction box form a cable (figure 3, item 9) that connects the headset to the sound powered phone system by means of a jack plug (figure 3, item 10).

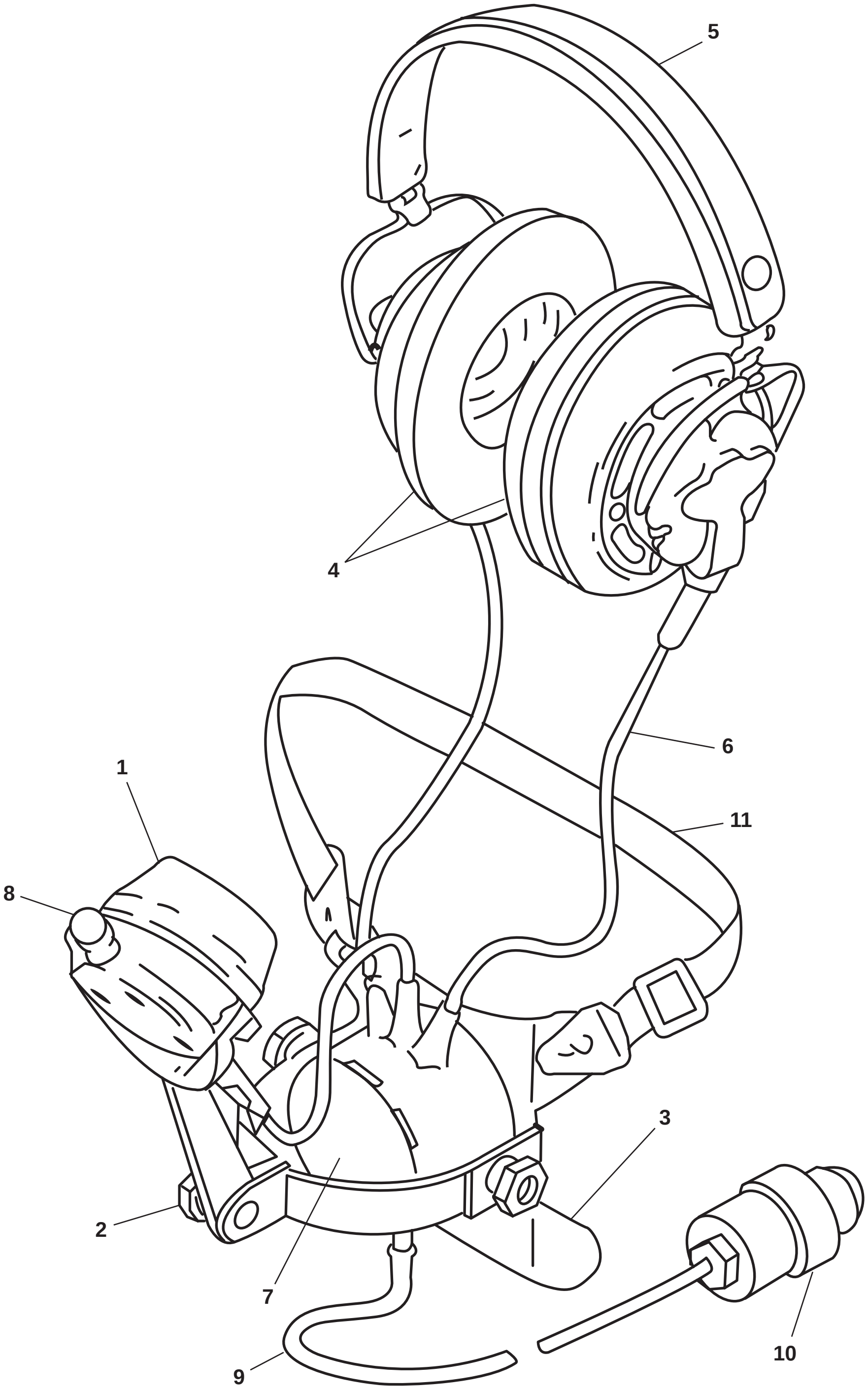


Figure 3. Headset-Chestset

When donning the headset-chestset use the following procedure:

1. Remove the made-up headset (figure 4, item 1) from the stowage hook or stowage box.

2. Hold the set and coiled cable (figure 4, item 2) in one hand.

3. Unhook the neck strap (figure 4, item 3) and unwind the coiled cable. Do not allow the set to dangle by its connecting wires (figure 3, item 6) as this can damage the phones.

4. Put the strap (figure 3, item 11) around your neck and secure the strap end to the tabs on the chest plate (figure 3, item 3).

5. Put on the earphones (figure 3, item 4) and adjust the headband (figure 3, item 5) for maximum comfort.

6. Straighten out any kinks in the cable and wires.

7. Remove the cover on the jack box (figure 5, item 1) and connect the plug (figure 3, item 10) into the jack.

8. Test the headset for satisfactory operation.

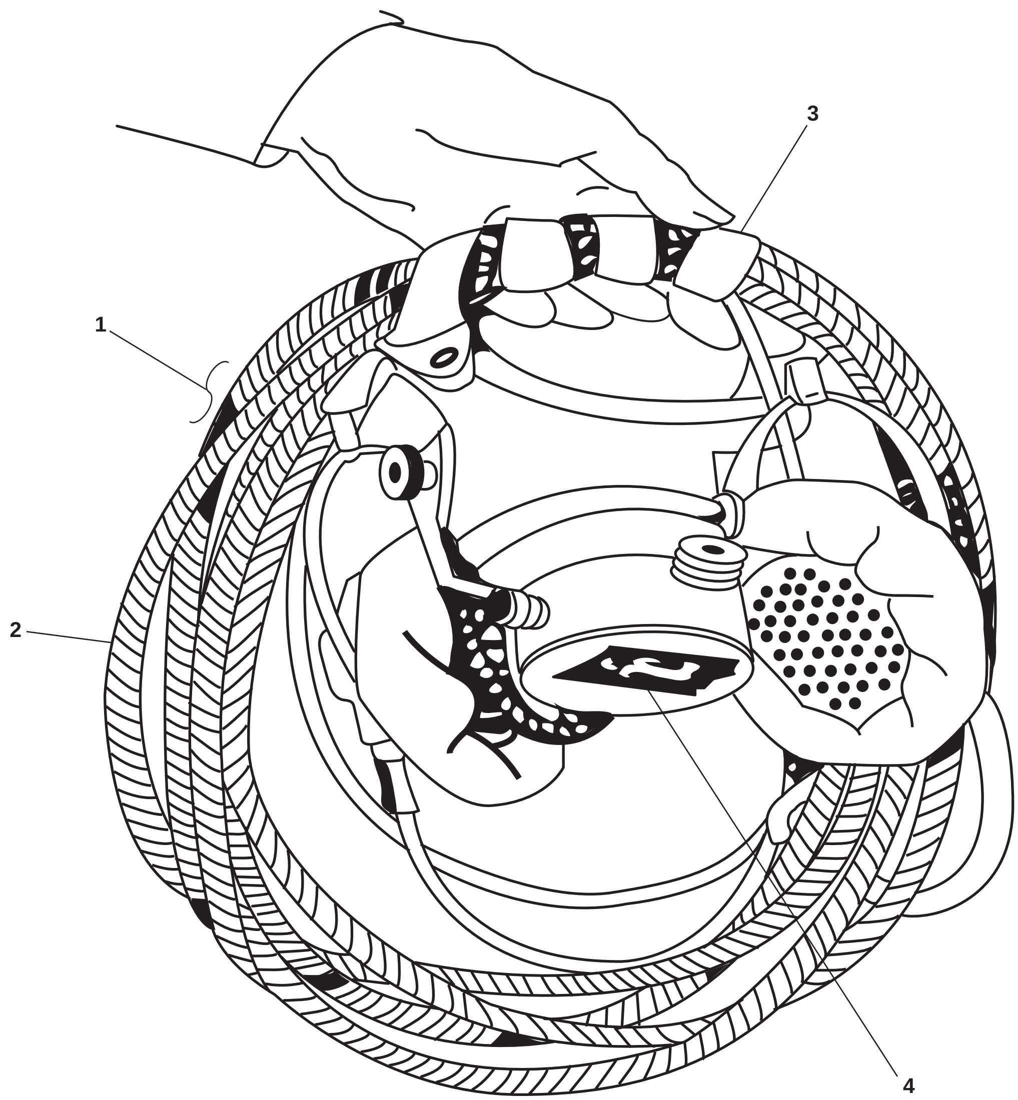


Figure 4. Properly Made-up Headset-Chestset

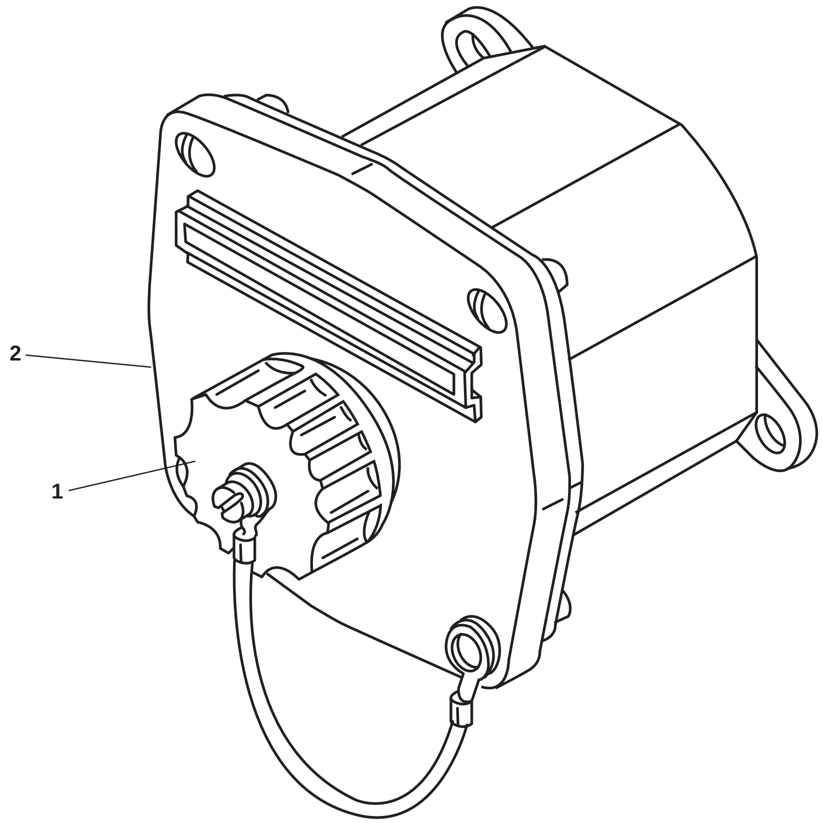


Figure 5. Sound Powered Telephone Jack Box

To find out if telephone stations are manned and ready, the controlling station (usually the bridge) conducts a circuit test. The circuit test consists of a phone check of all stations. When making the phone check, the controlling station says, “All Stations – Pilothouse…..Phone check.”

Each talker then acknowledges in assigned order. Assigned order is normally accomplished as forward to aft, and top to bottom of the vessel. Each station responds in order, but waits only a few seconds for the station immediately proceeding their own to acknowledge. A circuit test is not complete until every station has answered, and all faults with the phone system are corrected.

Always handle sound-powered telephones with care so that they will work properly if an emergency occurs. When not in use, stow them in their proper place. The sets are made as waterproof as possible, but should not be exposed unnecessarily to the weather. Do not drag the cables over sharp edges, pull on them too hard, or allow them to kink. When unplugging the cable from a jack, always pull on the body of the plug; never pull on the cable. When the evolution is complete, remove and properly store the headset. To remove and make up a sound-powered telephone headset, use the following procedure:

1. Remove the earphones (figure 3, item 4) from the head, and hang the headband (figure 3, item 5) over the transmitter yoke (figure 3, item 2).

2. Unscrew the jack plug (figure 3, item 10) from the jack box (figure 5, item 2).

3. When the collar is loose, grasp the jack plug (figure 3, item 10) and pull it out.

4. Replace the jack cover (figure 5, item 1) on the jack box (figure 5, item 2) to keep out moisture and dirt.

5. Lay the cable (figure 3, item 9) out on the deck and remove any kinks.

6. Coil up the cable (figure 3, item 9), starting from the end that attaches to the chest plate (figure 3, item 3).

7. After the cable (figure 3, item 9) is coiled, remove the headband (figure 3, item 5) from the transmitter yoke (figure 3, item 2) and hold the headband in the same hand with the cable.

8. Fold the transmitter yoke (figure 3, item 2) flat so that the mouthpiece (figure 3, item 1) lies flush against the chest plate junction box (figure 3, item 7). Take care not to pinch the cable (figure 3, item 9).

9. Hold the headband (figure 3, item 5) and cable (figure 3, item 9), then unhook one end of the neck strap (figure 3, item 11) from the chest plate (figure 3, item 3).

10. Bring the top of the chest plate (figure 3, item 3) level with the headband (figure 3, item 5) and cable (figure 3, item 9).

11. Secure the chest plate (figure 3, item 3) in this position by winding the neck strap (figure 3, item 11) around the headband (figure 3, item 5) and coiled cable (figure 3, item 9) just enough times that a short end will be left over.

12. Twist the end of the neck strap (figure 3, item 11) once and fasten it to the chest plate (figure 3, item 3). The set is now made up and ready for stowing and should look similar to the made-up set in figure 4.

In enclosed spaces, headset-chestsets are stored on hooks. In machinery spaces and on the weather decks, they are stored in stowage boxes. A properly made-up set (figure 4, item 1) should fit into its stowage box without having to force the box closed. Never allow a loose cable to hang out of the box, as it may be damaged when the lid is closed. Never use the stowage box for storing cleaning gear or tools. Cleaning rags give off moisture while chemicals give off fumes that will cause the aluminum diaphragms to rapidly oxidize. Tools and other loose gear may damage the set, and that may prevent you from having a useable set to use in an emergency.

BASIC SOUND POWERED PHONE OPERATION

Each phone talker must become familiar with the phone talker rules and procedures. The operation of a sound-powered telephone circuit involves a message originator, a control station, and the other phone talkers at different stations. Each person plays a distinct role in ensuring that messages are transmitted and understood properly. When communicating with the sound powered phone system, use statements instead of direct questions. For example, say “Report the status of the bow thruster engine” instead of asking, “What is the status of the bow thruster engine?” Say, “Report the estimated repair time of the emergency diesel generator” instead of asking “When will the emergency diesel generator be repaired?” Do not use slang expressions or locally devised codes. Also do not use abbreviations that may be easily misunderstood, such as EDG or SSDG.

Permission must be granted by the controlling station to change phone talkers. Use the following procedure to request permission: “Pilothouse – Emergency Steering Gear…..Request permission to change phone talkers.” The controlling station must be informed, and permission must be granted to exchange a set of faulty phones for a good set as per the following procedure: “Pilothouse – EOS…..Request permission to change phones.” Once permission is granted, go off line to change phones. Additionally, a report must be made to the controlling station that a phone talker is online after relieving a phone talker or when the faulty phones are replaced.

Before securing from the circuit, always get permission. For example, the fantail asks, “Pilothouse – Fantail…..Request permission to secure phones.” The pilothouse says, “Request permission to secure phones…..Stand by.” The pilothouse phone talker then gets permission for the phone talker on the fantail to secure, and then says, “Fantail – Pilothouse…..Secure phones.” The fantail talker replies, “Fantail…..Securing phones.” The Army has developed and refined circuit discipline and telephone talker procedures over a period of many years. The objective of the telephone talker is to pass important information from one station to another without confusion or misinterpretation. Master these procedures and you will become a reliable communicator that your vessel can count on.

LS-519A/SIC INTERCOMMUNICATION SYSTEM

The purpose the LS-519A/SIC intercommunication system (intercom) is to provide two-way communication between various stations. Each unit has a number of selector switches. To talk to one or more stations, press in the appropriate switches, and then push down on the PRESS-TO-TALK switch. A red signal light mounted above each selector switch shows if the station is busy. If the station is busy (talking to another station), the light flashes. If the light remains lit, the station is ready to receive.

The LS-519A/SIC Intercommunication system has a capacity for 20 stations. Twelve stations are presently being used, which allows eight stations for future expansion. The twelve stations in use are at the following locations:
Station Number Location

1. EOS
2. Chief Engineer's Stateroom
3. Crew's Mess
4. Crew Stateroom 1
5. Crew Stateroom 2
6. Crew Stateroom 3
7. Crew Stateroom 4
8. Pilothouse
9. Officer Stateroom 1
10. NCO Stateroom
11. Officer Stateroom 2
12. Captain's Stateroom

Each intercom unit is capable of providing two-way voice communication between any two sections simultaneously. The system is powered by 115 Vac, 60 Hz, single-phase power. Each station contains the following controls:

1. Two 10-pushbutton station selector switch assemblies (figure 6, item 1).
2. A microphone or headset connector (figure 6, item 2).
3. A HANDS FREE/NORMAL/PRESS-TO-TALK switch (figure 6, item 3).
4. A VOLUME control switch (figure 6, item 4) for incoming loudspeaker audio.
5. A DIMMER switch (figure 6, item 5) for illumination control.
6. A release (REL) lamp (figure 6, item 6), CALL lamp (figure 6, item 7) and a BUSY lamp (figure 6, item 8).

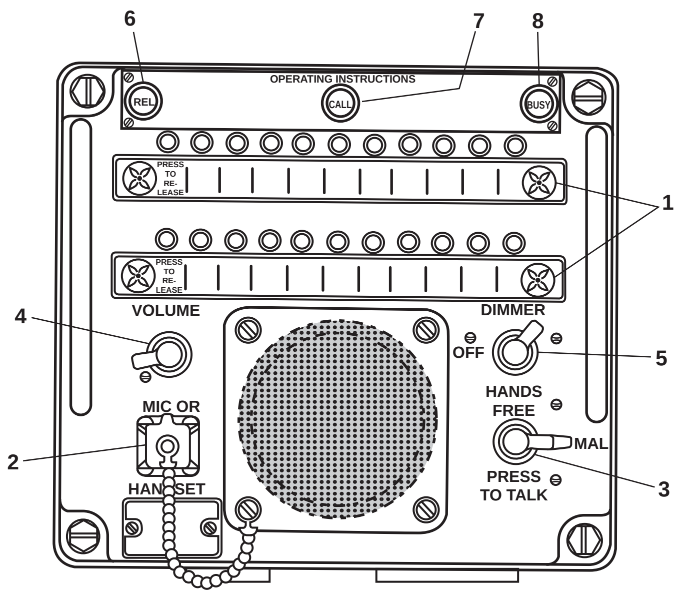


Figure 6. Intercom Unit

GENERAL ALARM SYSTEM

The general alarm system is a contact switch activated multipurpose alarm that is used to alert the crew to general alarm conditions and casualties. In the event of an emergency such as fire, flooding, or collision, the general alarm is activated, and an announcement is made to inform the crew of the nature of the casualty. The general alarm is also used to call the crew to general quarters (battle stations).

The general alarm is powered by a 24 Vdc power supply. The power supply is fed by the general alarm battery bank. This power source is used because it is considered the most reliable. The general alarm circuit remains in an electrically open position (OFF) until one of two contact makers (figure 7) complete the circuit. One contact maker is located in the pilothouse and the other is in the 01 level passageway. Each contact maker contains an internal switch that closes when placed in the ALARM position. The closed switch completes the circuit, and 24

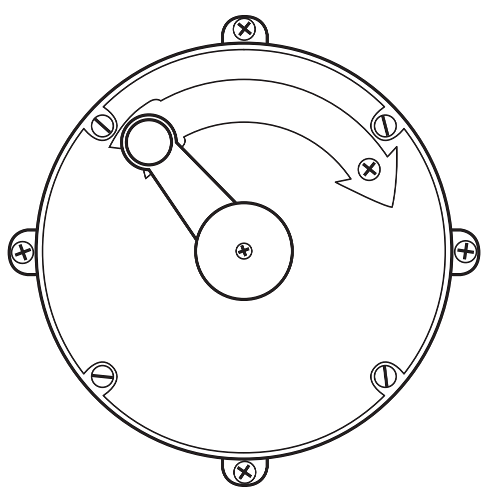


Figure 7. General Alarm Contact Maker

Vdc from the general alarm feeder distribution panel actuates the alarm bells. Twelve bells (figure 8) provide an audible alarm throughout the LT. In the auxiliary machinery spaces and engine room, the system is equipped with relays that provide 110 Vac to rotating beacons (figure 9). The beacons provide a visual indication that the general alarm was sounded in areas where engine noise prevents hearing the bells.

Bells are placed in the following locations:

1. Pilothouse
2. 01 Level, Passageway
3. Pilothouse, Centerline, Frame 34
4. Boatswain's Storeroom
5. Main Deck Passageway, Centerline, Frame 33
6. Bow Thruster Compartment
7. Enclosed Operating Station (EOS)
8. AMS 1
9. AMS 2
10. Towing Gear Locker
11. Crew's Mess
12. Engine Room

Red beacons are placed in the following locations:

1. Engine Room
2. AMS 1
3. AMS 2

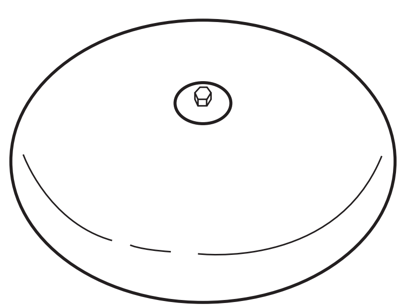


Figure 8. Alarm Bell

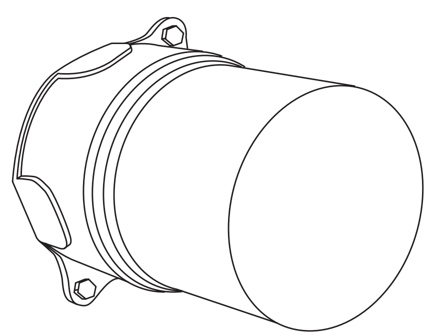


Figure 9. Rotating Beacon

FIRE ALARM SYSTEM

The purpose of the fire alarm system is to automatically alert the crew by sounding an alarm when sensors detect smoke or fire. The crew can manually activate the fire alarm system by means of 11 fire alarm pull stations (figure 10) located throughout the vessel. When one of the various sensors detects an alarm condition or a fire alarm pull station is actuated, a signal is sent to the fire and smoke detection panel in the EOS. The fire and smoke detection panel activates the alarm, determines what zone the alarm condition is in, turns on the appropriate alarm LED, and sends the appropriate signal to the remote indicator unit (figure 11) in the pilothouse. The remote indicator unit in the pilothouse displays which zone the alarm condition is located in.

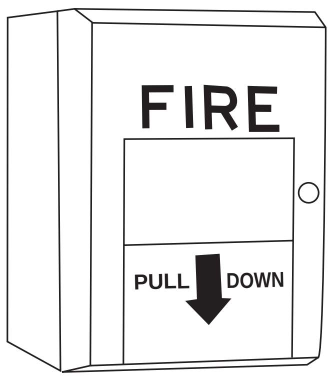


Figure 10. Fire Alarm Pull Station

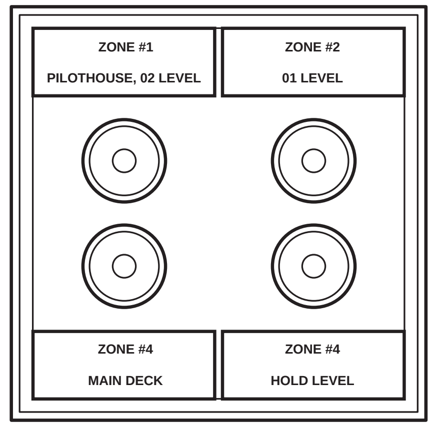


Figure 11. Fire Alarm System Remote Indicating Panel

The fire alarm system is capable of detecting heat, smoke, and fire. It relies on various sensors placed throughout the vessel to detect the alarm condition. The sensors are grouped into four zones on the vessel. The four zones outlined in figure 12 are:

Zone 1 Pilothouse, 02 level passageway, and radio room

Zone 2 01 level and EDG room

Zone 3 Boatswain's locker, main deck passageway, galley, and crew's mess area

Zone 4 AMS 1, engine room, AMS 2, and towing gear locker

The fire and smoke detection panel (figure 13) is located in the EOS. The remote indicating panel (figure 11) is located in the pilothouse. The infrared thermal heat detectors are mounted in the crew's mess and recreation area, galley, and EDG room. There are 15 smoke detectors in various locations throughout the vessel. The smoke detectors contain a set of normally open contacts that close when smoke is detected. When the contacts are closed, the fire and smoke detection panel in the EOS senses the condition and sounds the alarm. There are three thermal heat detectors, one each is located in the EDG room, the galley, and the crew's mess/recreation area. The thermal heat detectors are similar to the smoke detectors except that the contacts close when a temperature of 135 °F (55.2 °C) is sensed.

The fire alarm system sounds two system bells and energizes a beacon. One bell is located in the pilothouse, and the other one is in the EOS. The beacon is mounted in the radio room. In the event of an alarm condition, the bells will continue ringing, and the beacon will flash until the circuitry is reset at the fire and smoke detection panel in the EOS.

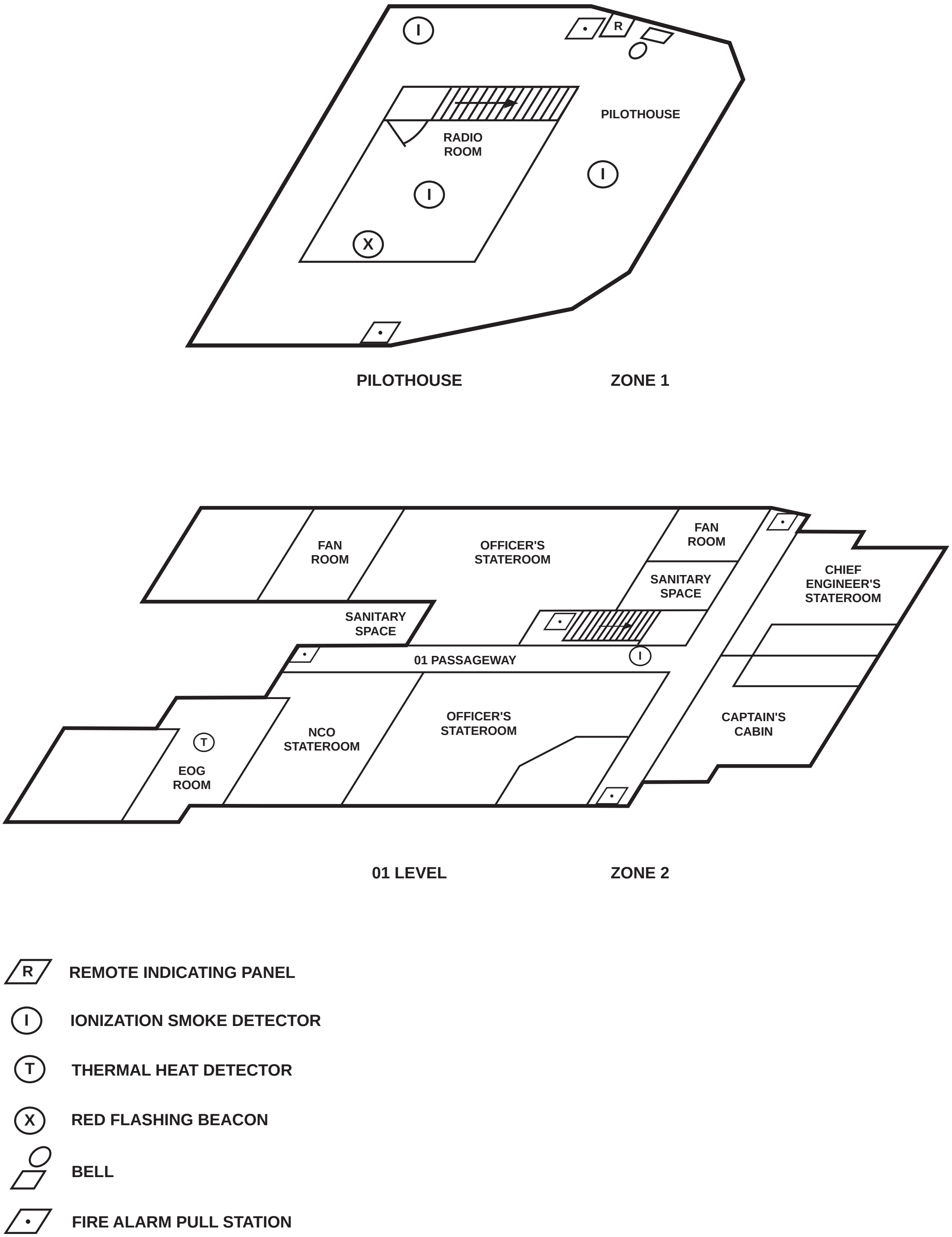
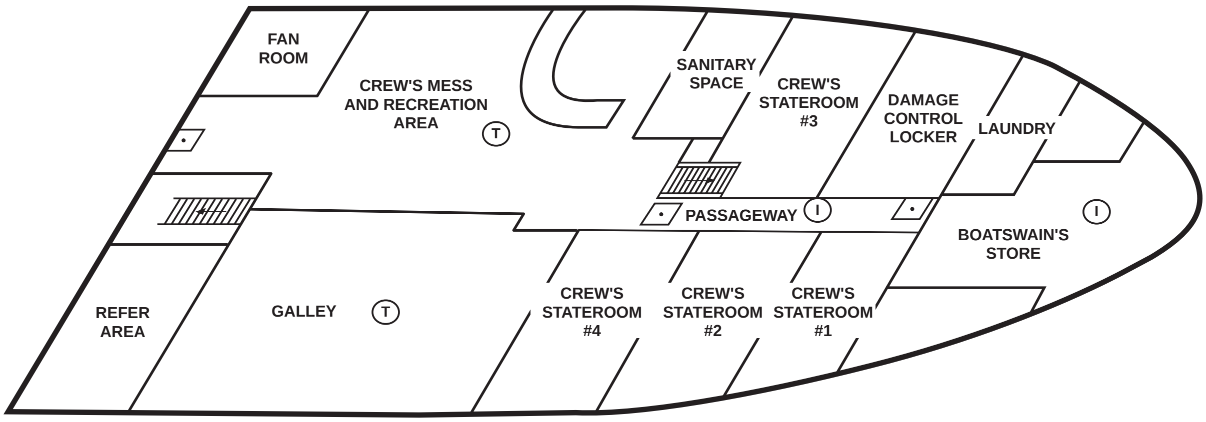
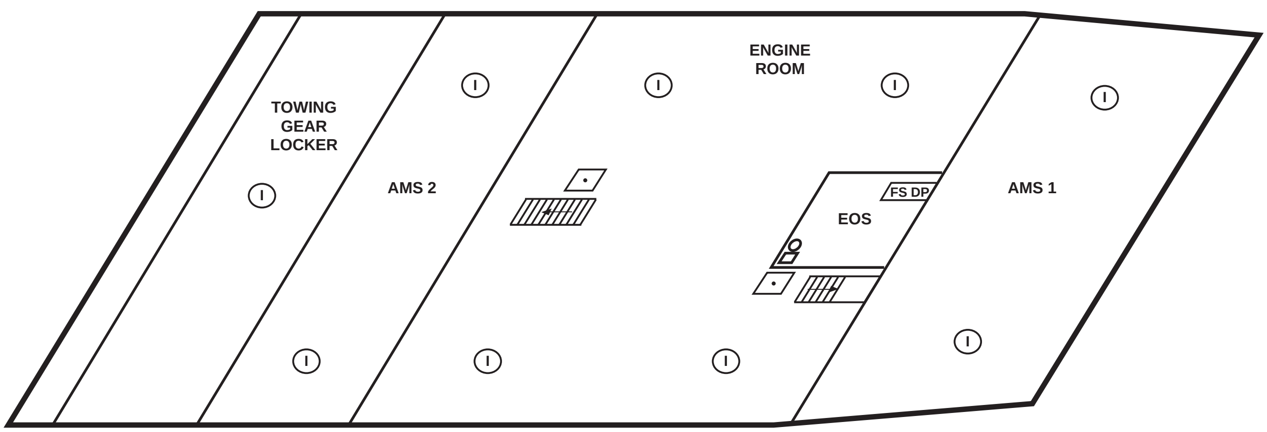


Figure 12. Components of the Fire Alarm System by Zone (Sheet 1 of 2)



MAIN DECK ZONE 3



HOLD LEVEL ZONE 4

(T) THERMAL HEAT DETECTOR

(I) IONIZATION SMOKE DETECTOR

BELL

FIRE ALARM PULL STATION

FS DP FIRE AND SMOKE DETECTION PANEL

Figure 12. Components of the Fire Alarm System by Zone (Sheet 2 of 2)

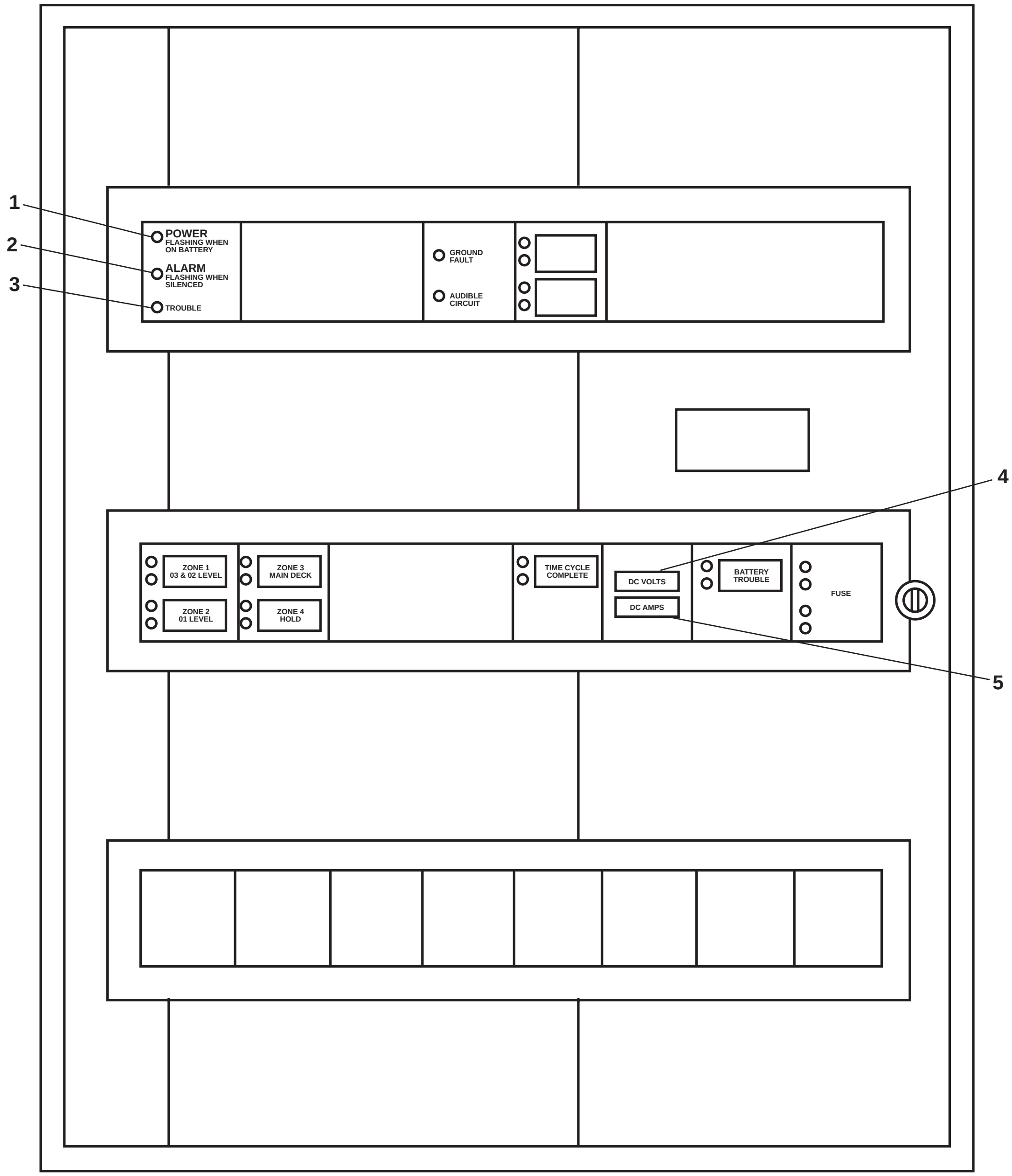


Figure 13. Fire and Smoke Detection Panel

The fire and smoke detection panel also alerts the crew to any fire detector faults in the system. The panel contains other indicators that illuminate during specific conditions. The POWER indicator (figure 13, item 1) illuminates to indicate that normal power is being supplied to the fire detection panel, and flashes when the fire detection panel is on battery power. The ALARM indicator (figure 13, item 2) illuminates when an alarm condition is detected, and it flashes when an alarm condition exists and the alarm is silenced. It will continue to flash as long as the audible alarm is silenced and an alarm condition is detected. The TROUBLE indicator (figure 13, item 3) illuminates when the system detects a fault in the backup battery system. The fire alarm system has its own backup battery in the fire and smoke detection panel. The DC VOLTS meter (figure 13, item 4) measures the dc voltage available to the fire detection system, and the DC AMPS meter (figure 13, item 5) indicates the dc current used by the alarm system. The voltage and current indications are necessary in determining the status of the fire alarm system. If the TROUBLE indicator illuminates and normal power is lost, the reliability of the fire alarm system may be suspect.

FM-200 FIRE SUPPRESSION ALARM SYSTEM

The purpose of the FM-200 fire suppression alarm system is to warn personnel on the hold level (AMS 1, the engine room, and AMS 2) that the FM-200 fire suppression system will be actuated. In the event of fire in the engineering spaces, personnel should make every effort to put the fire out using established firefighting procedures. The FM-200 fire suppression system should only be used if traditional firefighting measures are not, or will not, suppress the fire.

The fire suppression alarm system is needed because the FM-200 agent produces Hydrogen Fluoride (HF) gas when exposed to temperatures at or above 1300 °F (704.4 °C). When the FM-200 system is actuated, ventilation to and from the engineering spaces, the ship's service diesel generators, and the bow thruster and pump drive engines are automatically shut down to prevent the FM-200 agent from being extracted from the spaces. Although the FM-200 agent itself is breathable, the atmosphere in the engineering spaces will rapidly degrade in a casualty condition, and HF gas may be present. The personnel in those spaces must have warning to evacuate, or make preparations to find breathable air.

The FM-200 fire suppression alarm system is an automatically actuated alarm system. When the FM-200 system is actuated, pressurized CO_2 from the system's actuating circuit closes the alarm switch. This switch, in turn, energizes the yellow strobe lights, and sounds the horns and bell. Location of the yellow strobe lights, horns, and bell are illustrated in figure 14. Once the alarm begins to sound, the occupants of the engine room and AMS 1 have 60 seconds before FM-200 agent is released. The alarm system consists of five amber strobe lights, two horns, and one bell. Three strobe lights are mounted in the engine room, and one each in AMS 1 and AMS 2. The alarm system bell is mounted on the aft exterior main deck at frame 21. The strobe lights and bell are powered by emergency lighting panel 1. The fire suppression alarm system has two horns. One horn is mounted in the engine room, and the other is in AMS 1. The horns are powered by the emergency generator battery charger circuit. The use of two separate power sources provides greater assurance that personnel in the hold level will be warned if the FM-200 fire suppression system is activated.

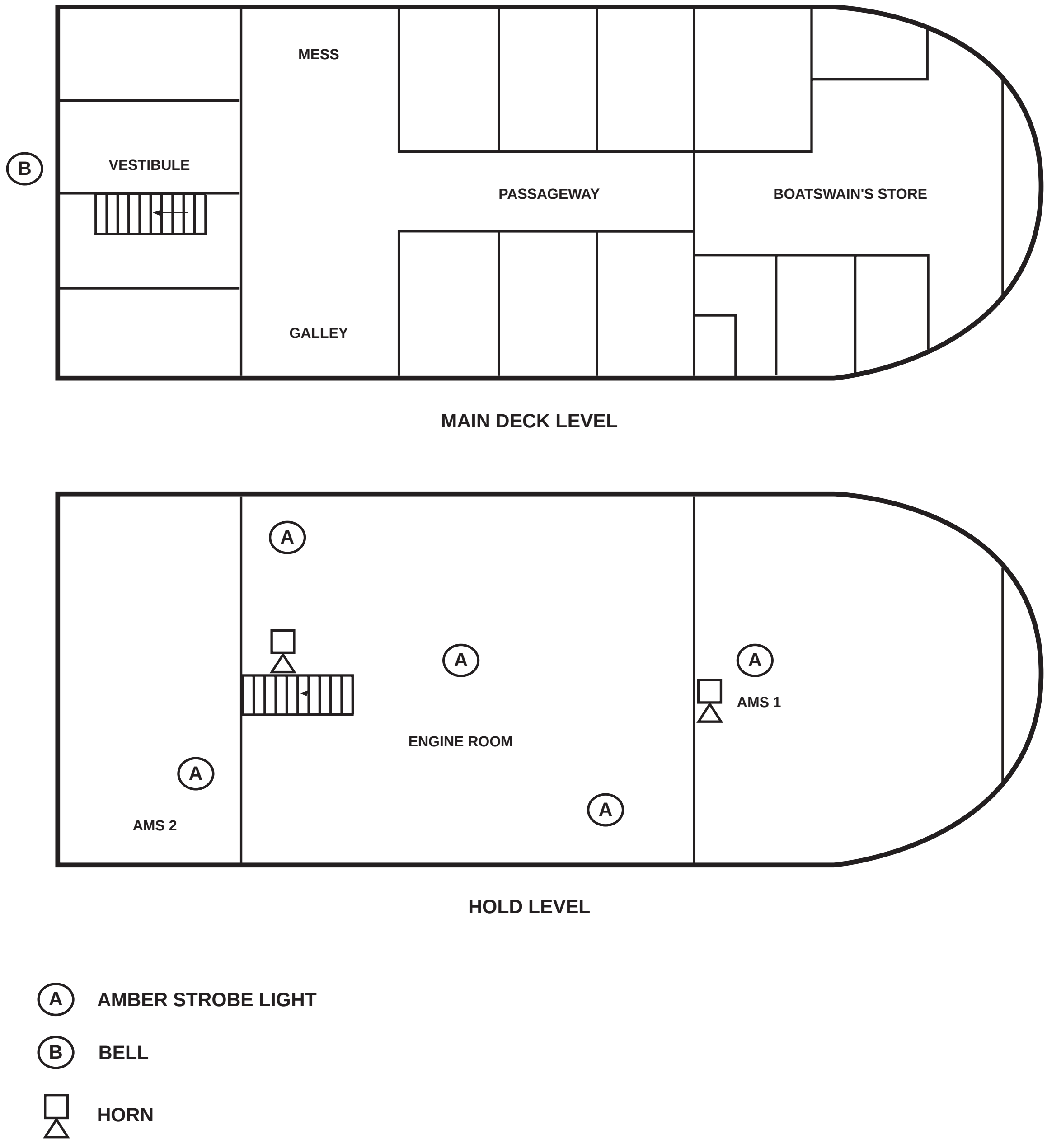


Figure 14. Components of the FM-200 Fire Suppression Alarm System

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR
INLAND AND COASTAL LARGE TUG (LT)
FIREFIGHTING EQUIPMENT AND FIRE SUPRESSION SYSTEM

EXTINGUISHING AGENTS

DRY CHEMICAL

The extinguishing agent dispensed from portable hand-held equipment used on the LT is dry chemical based (figure 1). Dry sodium bicarbonate chemical is non-toxic, non-corrosive, and non-abrasive. It can be used effectively on oil fires, and it is four times more effective than equal weights of CO_2 in extinguishing a flammable liquid fire. Dry chemical is also effective on electrical fires. Because the agent has little effect on the removal of heat, repeated applications may be required to prevent the fire from reflashing. Dry chemical is the most effective hand held extinguisher in combating an oil spray fire. The effective range of this agent is 13 to 22 feet (4 to 6.7 meters). Dry chemical can cover a large area, but the residue left behind is difficult to remove.

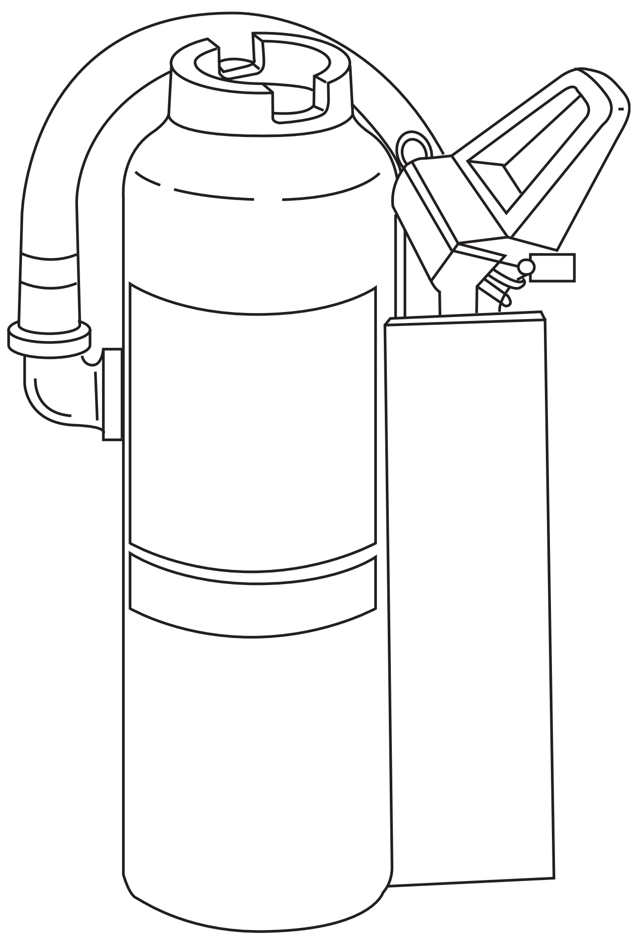


Figure 1. Portable Dry Chemical Extinguisher

WATER

Water is the most commonly used extinguishing agent. Water lowers the temperature of a burning substance below its ignition point. Water brought to bear on a fire can be in the form of high velocity fog, low velocity fog, or a solid stream using the all-purpose nozzle on a pressurized fire hose. Using water in the form of fog greatly increases the applied surface area. This means that fog provides the fastest means of reducing the heat created by burning material. Fighting fires with water also produces steam, which aids in smothering the fire.

High velocity fog (figure 2) allows the firefighter to attack the fire from a greater distance, and will cause cool air to be drawn toward the fire past the firefighter. High velocity fog shields the firefighter from heat and protects the fire team from exposure. However, the use of high velocity requires more water, and more water in a space could lead to flooding problems.

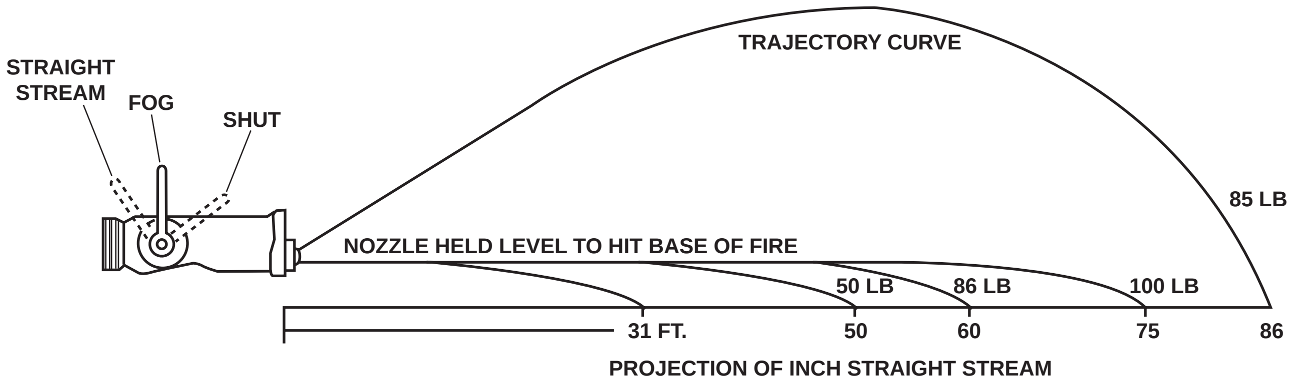


Figure 2. High Velocity Fog

Low velocity fog (figure 3) requires the use of a low velocity fog applicator. With the applicator, the nozzle man can reach over or around obstructions to place a cooling, smothering blanket of fog on the fire. The all-purpose nozzle, when equipped with the applicator and fog head, projects a fog of maximum diffusion. The fog pattern is most effective 5 to 6 feet (1.5 to 1.8 meters) away from the tip of the applicator. Low velocity fog also precipitates and dissolves smoke while providing a cool path for advancing on the fire. However, care must be taken when using the low velocity fog applicator to put out electrically caused fires because of electrocution concerns.

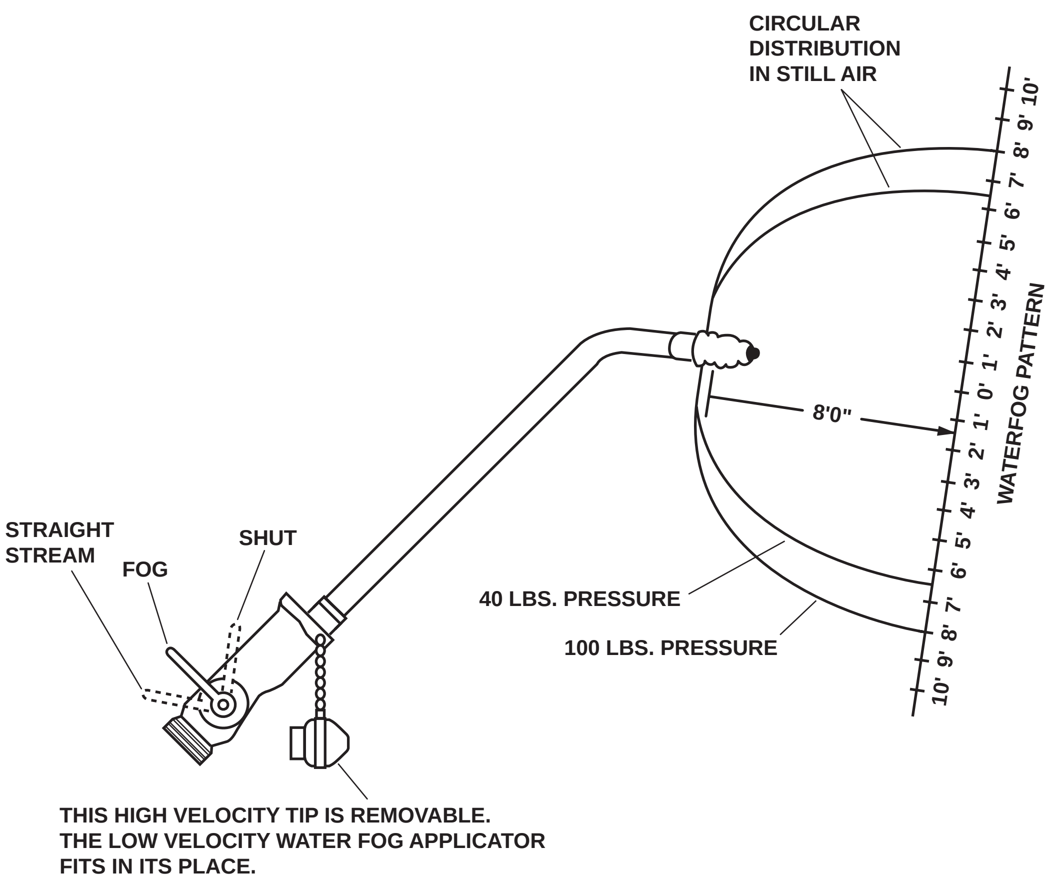


Figure 3. Low Velocity Fog

Water in the form of a solid stream (figure 4) is not a preferred method of water use on board any vessel at sea. It is not as efficient as fog at removing heat, and it adds large quantities of water to an area that must be pumped out. Additionally, the splashing effect of the solid stream causes damage to surrounding equipment. Therefore when below decks, water in the form of a solid stream is used only as a last resort and if no other agent is available.

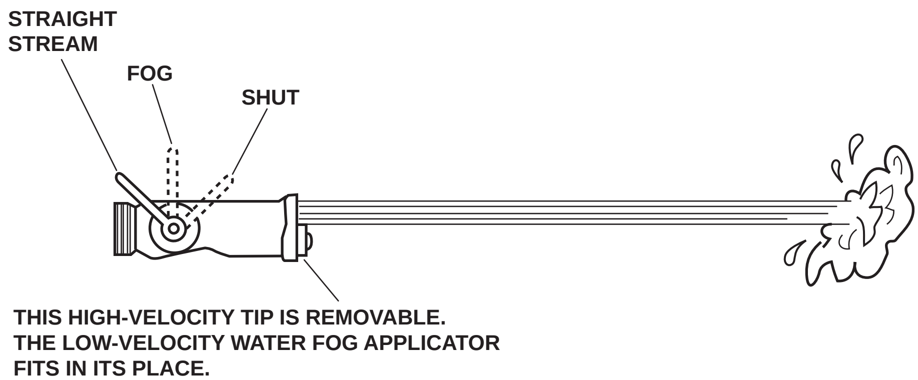


Figure 4. Solid Stream

FIRE MAIN

The fire main is made up of two electrically driven pumps and one diesel engine-driven pump. The two electric fire pumps, located in AMS 2, are rated at 250 gal/min (946 L/min) with a discharge pressure of 125 lb/in² (8.6 bar). The diesel engine-driven fire pump is located in AMS 1. It is rated at 1000 gal/min (3785 L/min) with a discharge pressure of 125 lb/in² (8.6 bar). A local start/stop control for all pumps is provided, and each pump can be controlled from the pilothouse.

FIRE MONITORS

Three fire monitors (figure 5) are provided primarily to fight fires on other vessels when rendering aid. The monitors are located on the top of the pilothouse to provide 360 degree coverage of the vessel. Each monitor is rated at 500 gal/min (1893 L/min) with a 100 lb/in² (6.9 bar) discharge pressure. The monitors are capable of directional and elevation control, and they can dispense both raw water and Aqueous Film-Forming Foam (AFFF). The diesel engine-driven pump is required when operating more than one fire monitor.

AFFF is also known as “light water.” It is synthetic, film-forming foam designed for use in shipboard firefighting systems. When used properly, it provides a vapor seal over a fuel spill, and it is designed to extinguish class BRAVO fires. AFFF is a highly effective extinguishing agent for smothering large fires, particularly those in oil, gasoline, and jet fuels. The foam proportioning equipment in combination with the fire monitors and diesel engine-driven pump generate a very effective foam blanket. AFFF is equivalent to raw water when it is used to extinguish class A fires.

The unique action of AFFF stems from its ability to make a lightwater film float on flammable fuels. As foam is applied over the flammable liquid surface, an aqueous solution drains from the foam bubbles. The aqueous solution then floats out over the surface of the flammable liquid to provide a vapor seal. This aqueous film-forming action enhances extinguishment and prevents reflash, even when the foam blanket is disturbed. Flammable liquids such as fuel that have not been ignited can be protected with this action. AFFF can be used alone or in combination with dry chemical powder.

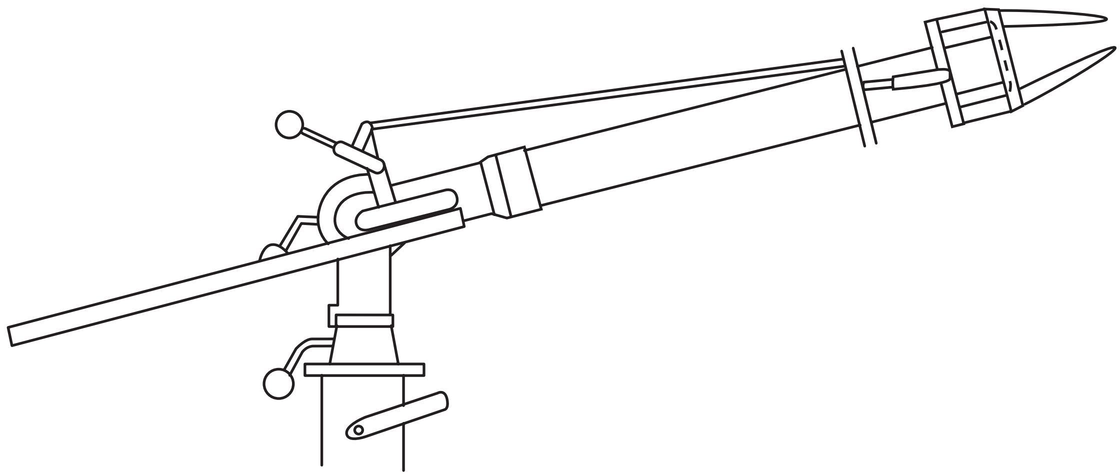


Figure 5. Fire Monitor

FIRE STATIONS

There are 11 fire stations located throughout the vessel. Each is provided with 50 feet (5.2 meters) of 1-1/2 inch diameter high pressure fire hose (figure 6, item 1), a spanner wrench (figure 6, item 2), and an all-purpose nozzle (figure 6, item 3).

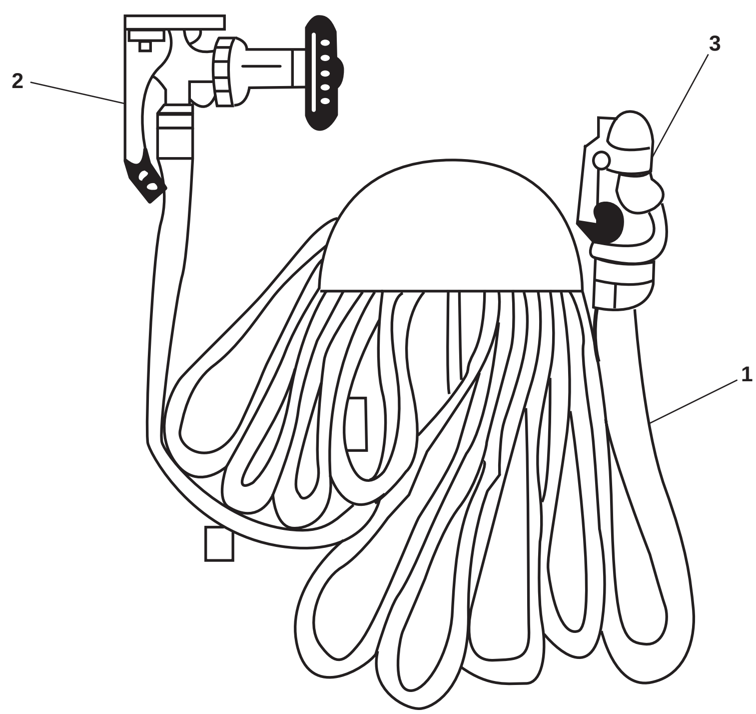


Figure 6. Fire Station

SPRINKLER SYSTEMS

AMMUNITION STORAGE LOCKERS

The arms and ammunition storage locker is equipped with a flooding system designed to cool the contents in case of fire in, near, or around the locker. However, if the surrounding area becomes heated, maintain a safe distance from the source of the fire while applying high velocity water fog.

Temperature stability in ammunition and pyrotechnic storage areas is essential to prevent decomposition and deterioration of stored devices. Ready service lockers and other ammunition stowage spaces are designed to maintain temperatures within prescribed limits under normal operating conditions. The stability of smokeless powder decreases at temperatures in excess of 100 °F (37.8 °C). Stowage in airtight spaces at temperatures of 70 °F (21.1 °C) or less is necessary to ensure normal life of any service ordnance. Mechanical cooling is necessary if temperatures will exceed 100 °F (37.8 °C). If mechanical cooling is not provided, artificial methods, such as water spray or wet canvas covers can be used to reduce the high temperature.

ARMS LOCKER DRENCHING SYSTEM

The arms locker drenching system is connected to the fire main system. The system is designed to provide raw water to the arms locker in the event of a fire or excessive high temperature. The arms locker drenching system has to be manually activated. The system can be activated in the boatswain's locker (local) or from the O-1 level (remote) at the bow by means of a reach rod valve system.

System activation occurs when the thermal heat detector (figure 7, item 1) senses a temperature above 105° F (40.5°). The thermal heat detector sends an alarm signal to the pilothouse indicating a high temperature situation in the arms locker. The crew would then investigate the situation and if necessary, the fire main system would be charged. Once it is determined that the alarm condition exists and the fire main system is charged, the manual activation valve (figure 7, item 2) is OPENED either locally or remotely. As raw water enters the piping system in the arms locker, a pressure switch (figure 7, item 3) activates an alarm in the pilothouse to indicate that the arms locker drenching system has been activated. The raw water from the fire main flows into the arms locker and out of two sprinkler heads (figure 7, item 4). Once activated, the system will continue the flow of raw water into the arms locker until the manual activation valve is closed, or the fire main system is secured.

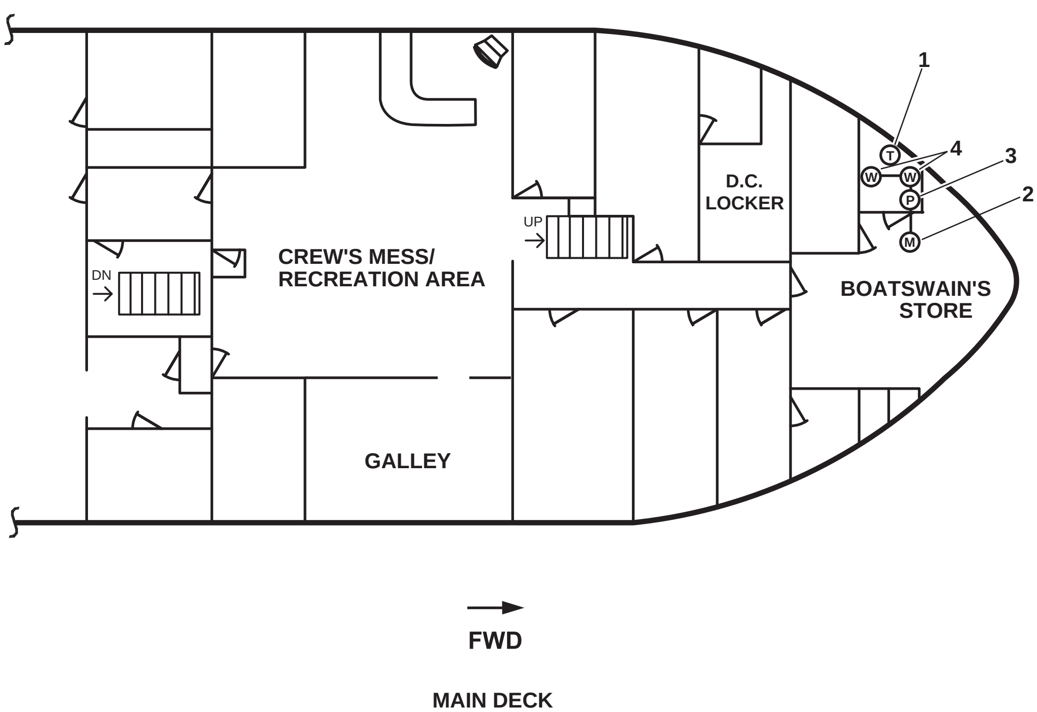


Figure 7. Arms Locker Drenching System

WASHDOWN COUNTERMEASURE SYSTEM

The vessel has an installed countermeasure washdown system that is capable of forming a protective umbrella of raw water over the superstructure of the vessel. It is designed for protection against Nuclear, Biological, and Chemical (NBC) contaminants. If time allows, the vessel should be wet down before an NBC attack. NBC agents would then be washed immediately overboard. The washdown system is more effective as a preventive measure than as a decontamination measure. Another benefit of using the countermeasure washdown system is that it cools the external superstructure of the vessel. This can aid in removing excess heat from the vessel in the event of fire.

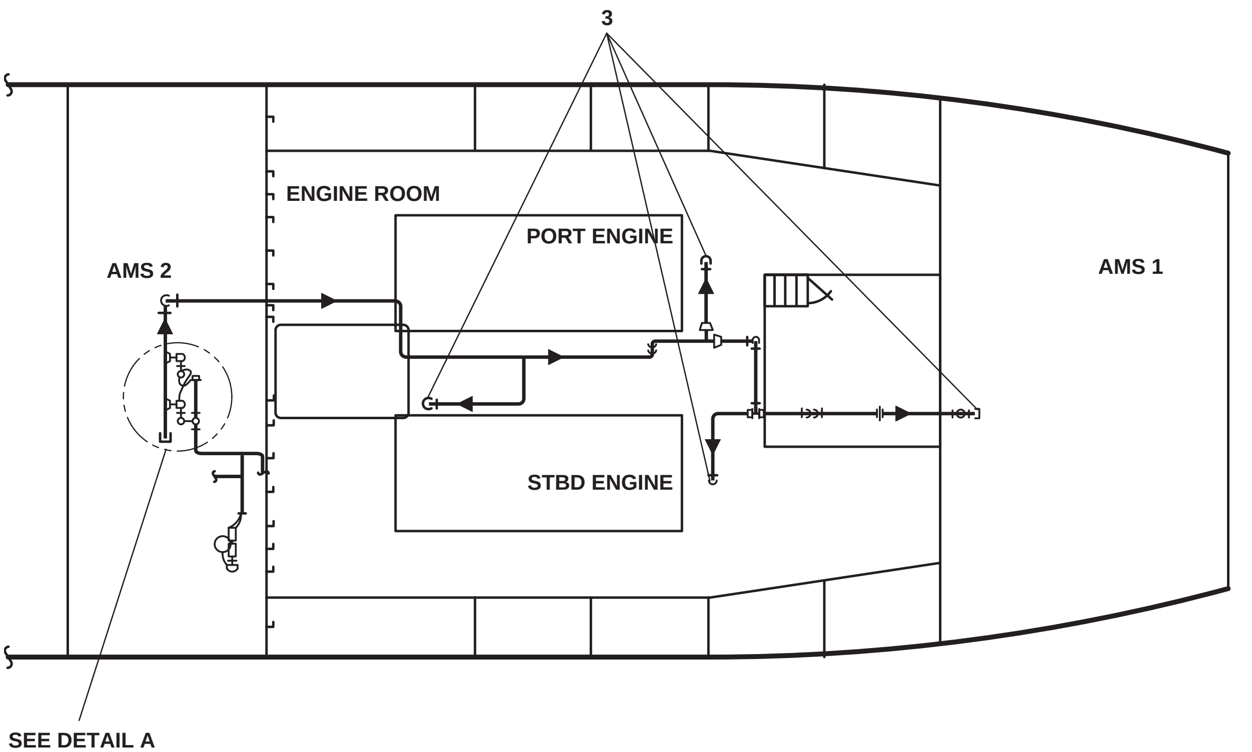
FM-200 WATER WASHDOWN SYSTEM

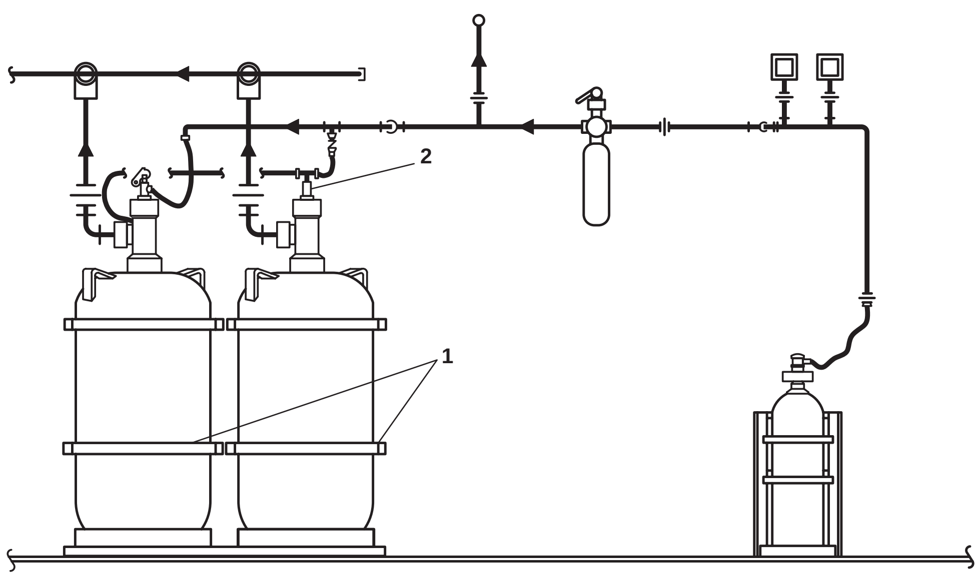
The FM-200 installation is supplemented by the installation of a manually activated water washdown system. The purpose of the system is to reduce the compartment temperature prior to the discharge of the FM-200 agent. The reduction of compartment temperature helps to minimize the production of Hydrogen Fluoride (HF) gas. HF gas is generated when the FM-200 agent comes in contact with hot surfaces and flame above 1300 °F (704.4 °C). The sprinkler water also acts to keep smoke particulate down and expedites ventilation of the compartment when the fire is out.

FM-200 FIRE SUPPRESSION SYSTEM

The engine room and AMS 1 are fitted with an FM-200 fire suppression system. The system is a manually actuated, stand-alone, total flooding fire suppression system. The system is capable of extinguishing Class A, Class B, and Class C fires when properly deployed. It consists of storage cylinders containing FM-200 extinguishing agent (figures 8 and 9, item 1), control heads (figures 8 and 9, item 2), discharge nozzles (figures 8 and 9, item 3), and manual fire pull boxes (figure 10).

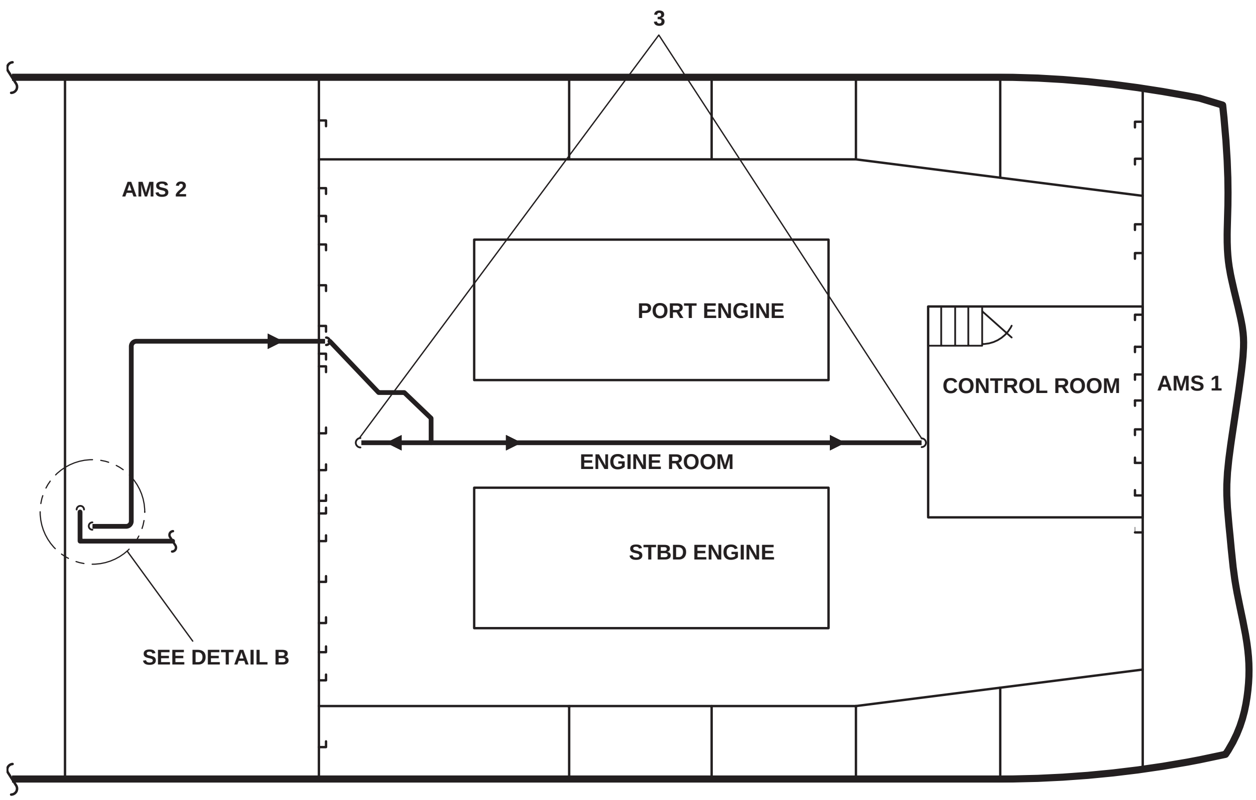
When the FM-200 system is actuated, ventilation to and from the engineering spaces, the ships' service diesel generators, and the bow thruster and pump drive engines are automatically shut down to prevent FM-200 gas from being extracted from the spaces. When a pull box is actuated, horns sound and amber strobe lights are activated to alert personnel to evacuate the space. A 60 second delay is provided before the FM-200 agent is actually released to allow for evacuation of the engineering spaces.

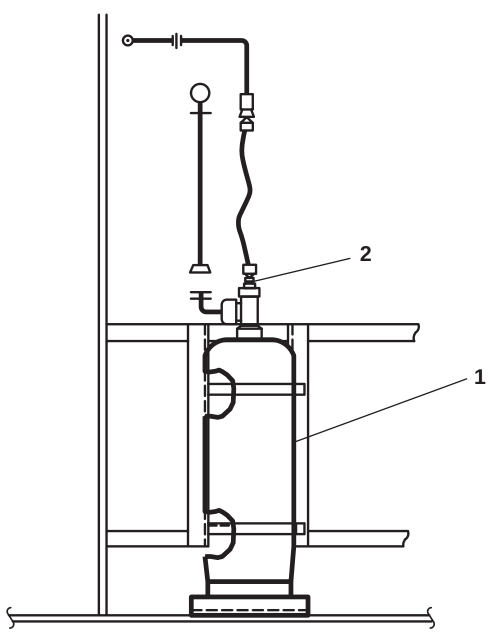




DETAIL A

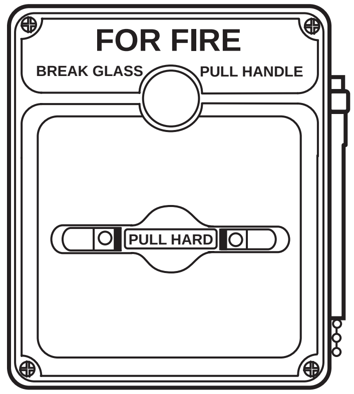
Figure 8. FM-200 Component Locations (Overhead System)



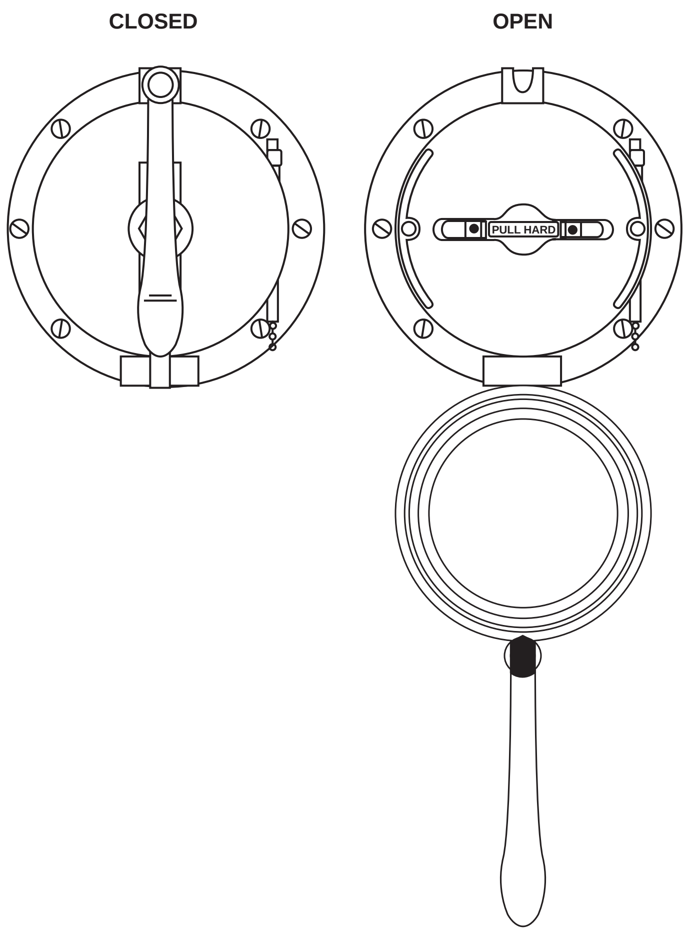


DETAIL B

Figure 9. FM-200 Component Locations (Bilge System)



FM -200 Interior Manual Pull Box



FM -200 Exterior Manual Pull Box

Figure 10. FM-200 Manual Pull Boxes

GALLEY FIRE SUPPRESSION SYSTEM

The galley fire suppression system is designed to extinguish fires that start on, or in, galley cooking equipment. The Ansul R-102 system is a pre-engineered, wet chemical, cartridge operated, regulated pressure type extinguishing system. The system is capable of manual activation through the use of a manual pull station (figure 11, item 1) or automatic actuation by the melting of a fusible link (figure 11, item 2) rated at 360° F (182° C) over the deep fat fryer, or the melting of any of the two fusible links (figure 11, item 3) rated at 500° F (260° C).

The extinguishing agent is formulated with an aqueous solution of organic salts with a ph range between 7.8 and 8.2, which is designed for flame knock down and foam coverage of grease related fires. The wet chemical agent is stored in a 3 gallon (11.3 liter) carbon steel tank housed in a stainless steel enclosure (figure 11, item 4) mounted on the starboard bulkhead of the galley. The storage tank has a working pressure of 100 PSI (6.9 bar). The extinguishing agent is propelled by the use of a gas cartridge of carbon dioxide or nitrogen gas and delivered to the distribution nozzles (figure 11, item 5). The distribution nozzle tips have blow off caps to keep the nozzle orifices free of cooking grease buildup.

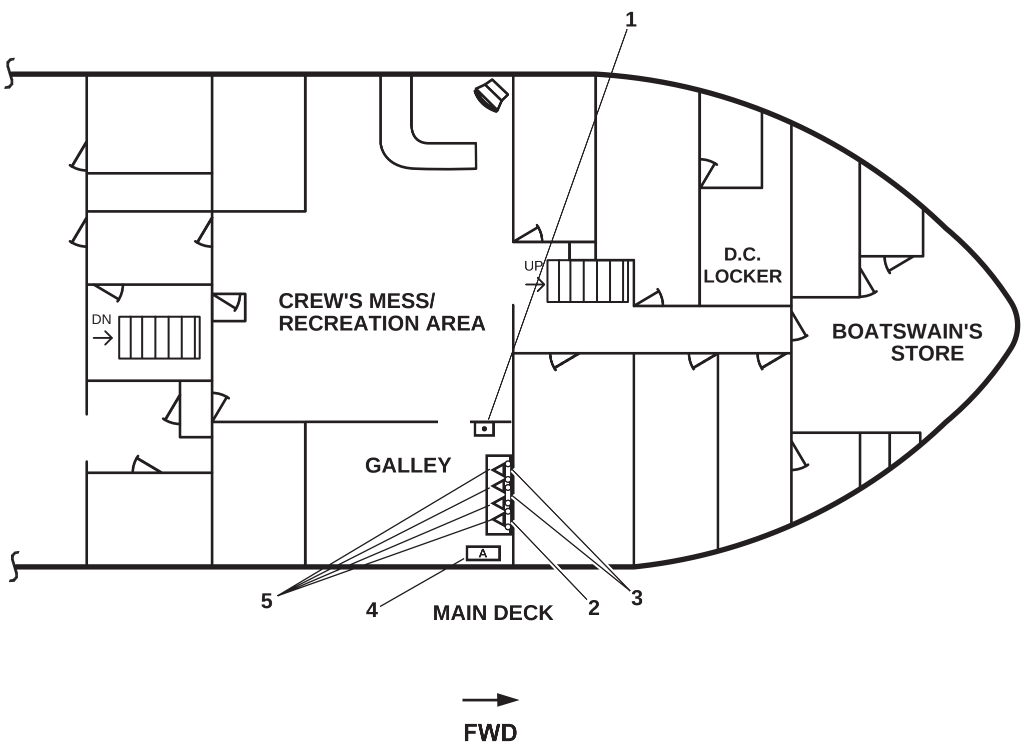


Figure 11. Galley Fire Suppression System

FIREFIGHTING EQUIPMENT

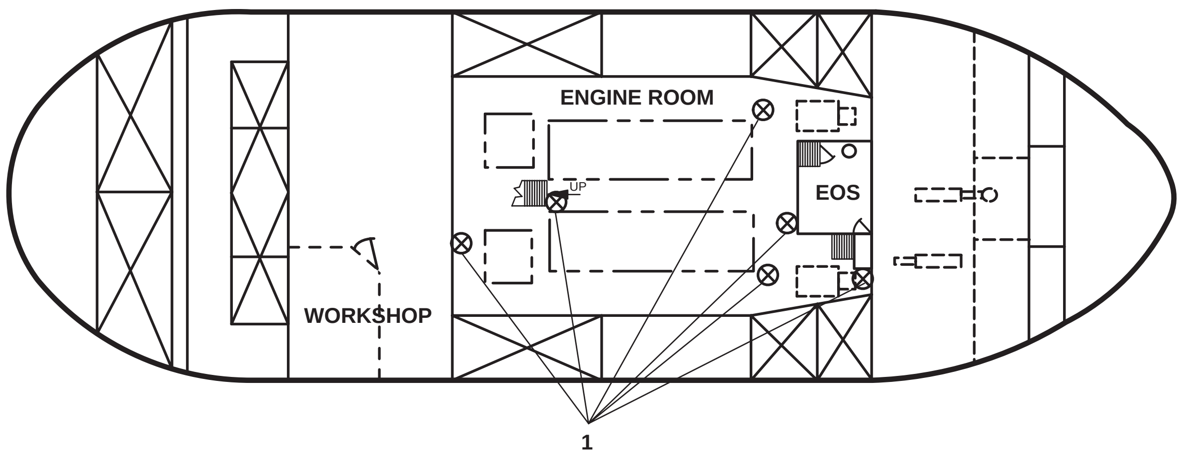
Firefighting equipment is stored at various locations throughout the vessel. Types of equipment and locations (figures 12 and 13) are as follows:

1. Ten-pound, Tri Class A B C, Size II dry chemical fire extinguishers (figures 12 and 13, item 1):

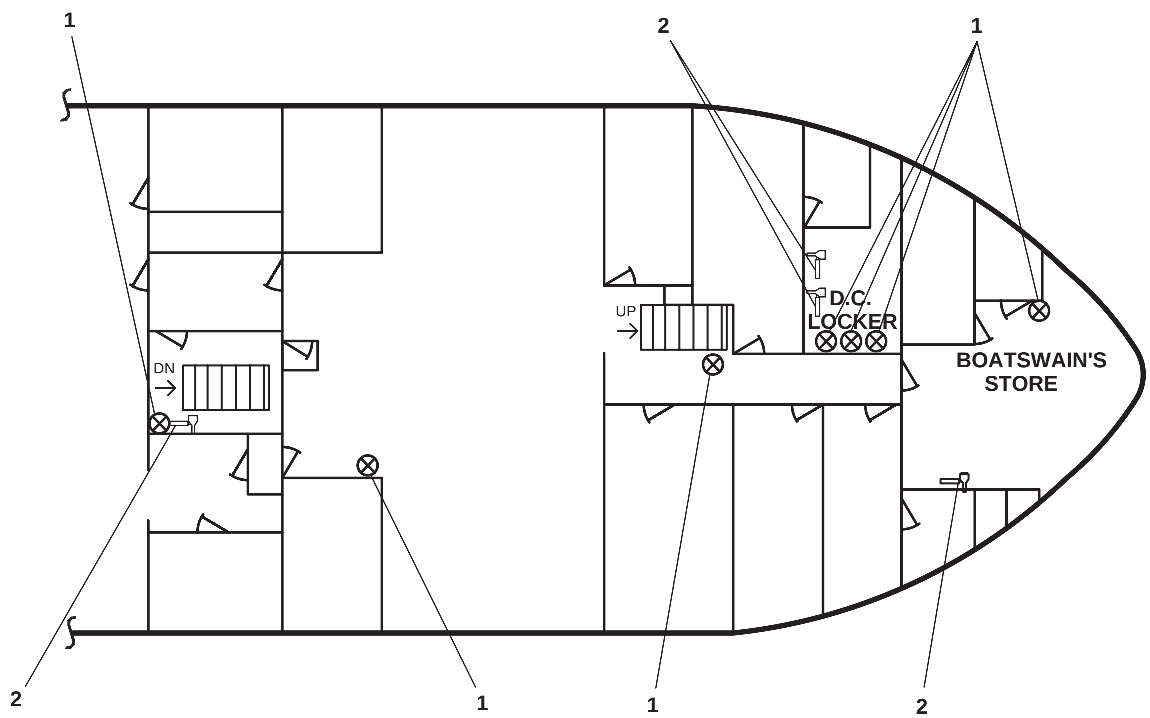
   a. Radio Room

   b. Pilothouse, aft of the radio room

   c. Pilothouse, forward of the radio room



BELOW MAIN DECK



MAIN DECK

Figure 12. Main Deck and Below Main Deck Firefighting Equipment Locations

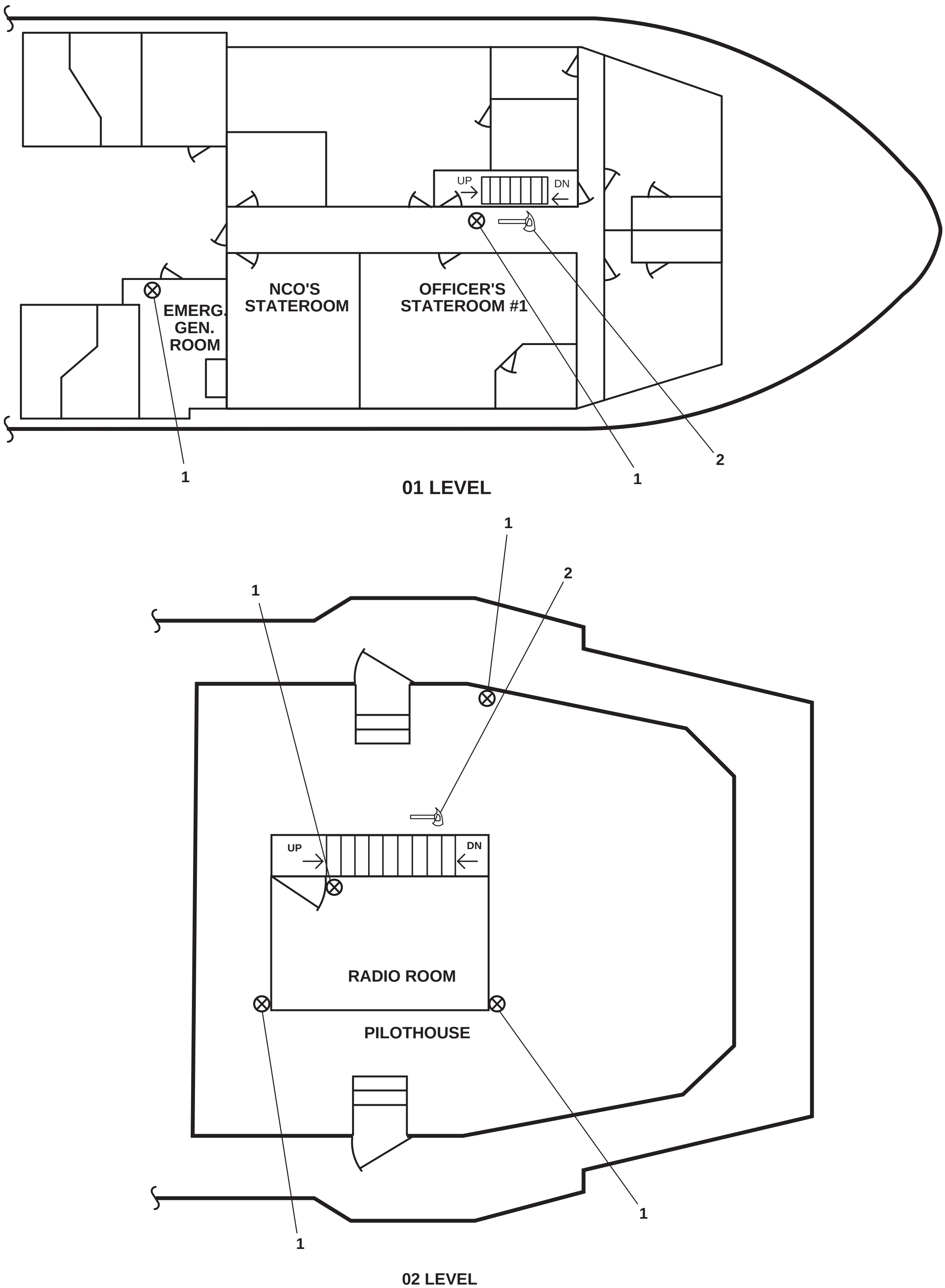


Figure 13. Pilothouse and 01 Level Firefighting Equipment Locations

d. Pilothouse, port side

e. 01 Level, passageway near ladder

f. 01 Level, EDG room

g. Main deck, boatswain's store port side

h. Main deck, passageway, near ladder

i. Main deck, galley, outside dry provision storeroom

j. Main deck, inside door to engine room access

k. Engine room, near AMS 1 entry

l. Engine room, near starboard main engine

m. Engine room at front to side

n. Engine room near port main engine

o. Engine room near aft end of starboard engine

p. Engine room aft near AMS 2 entry

2. Fire axes (figures 12 and 13, item 2):

a. Pilothouse, port side near ladder

b. 01 Level, passageway near ladder

c. Main deck boatswain's store

d. Damage Control (DC) locker

e. Main Deck inside access to Engine Room

3. Firefighter's Ensembles:
Six sets of heat protection coveralls are stored in the DC locker.

4. Oxygen Breathing Apparatus:
Six A-4 OBAs are located in the DC locker with replacement canisters.

P-100 PORTABLE EMERGENCY PUMP

The P-100 portable pump (figure 14) is a diesel engine-driven centrifugal pump assembly. Its primary purpose is for dewatering, but it can be configured for firefighting, too. When used for firefighting, the P-100 portable pump draws water from the sea or from a flooded space. The water is then pumped through individual fire hoses. If no other pumps on the vessel are operational, it can be rigged to charge the fire main. The P-100 portable pump can provide 100 gal/min (378 L/min) at 83 PSI (5.7 bar) with a suction lift of 20 feet (6.1 meters). Another configuration may be rigged to create a greater suction lift. The two examples of firefighting hookups are shown in figures 15 and 16.

WARNING

The diesel engine exhaust contains poisonous carbon monoxide. Never use the P-100 pump unit in poorly ventilated locations, such as enclosed spaces. If such operation is unavoidable, provide proper ventilation, and use an approved exhaust hose routed to the weather decks.

The P-100 portable pump is powered by an air-cooled single-cylinder, four-cycle diesel engine rated at 10 horsepower. A mechanical governor is used to control the speed of the engine. It contains a 1.45 gallon (5.5 liter) fuel tank that will allow up to 2.75 hours of operation. The engine exhaust muffler is constructed to receive an exhaust hose. An exhaust hose should always be used. If the P-100 portable pump is to be used below decks, the exhaust hose will be used.

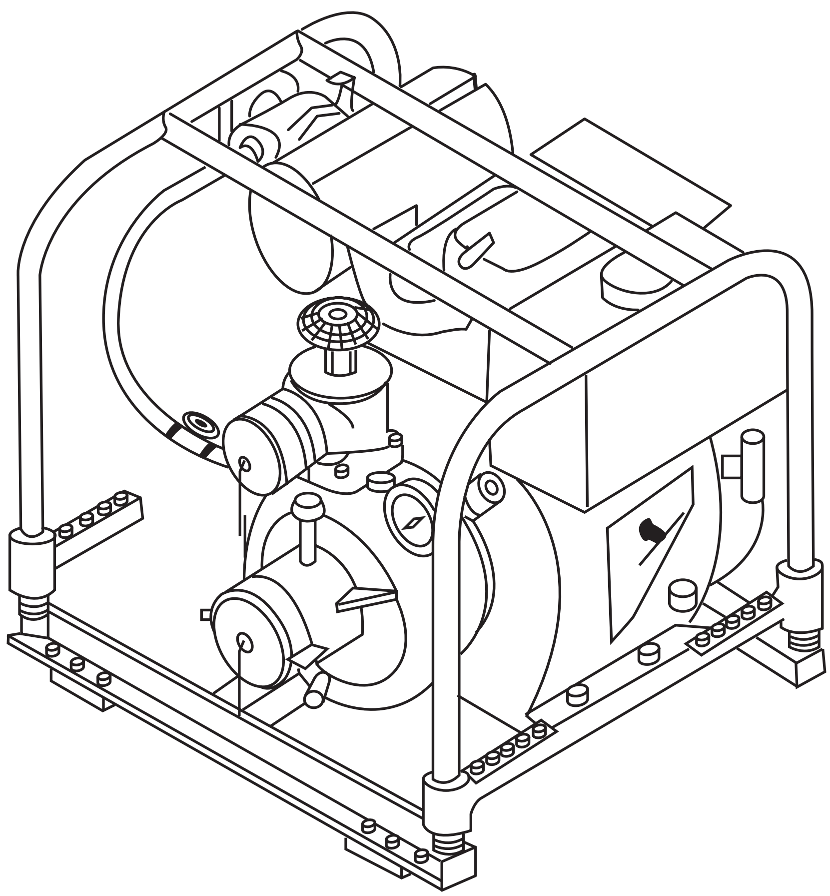


Figure 14. P-100 Portable Pump

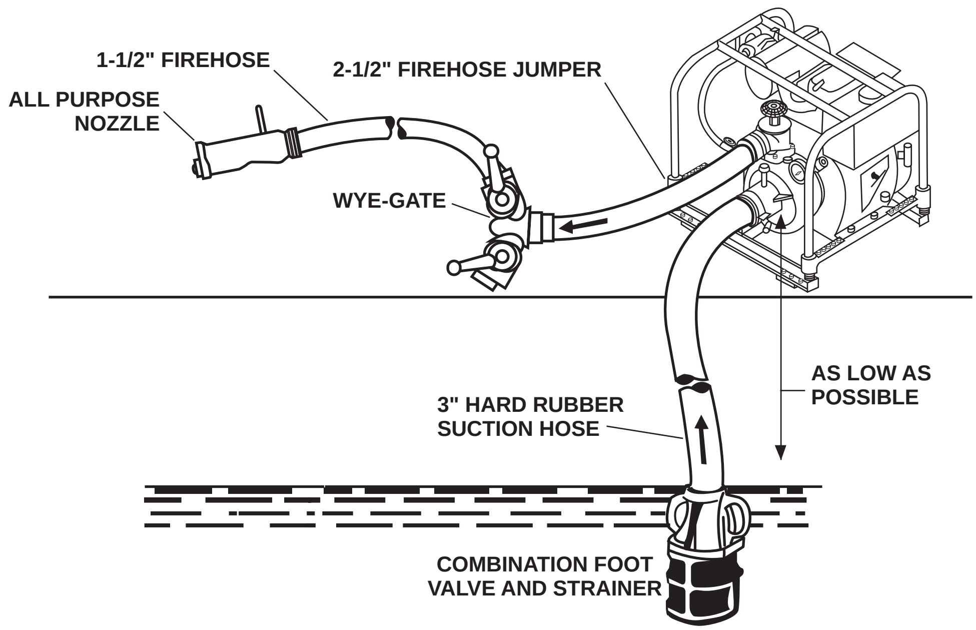


Figure 15. P-100 Configured for Firefighting With Suction Head Less Than 20 feet (6.1 meters)

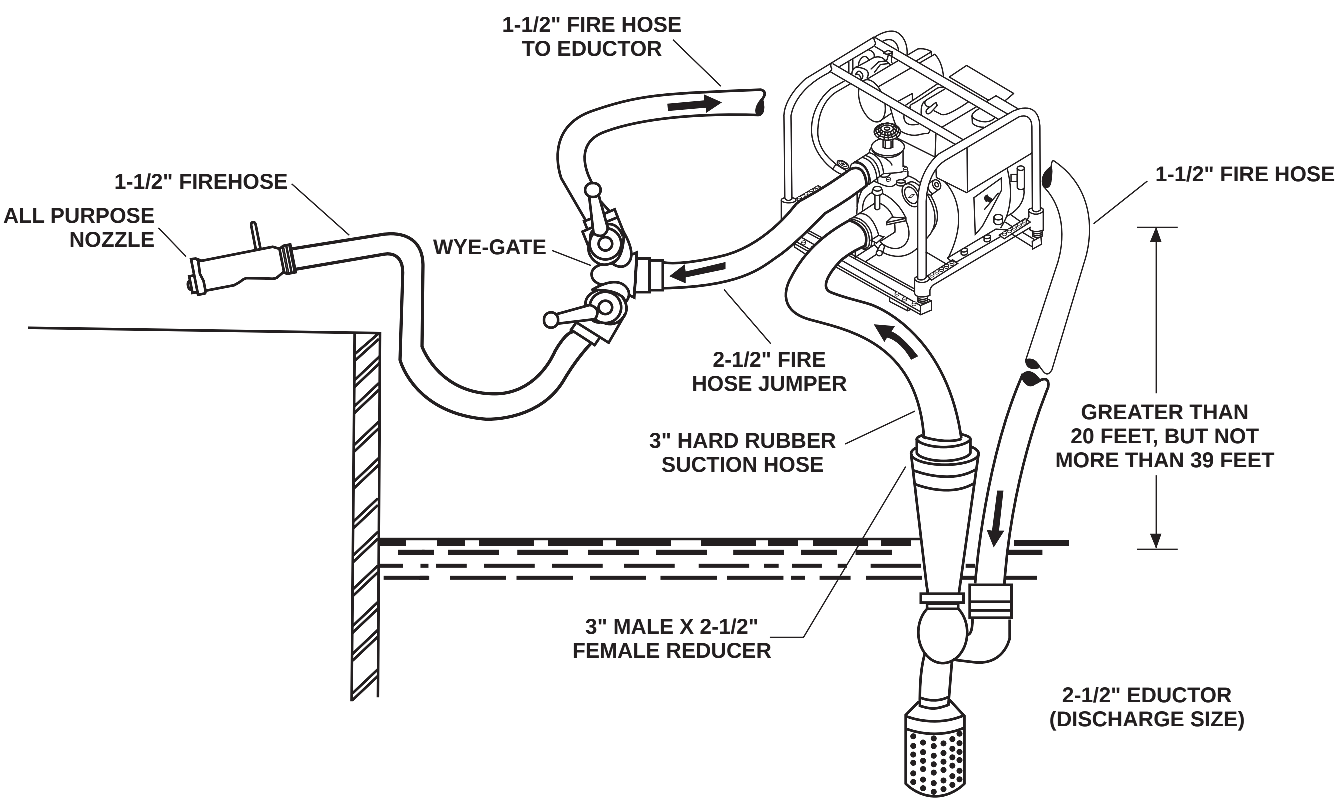


Figure 16. P-100 Configured for Firefighting With Suction Head Greater Than 20 feet (6.1 meters)

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) FLOODING CONTROL EQUIPMENT

The ability to resist sinking after sustaining damage depends on compartmentation and watertight integrity. When these features are properly maintained, flooding is more effectively isolated to a limited area. Without compartmentation or watertight integrity, the vessel is doomed if it is severely damaged. Compartmentation is the major feature of watertight integrity. It divides the interior area of the vessel's hull into smaller spaces by the use of structural members.

The vessel is fitted with remotely operated watertight doors that divide the lower deck area into thirds. If flooding results from a collision, the sliding watertight doors can be closed to isolate the flooding in a particular area of the vessel. Watertight hatches, scuttles, and manholes are installed to enable access to isolated areas of the vessel in the event of a casualty. The watertight fittings also keep the flooding isolated to specific areas of the vessel where it can be better controlled. Proper maintenance of watertight fittings is essential to survival if the vessel floods.

PUMPS

The vessel is equipped with the means to remove or redistribute liquid weight. During flooding, undesired weight is most likely represented in the form of excess water. The use of pumps is the most efficient means of removing or redistributing this excess weight. The vessel has many options available. Some examples of these follow:

Bilge/ballast pumps and eductors are designed to remove weight from the ship in the form of water. When configured to pump bilges, the system can remove water from a flooded space and pump the water overboard. When configured to move ballast, the system redistributes weight within the vessel.

The P-100 is a portable diesel operated pump (figure 1) that is capable of removing 100 gallons (379 liters) of water per minute. This equates to about 840 lbs (381 kg) per minute. This is a significant amount of weight that can be removed from the interior of the vessel in a short amount of time. The pump is fully self-contained, and does not need an external power source to operate.

The suction connection is a 3 inch male threaded connection, and the discharge connection is 2 ½ inch male threaded connection. The suction hose is a 3-inch hard rubber hose (non-collapsible) and can be fitted with a foot valve assembly. The foot valve consists of a flapper that acts as a check valve to keep the engine primed, and a strainer to keep large foreign matter out of the pump.

WARNING

The diesel engine exhaust contains poisonous carbon monoxide. Never use the P-100 pump unit in poorly ventilated locations, such as enclosed spaces. If such operation is unavoidable, provide proper ventilation, and use an approved exhaust hose routed to the weather decks. Failure to comply with this warning may result in serious injury or death.

The P-100 is powered by an air-cooled single-cylinder, four-cycle diesel engine rated at 10 horsepower. A mechanical governor is used to control the speed of the engine. It contains a 1.45 gallon (5.5 liter) fuel tank that will allow up to 2.75 hours of operation. The engine exhaust muffler is constructed to receive an exhaust hose. An exhaust hose will be used when the P-100 is used below decks.

Two types of portable electric pumps are available to remove liquid from flooded areas of the vessel. They are the Jabsco model 11810 (figure 2, item 1) and the Barnes 75B (figure 2, item 2). Both are powered by a standard 115 Vac outlet. The Barnes unit is a submersible pump. To dewater a flooded area, a discharge hose is attached to the pump. The pump is then lowered into the flooded area, plugged in, and liquid is pumped through the hose to another area of the vessel or overboard. The Jabsco unit must be fitted with a suction hose, and the suction hose must be a non-collapsible type. Discharge hoses can be either collapsible or non-collapsible. The advantage of the Barnes unit is that it does not require a non-collapsible hose. The advantage of the Jabsco unit is that due to the smaller size of the non-collapsible hose, the Jabsco pump is easier to use when dewatering voids because the hose can fit into tighter spaces.

Other options exist that may be employed to remove unwanted weight from the vessel. The sanitary pumps and the Marine Sanitation Device have the ability to remove large amounts of water from the vessel. The pumps are not designed to operate under water, but they do have piping that allows them to pump directly overboard. Planned creative use of this system could be very helpful under certain circumstances.

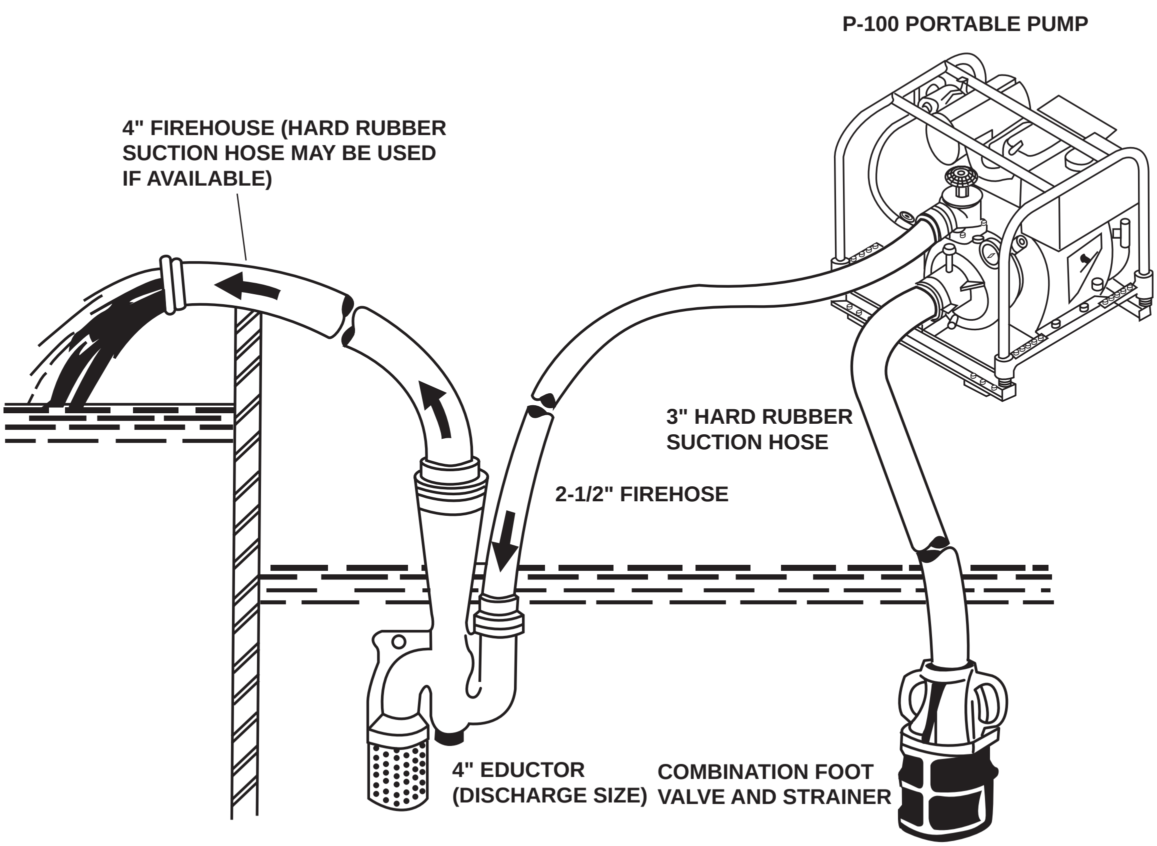


Figure 1. P-100 Portable Pump Configured to Dewater

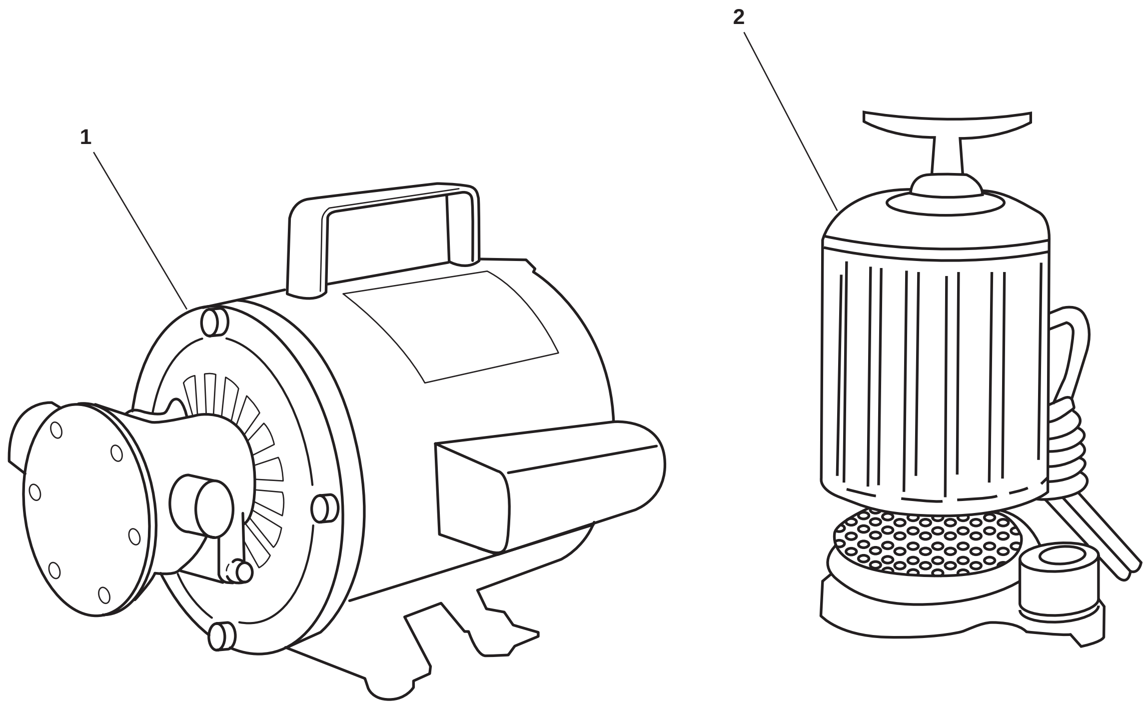


Figure 2. Portable Electric Pumps

DAMAGE CONTROL EQUIPMENT

The vessel's damage control locker is equipped with kits containing various plugs, wedges, and tools. Cloth is available to help the plugs grip and fill the hole better. Plugs are best used in small round holes, and wedges in small cracks. Plugs and wedges are the simplest method of stopping a fairly small hole (figure 3). Plugs are made of softwood, such as yellow pine or fir. They are effective for plugging holes up to about 3 inches by 3 inches in size. Sometimes you may use these plugs to plug larger holes as well. However, for larger holes it is usually necessary to fashion a patch.

Any item that is flexible, expands when wet, and is portable can most likely be used in a flooding casualty. The most common items used that fit this description are pillows and mattresses. Pillows and mattresses have been rolled up and shoved into holes and torn apart and used as gaskets for plugs. These are only very temporary solutions because such plugs have a tendency to be torn out of the holes by the action of the sea.

A better solution would be a box patch (figure 4). Box patches are custom fashioned, and are usually held in place with shoring. This is a suitable patch for use over holes having jagged edges that protrude inward because the steel box is placed completely over the hole and the jagged edges. The box is open at one end, and a gasket runs along the facing edges. When the compartment is pumped dry, the box may be better secured by welding angle clips between the box and the hull plating. The shoring timbers then can be removed for use elsewhere. The box can also be stuffed with pillows, or can be laid over an existing plug and wedge repair.

An ordinary galvanized bucket can be used in a variety of ways to stop leaks (figure 5). It can be pushed into a hole, bottom first to form a metal plug. It can be stuffed with rags and put over a hole like the box patch. It can even be held in place by shoring or other fasteners.

Small holes or cracks in low pressure piping can be repaired by what are known as soft patches (figure 6). First reduce the area of the hole by driving in softwood wedges. The wedges are then to be trimmed flush with the outside of the pipe, then covered with a strip of sheet rubber packing and tightly held in place by layers of marline or wire. Marline has been used successfully as a caulking material in cracks. In many cases, as in sharp curves, it is not possible to use sheet packing. Combinations of wedges, marline, and various plastics will often make effective patches. Wooden plugs covered with cloth have stopped many leaks in piping, and sometime a combination of plugs and wedges are needed. Set the plugs with a hammer and try to secure them in place with clamps or wires.

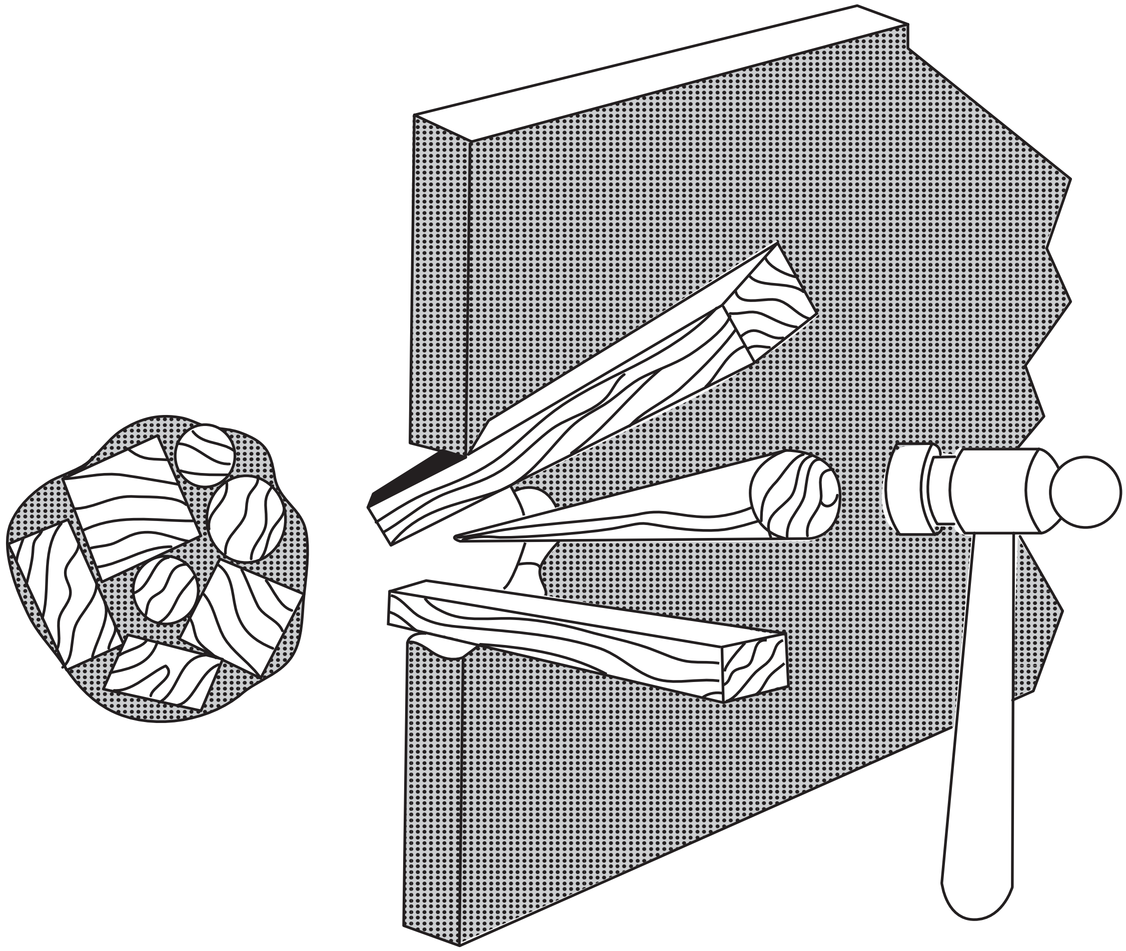


Figure 3. Example of Plug and Wedge Use

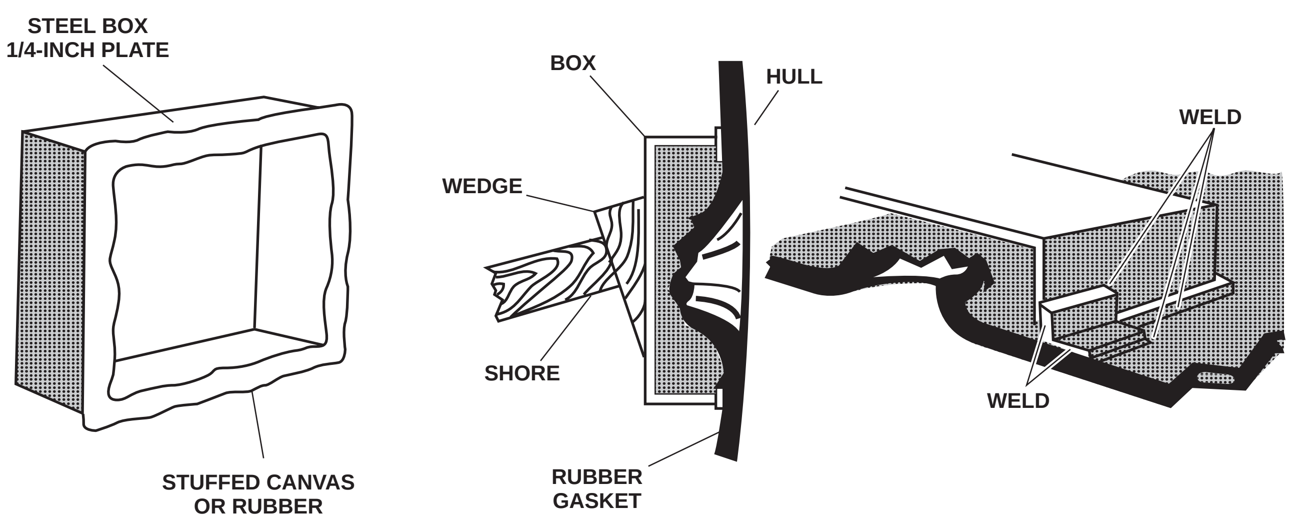


Figure 4. Example of Box Patch

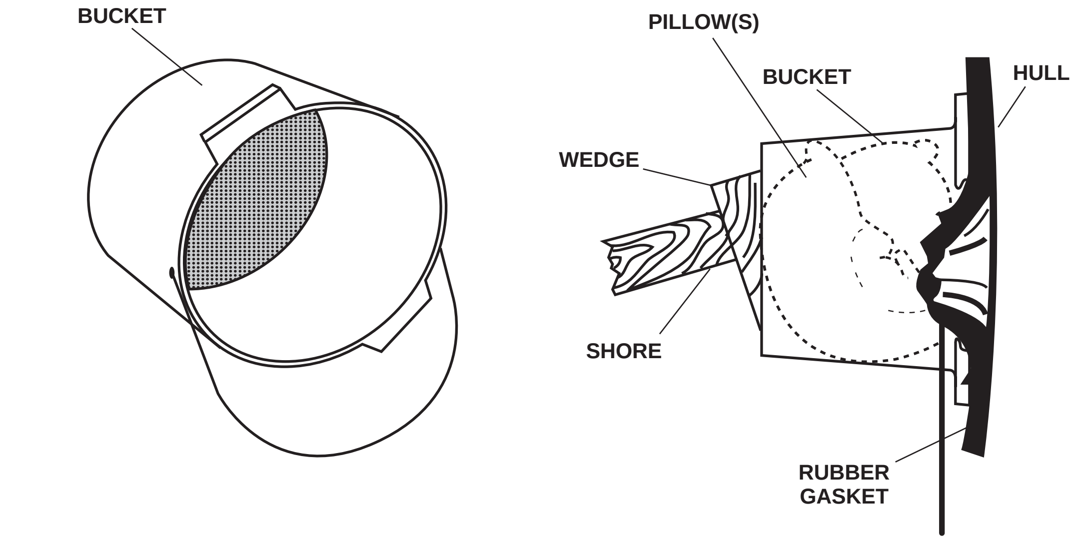


Figure 5. Example of Bucket Patch

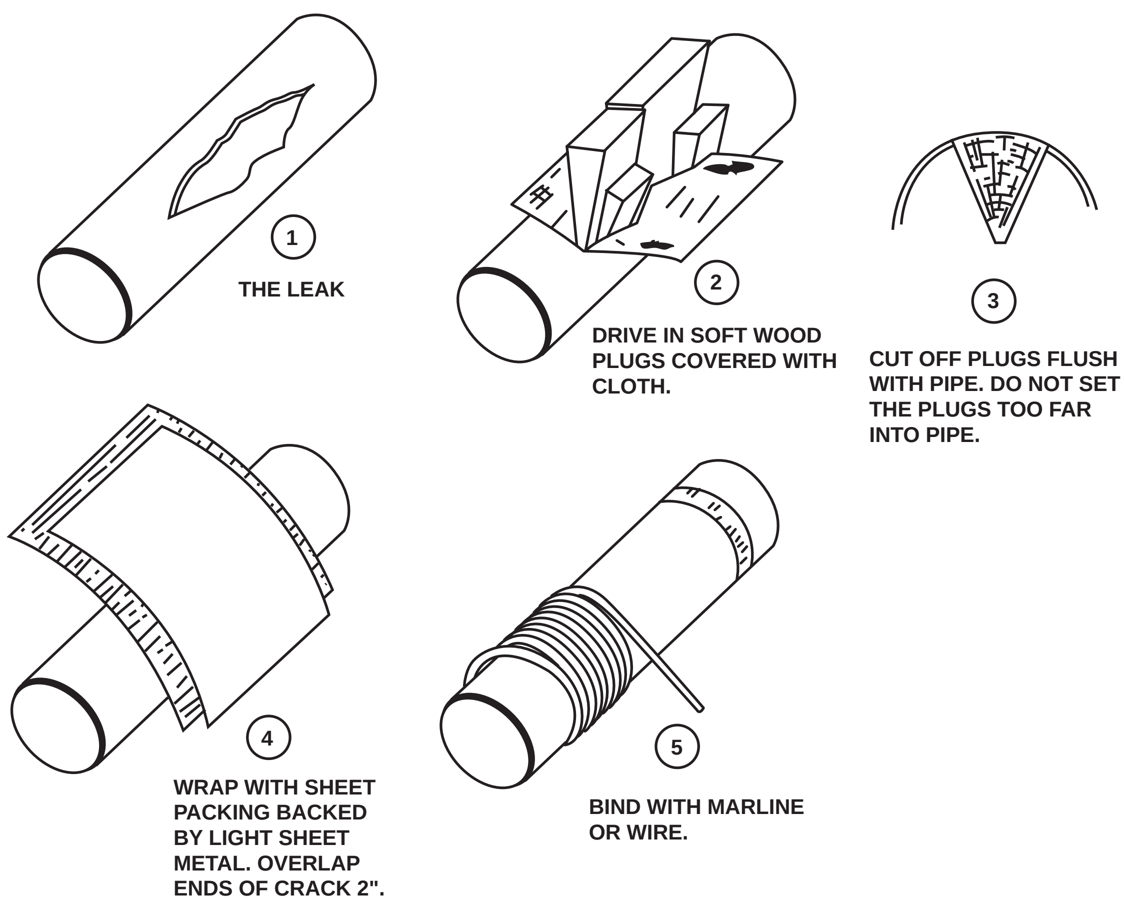


Figure 6. Example of a Soft Patch

A metal clamping tool, usually referred to as the band-it (figure 7), has many uses in the repair of piping. It is very simple to operate and produces a very effective repair when properly applied. The crew must practice its use during flooding drills. This device can be used to patch pipes of any diameter on the vessel. The steel bands can hold plugs, wedges, and strongbacks in place in pressurized piping.

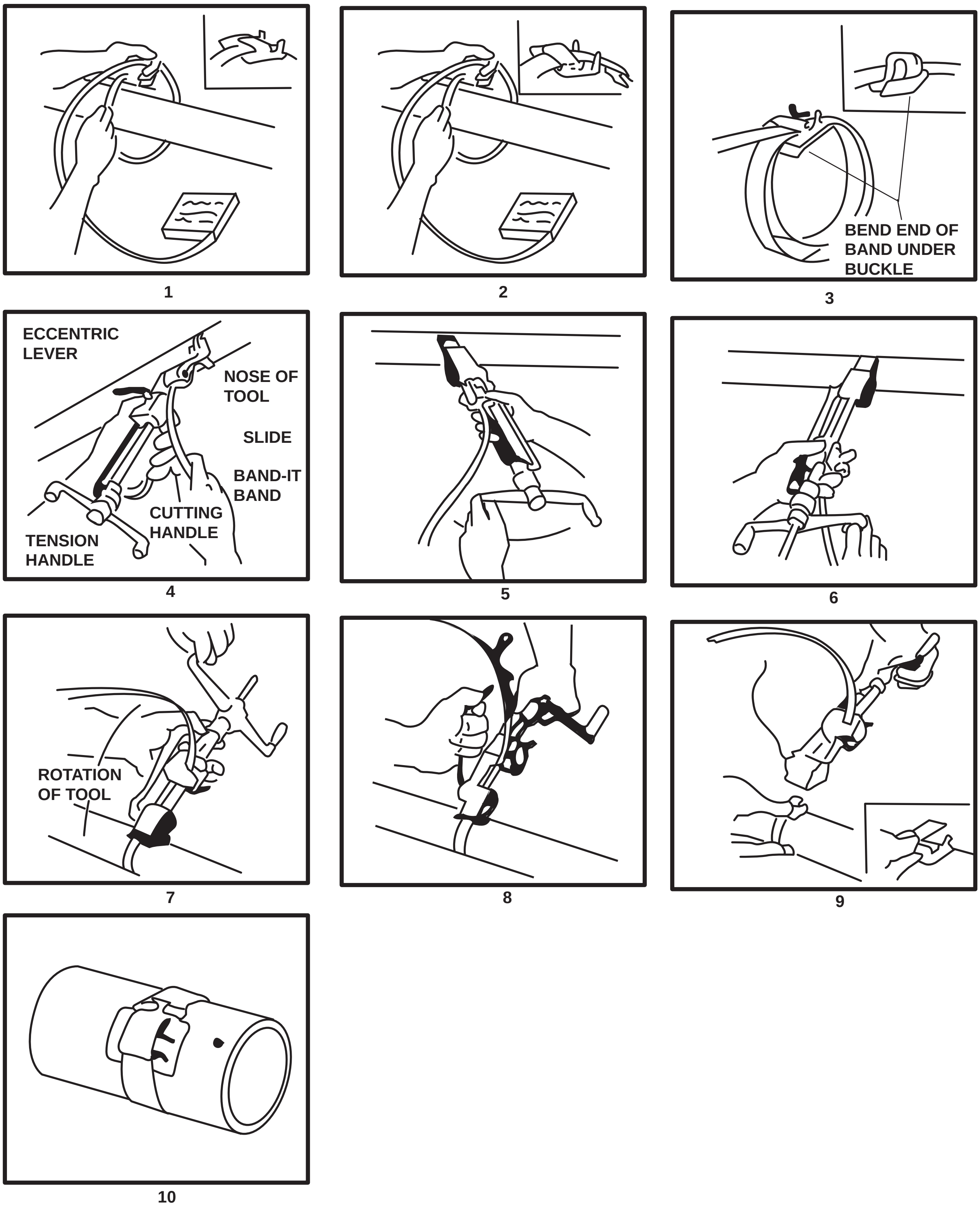
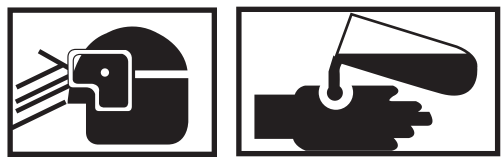


Figure 7. How To Use The Band-it Tool

All water, fuel, and gas lines can be repaired by use of the piping repair kits (figure 8). The complete kit is basically a fiberglass repair kit, and is versatile because it can be used repair piping systems, fittings, bulkheads, and decks. It can also be used as filler for cracks and small holes. The patch has excellent adhesive qualities when applied to ferrous and cuprous metals. It can be employed for emergency repairs to damaged structures having smooth or jagged edges. The plastic patches can be applied under conditions that delay repairs by other methods.

WARNING



Eye protection and latex gloves shall be worn when working with EWARP. Failure to comply may result in serious illness, injury, or death.

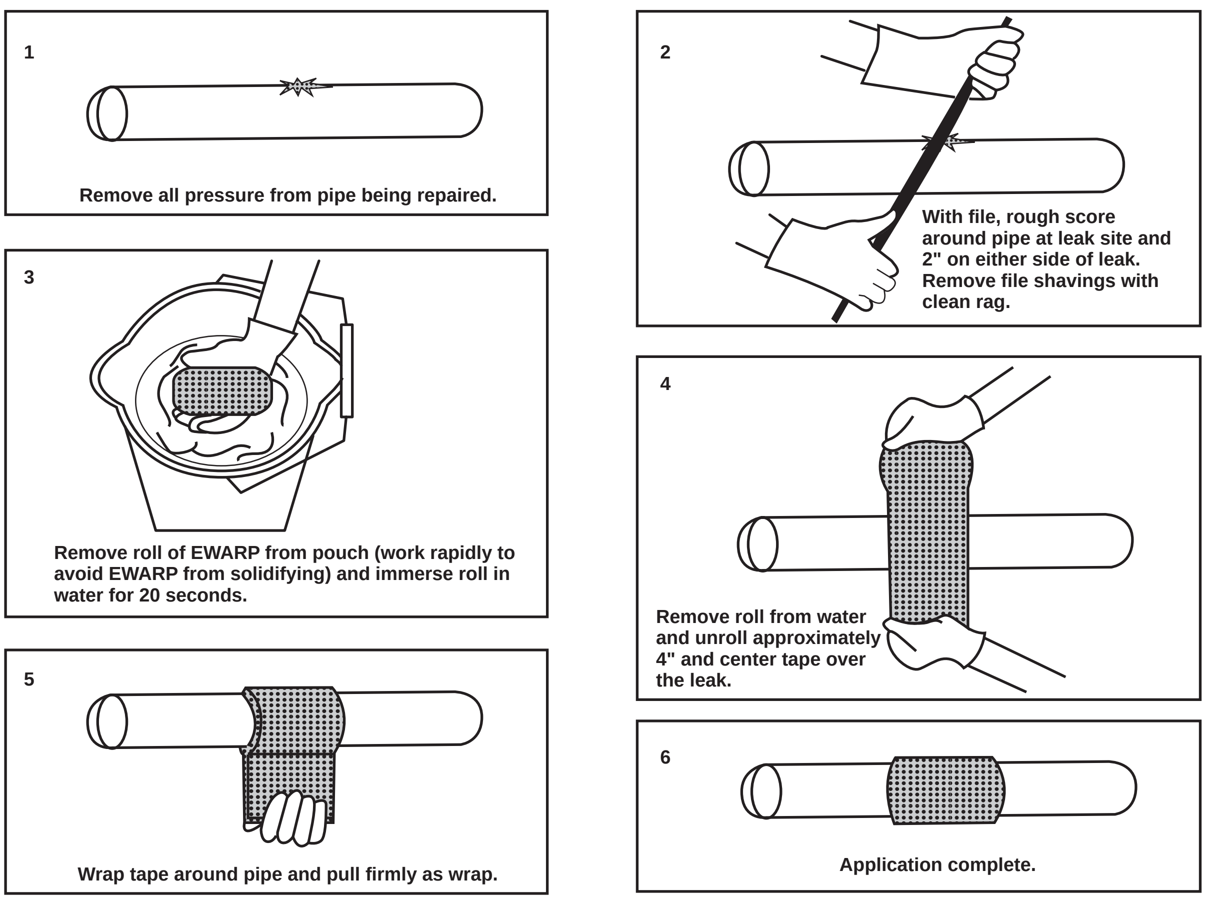


Figure 8. How to Use The Piping Repair Kit

SHORING

Doors and hatches sprung by blast or shock will be difficult to secure until they are properly repaired. Often the closure can be made tight again with shoring (figure 9). If the damage is too great, it may be better to remove the closure and replace it with a mattress backed by a shored plate. Shoring is also used to reinforce bulkheads and decks.

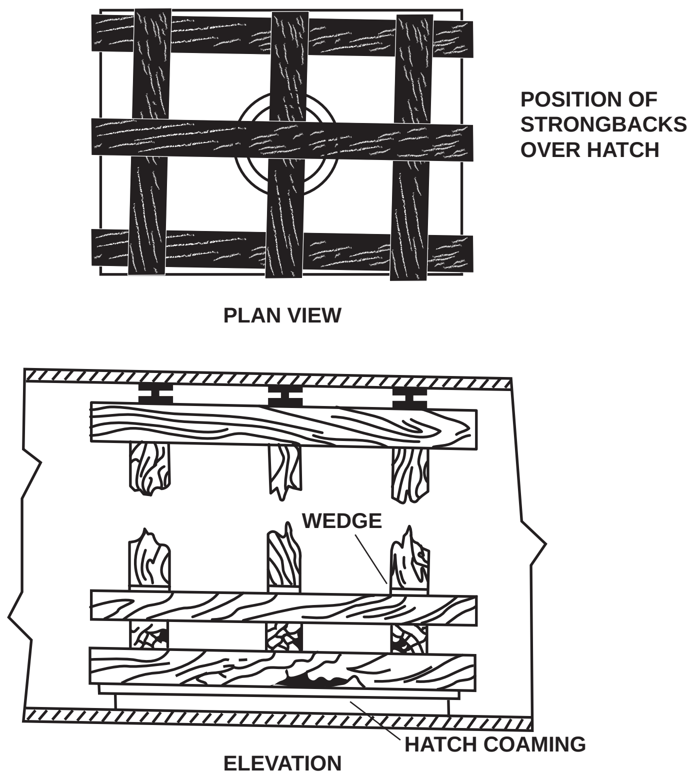


Figure 9. Shoring a Hatch

WELDING AND BRAZING

The vessel is equipped with an arc-welding machine and an oxygen acetylene torch. These tools can be used to make durable semi-permanent repairs to any metal item on the vessel. Welding, brazing, and silver soldering can be used to repair leaks, especially at the joint between pipes and flanges. These methods are slow, and are not reliable in the hands of unskilled personnel. Fires and explosions may occur if these methods are not performed correctly. These are not solutions for repairing damage in combat. However, when the initial repair begins to fail, this option is still available to assist in making stronger repairs.

THE CREW

No matter how well designed or equipped the vessel, the unknown quantity to predicting survivability in a casualty is the crew. It is the crew that must ensure that the watertight fixtures are properly maintained and not fouled. The crew must operate the vessel in a safe manner and within design parameters. The crew must inspect for casualty damage and respond correctly. The crew must know how to use the damage control equipment to repair their vessel and bring it home.

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) PERSONAL FLOTATION DEVICES AND LIFE RAFTS

The Large Tug (LT) is outfitted with enough life jackets for every crewmember on board to have two. It is vital to everyone's safety that all life jackets on board the LT are properly maintained. The life jacket is designed to ensure positive buoyancy when entering the water for any unexpected reason. If it becomes necessary, survival at sea will depend on the condition of the life jackets. Life jackets are installed throughout the LT as follows:

1. Life Jacket Locker 26

2. Engine Room 2

3. Stowage rack in each stateroom (1 per bunk)

4. Pilothouse 4

5. Workboat 3

6. EOS 1

The LT is equipped with Type I Personal Flotation Devices (PFD). These are designed for use as offshore life jackets. They are designed to provide the most buoyancy. The Type I PFD is effective in all waters. It is especially effective in open, rough, or remote waters where rescue may be delayed. The biggest benefit is that when donned properly (figure 1), it will turn unconscious wearers in the water to a face-up position. Additionally, it has the highest buoyancy rating of any life jacket, and it is designed to maintain buoyancy longer than other models. Close inspection of the life jacket is important to survival. Each Type I PFD should be outfitted with the following:

1. Reflective tape (figure 2, item 1)

2. Chemical light (figure 2, item 2)

3. Whistle (figure 2, item 3)

4. Vessel hull number stenciled on back (figure 2, item 4)

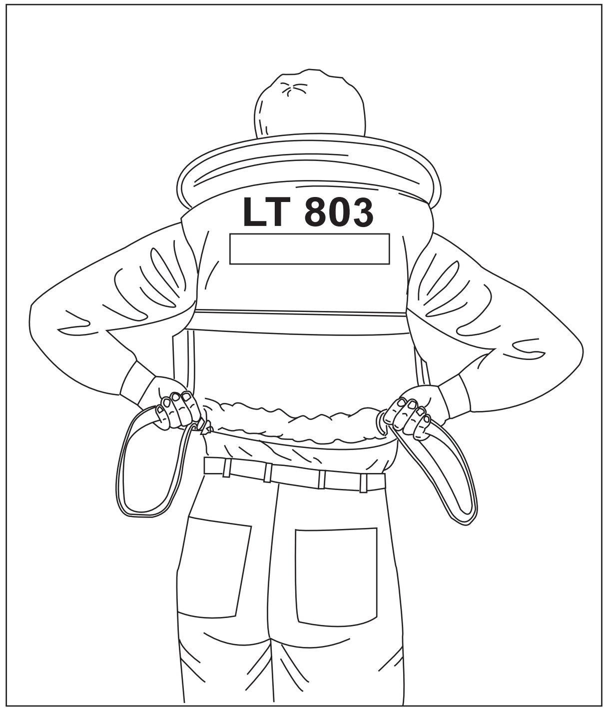
LIFE RAFTS

The Mark 7 (Mk VII) inflatable life saving craft is a life raft of 25-person capacity. It is completely self-contained and is designed to support life on the open ocean for a limited time. It contains stocks of food, water, first aid gear, and a Manual Reverse Osmosis Desalinator (MROD) (table 1). The vessel is outfitted with two Mark 7 life rafts (figure 3). They are each located forward of the stacks on the 02 level, one port and one starboard.

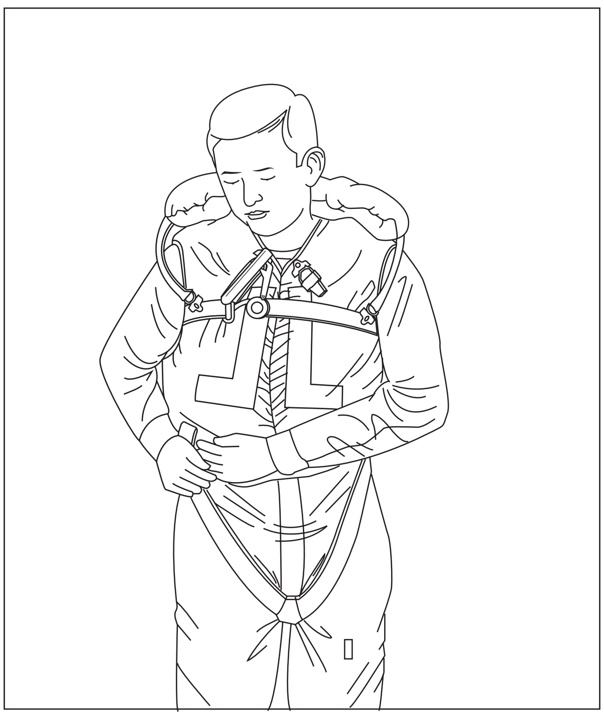
The life rafts are provided for use in abandoning ship or other emergencies. The life rafts are designed for compact storage aboard the vessel and for quick inflation when needed (figure 4). They are installed on racks especially designed for quick deployment. The raft is designed to inflate when the "automatic painter" is pulled as the raft hits the water. Pulling on the cylinder lanyard that connects the raft container to the deck will also cause the life raft to inflate. The life raft also has a hydrostatic release. This mechanism automatically actuates at a depth of 15 to 20 feet if the vessel should sink. Because the container is inherently buoyant, it will float to the surface. The raft will then automatically inflate because of the pulled cylinder lanyard.

Your life and that of the crew may depend on this equipment working properly in an emergency. Therefore, servicing must be accomplished every 60 months at a USCG approved facility. The servicing must comply with requirements of USCG specifications, and only certified facilities may service the life rafts. Crew servicing is limited to visual inspections only. Document and report all defects and discrepancies to unit maintenance.

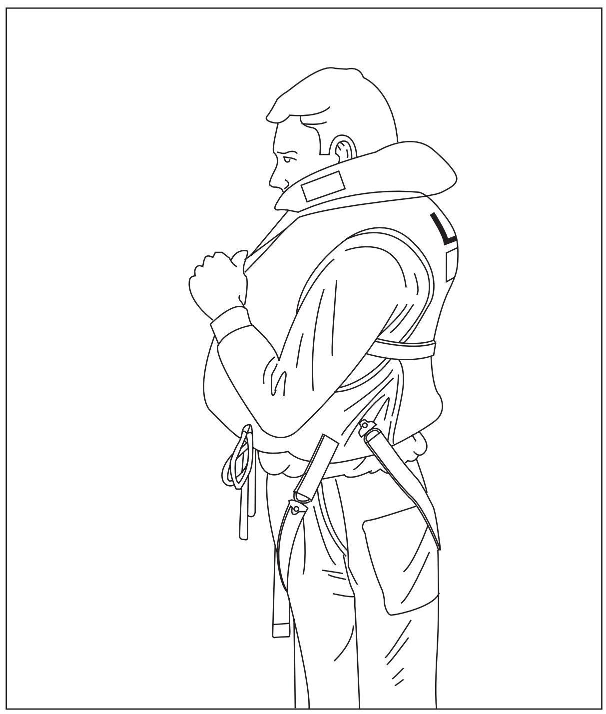
A. LIFE PRESERVER DONNED JACKET TIED AT UPPER CHEST AND WAIST: TIE PULLED SNUG, SNAP HOOK BEING FASTENED INTO RING ON CHEST STRAP.



B. LEG STRAPS BEING REMOVED FROM BACK OF PRESERVER; WILL BE LED BETWEEN LEGS.



C. BOTH STRAPS PULLED BETWEEN LEGS, ONE FASTENED TO D RING ON LEFT SIDE, OTHER BEING FASTENED.



D. TYING THE COLLAR.

Figure 1. Donning the Lifejacket (Type 1 PFD)

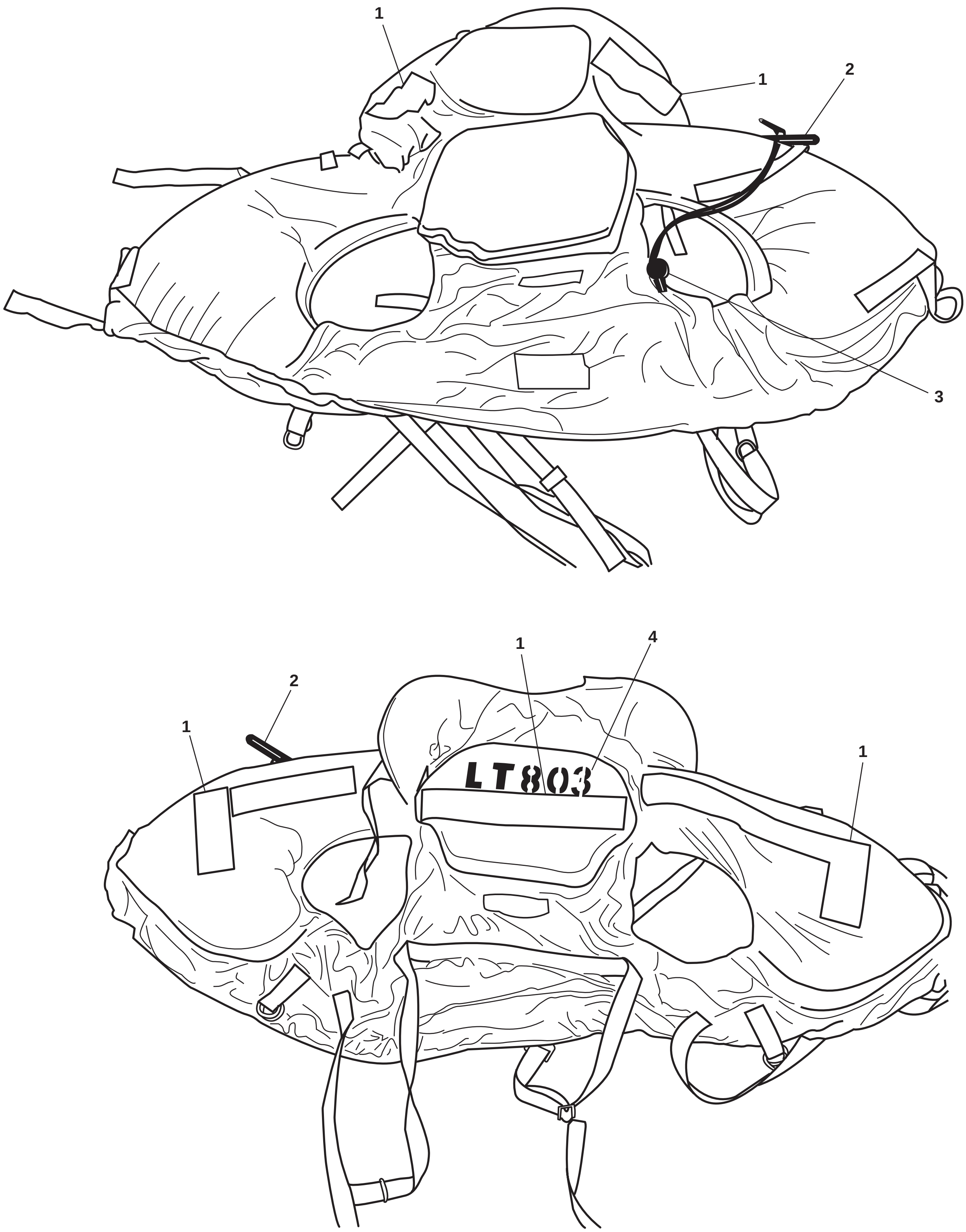


Figure 2. Life Jacket Equipment

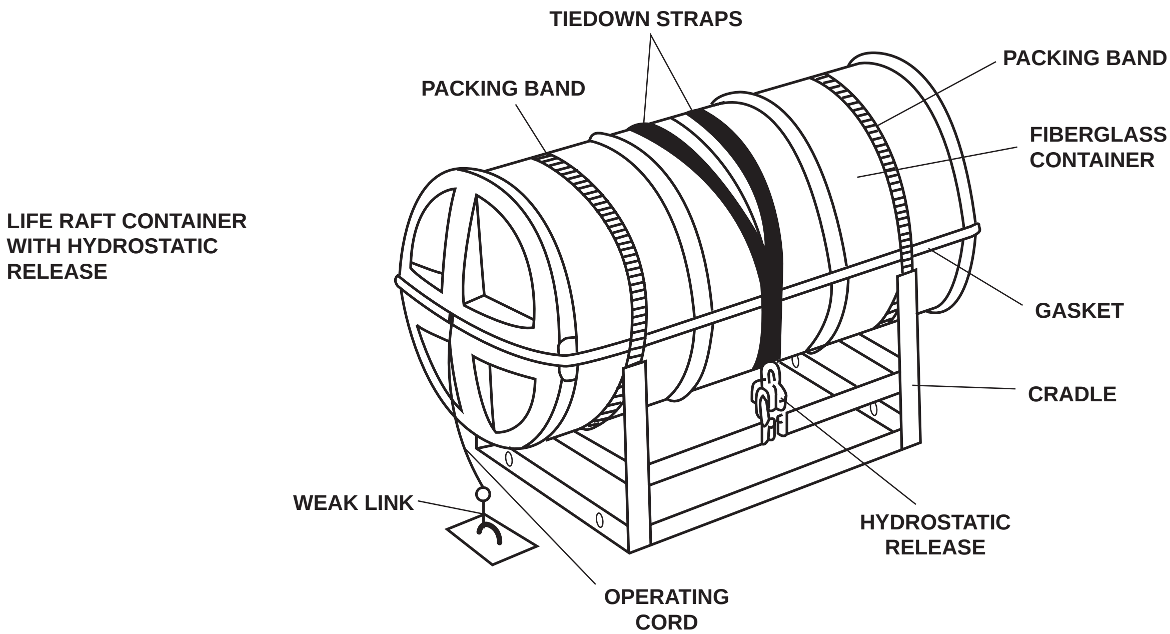


Figure 3. Containerized Mk-VII Life Raft

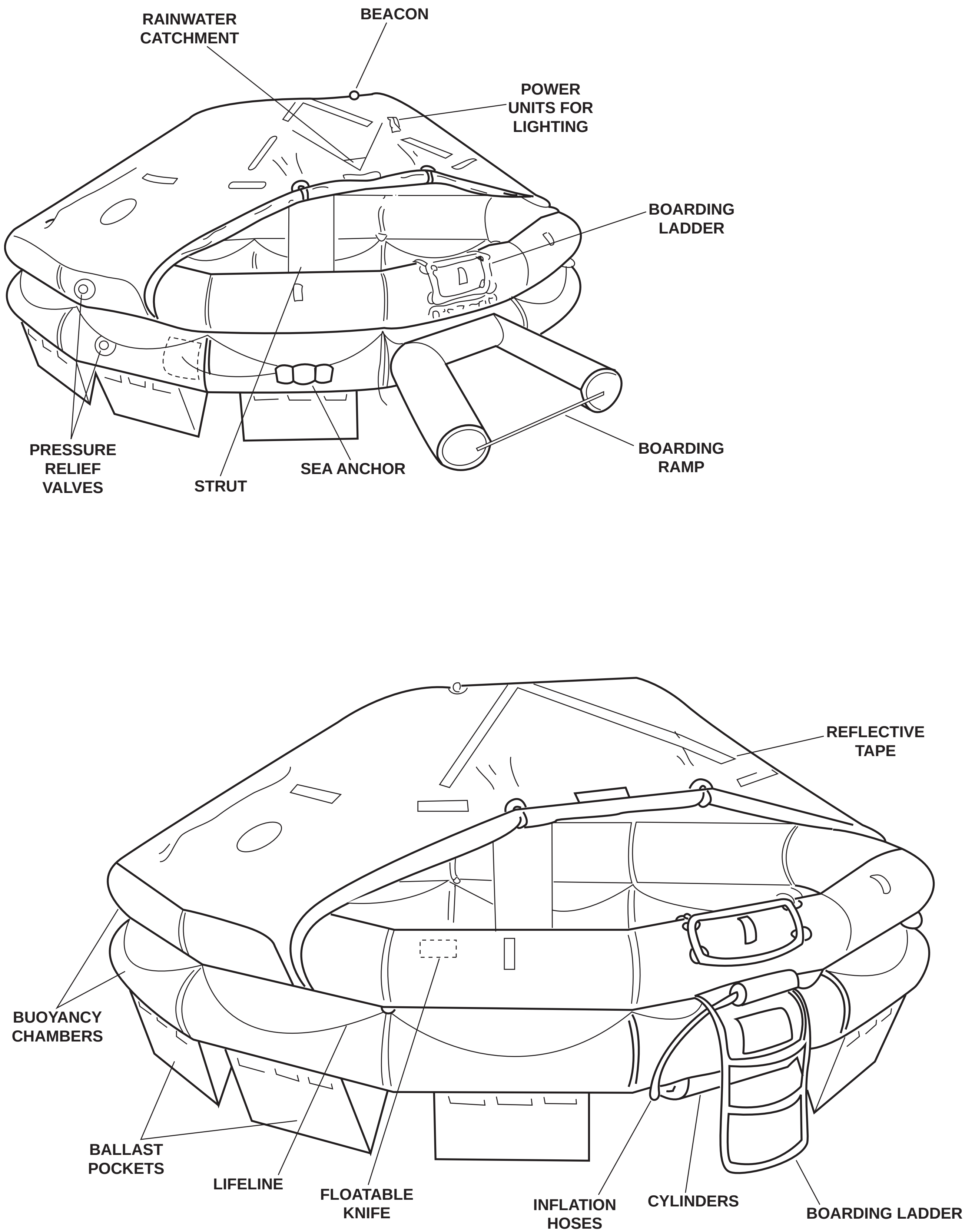


Figure 4. Deployed Life Raft

Table 1. Mark 7 (Mk-VII) Emergency Pack Inventory

Quantity	Component	Shelf Life in Months
Valise No. 1		
2	Manual Reverse Osmosis Desalinator (MROD)	*
25	Food Packets	48
25	Water Bottles, 0.5 l	40
Valise No. 2		
150	Anti-Seasickness Tablets	24
6	Batteries, Alkaline "D" size	*
2	Bulbs, Flashlight	*
1	First Aid Kit:	
100	Aspirin	24
10	Iodine Swabs	12
16	Adhesive Bandages	*
1	Eye First Aid Kit	24
1	Scissors	
1	Whistle	
1	Abandon Ship Signal Kit	
2	Bailer, with Lanyard	
2	Spare Sea Anchor	
1	Signal Mirror	
2	Sponge	
1	Rescue Signal Table	
1	Fishing Kit	
1	Immediate Action Instructions	
12	Thermal Protective Blanket	
2	Pressure Relieve Valve Retainer	
1	Pocket Knife	
1	Sea Dye Marker	
2	Water Storage Bottles	

*Replace at each five (5) year servicing/certification

Items the crew should check for are:

1. Any dents or cracks in the container, which could leak water

2. Any chafing, cuts, or loose connectors in the cables and lanyards

3. Labels missing or unreadable

4. Damage or defect of seals, hydrostatic release, or retainer clips and pins, which could cause the life raft to malfunction during deployment.

INHERENTLY BUOYANT LIFE RING AND BUOY LIGHT

The purpose of the inherently buoyant life ring (figure 5, item 1) is to act as an emergency life preserver in the event of a man overboard, both in port and at sea. The ring buoys are equipped with strobe lights (figure 5, item 2), and act as floating distress signals. They mark the position of, and provide positive buoyancy to personnel in the water. The life ring is considered a Type IV flotation device. Type IV devices are usually unmanned, and are designed to be thrown to personnel already in the water. The life ring is a backup to a wearable PFD, and the attached strobe light is easily seen at night. A disadvantage of the life ring is that it is useless to an unconscious person or a non-swimmer already in the water. However, in this situation, the flashing strobe is vital to marking the last known location of the person in the water. Type IV flotation devices are not considered replacements for wearable life preservers.

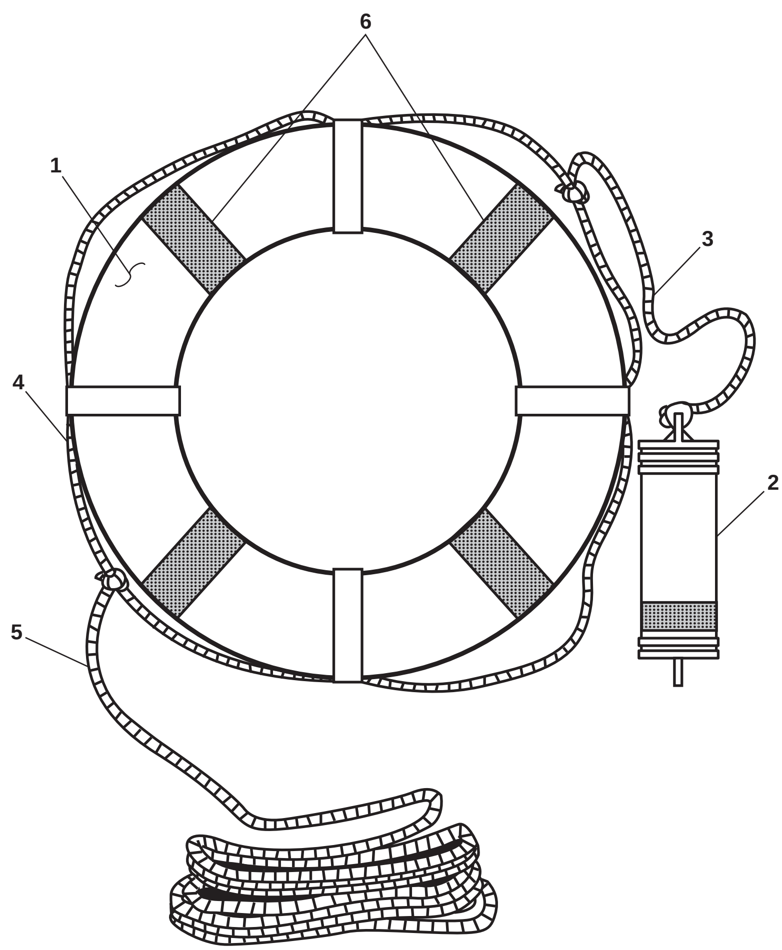


Figure 5. Ready Service Life Ring with Buoy Light Attached

The LT is outfitted with eight 30-inch (762 mm) inherently buoyant life rings. The life ring is attached to a self-righting buoy light with 4 feet (1.2 meters) of floating polypropylene line (figure 5, item 3). The life ring is designed to provide about 30 lbs (13.6 kg) positive buoyancy. This is enough buoyancy for two average size adults to remain afloat while holding onto the attached retrieval harness (figure 5, item 4). The strobe light typically has enough battery power to flash for about 36 hours. The strobe flashes once every 2-3 seconds and can be seen up to 2 nautical miles (3.7 km) away. A minimum of 50 feet (15 meters) of floating polyproylene line is attached to the life ring retrieval harness. The retrieving line (figure 5, item 5) makes it easier to recover conscious victims holding onto the life ring.

The buoy flashing strobe light serves several purposes. It provides the person in the water a location to swim to, it gives the vessel an object to steer to, and it creates a point of reference for all parties involved in the search. The flashing strobe light and life ring are designed to drift at approximately the same rate as a typical person in the water. The sooner the life ring and strobe light enter the water after the overboard person, the greater the accuracy in marking the last known position of the person. The buoy light is self-righting, and it will float upright and automatically begin flashing upon entry into water. It is equipped with a magnetic switch that turns on the strobe automatically when the lens is positioned upright. The ring buoy light is international orange in color, with a clear dome shaped lens at the strobe lamp end. The reflective tape augments the visibility of the buoy light if the battery is dead.

The ring buoys on the LT are constructed of international orange plastic material and are outfitted with the following components:

1. Four strips of reflective tape, 2” (5 cm) wide wrapped equidistantly from the outside to the inside edge so that equal reflectivity is provided on both sides of the life ring (figure 5, item 6).

2. A retrieval harness made of a length of floating line four times the outside diameter of the ring and attached at four equidistant points around the circumference of the life ring.

3. Organization and hull number of the vessel, stenciled in two inch non-reflective block capital letters on at least one side of the life ring.

4. A four-foot leader of high visibility floating line attached to a self-righting/energizing signaling buoy opposite the retrieving line. The signaling device should be capable of a minimum of 36 hours of operation with visibility of at least 1 nautical mile (1.85 km) and have a strip of two-inch reflective tape around the circumference of the lens end.

5. A high visibility floating retrieving line with a minimum of 50 feet (15 meters) attached to the retrieval harness opposite the buoy light leader.

END OF WORK PACKAGE

Chapter 5

Stability and Buoyancy
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) INTRODUCTION TO THE PRINCIPLES OF STABILITY

To understand the principles of stability, you need a basic understanding of the terms, definitions, and trigonometric equations that are used to express important relationships. Generally speaking, the weight of the vessel in the water pushes straight down, and the water it sits in pushes straight back up. When no other force acts on the vessel, these forces tend to cancel each other out. A state of equilibrium exists. However, when the center of gravity moves above the center of buoyancy, there is an “inclining moment.” This force is considered to be at a right angle to the forces of gravity and buoyancy. To better understand how these forces interact, an explanation of trigonometry is presented.

TRIGONOMETRY

Trigonometry is the study of triangles, and the interrelationship of the sides and the angles of a triangle. In determining vessel stability, only the part of trigonometry that pertains to right triangles is used. There is a fixed relationship between the angles of a right triangle and the ratios of the lengths of the sides of the triangle. These ratios are known as trigonometric functions, and they have been given the names sine, cosine, and tangent.

PRINCIPLES OF PHYSICS

There are certain principles of physics that you need to know in order to have an adequate understanding of stability. You should be familiar with such terms as volume, density, weight, center of gravity, force, and moments. Each is presented below.

VOLUME (V) AND DENSITY (D)

The volume of any object is determined by the number of cubic units contained in the object. The underwater volume of a vessel is found by determining the number of cubic feet or cubic meters that are in the part of the hull that is below the waterline. The density of any material is obtained by weighing a specific unit volume of the material and dividing the weight by the volume.

WEIGHT (W)

If you know the volume of an object and the density of the material it is made out of, its weight can be calculated. The weight of the object is found by multiplying the volume and the density. The formula for this is: $W = V \times D$. When an object floats in a liquid, the weight of the volume of liquid displaced by the object is equal to the weight of the object. This means that if you know the volume of the displaced liquid, the weight of the object is found by multiplying the volume and the density of the liquid. W is the weight (displacement) of the vessel expressed in long tons.

CENTER OF GRAVITY (G)

The center of gravity is the point at which all the weights of the unit or system are considered to be concentrated and have the same effect as all of the component parts.

FORCE (F)

A force is a push or pull. A force attempts to create a motion or to produce a change in motion. Force is what makes something move, speed up, slow down, or change direction. A force can act on an object without being in direct contact with it. A common example of force is the pull of gravity. Forces are usually expressed in terms of weight units such as pounds, tons, and ounces. To prevent motion or to keep a body at rest, you must apply an equal force in the same line of action, but in the opposite direction.

MOMENTS

In addition to the size and direction of a force, knowing the location of the force is also important. For example, if two persons of the same weight sit on opposite ends of a seesaw, equally distant from the middle support, the seesaw will balance. However, if one person moves, the seesaw will no longer remain balanced. The person farthest away from the support will move down because the effect of the force of his/her weight is greater. The effect of the location of a force is known as the moment of force. It is equal to the force multiplied by the distance from the axis that created its effect. The moment of this type of force tends to produce rotation. Rotational force is called torque. We express the weight units of torque as tons-foot, or pounds-foot. The system international (metric) unit is Newton-meter.

INCLINING MOMENT

In one sense, the vessel may be considered as a system of weights. If the vessel is undamaged and is floating in calm water, the weights are balanced, and the vessel is stable. However, any movement of weight on the vessel causes a change in the location of the center of gravity. This shifting of the center of gravity affects the stability of the vessel. An inclining moment is produced when weight is moved outboard from the centerline of the vessel. If an object weighing 20 tons (18.14 metric tons) is moved 20 feet (6.1 meters) outboard from the centerline, the inclining moment will be equal to 400 tons-foot (1084.6 kilo Newton meters). In physics, this is calculated as a rotational force (torque) that moves 20 tons (18.14 metric tons) with a lever arm of 20 feet (6.1 meters).

VERTICAL MOMENT

It is possible to calculate the vertical moment of any part of the vessel's structure or of any weight carried on board. In calculating a vertical moment, use the vessel's keel as the axis. The crane weighs 5 tons (4.53 metric tons), and it is located 20 (6.1 meters) feet above the keel. The vertical moment is 5 tons x 20 feet, or 100 tons-foot (271 kilo Newton meters). This torque is always applied even if the crane is at rest. When the crane is in use, even more torque acting as a vertical moment is applied.

BUOYANCY (B) VERSUS GRAVITY (G)

Buoyancy is defined as the ability of an object to float. Let's say we place an object of a given volume in water. If the weight of this object is greater than the weight of an equal volume of water, the object will sink. It sinks because the force that buoys it up is less than the weight of the object. In other words, the water is lighter (not as dense) as the object, so the object falls through the water. However, if the weight of the object is less than the weight of an equal volume of water, the object will float. The object floats because the force that buoys it up is greater than the weight of the object. Let's use a cube of steel as an example. Let's say it is solid and measures 1 foot by 1 foot by 1 foot. If you drop the steel cube into the water, the steel cube will sink. It sinks because it weighs more than a cubic foot of water. But if you hammer this cube of steel into a flat plate 8 feet (2.4 meter) by 8 feet (2.4 meter), bend the edges up 1 foot all-around, and make the corner seams watertight, it becomes a 6-foot (1.8 meter) by 6-foot (1.8 meter) by 1-foot (.3 meter) boat that will float. In fact, it will float so well (in calm water) that it will support an additional 1,800 pounds (816 kilograms).

Another fact you must understand is that it is the volume of the submerged part of a floating vessel that actually provides the buoyancy to keep it afloat. If the vessel is at rest, the buoyancy must be equal to the weight of the vessel. This is why the weight of a vessel is generally referred to as displacement. This means that the weight of the volume of water is displaced by the hull of the vessel. Since weight (W) is equal to the displacement, we can measure the volume of the underwater body (V) and multiply this volume by the weight of seawater to determine the weight of the vessel.

The displacement will vary as the depth of the keel below the water line varies. The measurement of the depth of the keel below the waterline is called the draft. As the draft increases, the displacement increases. The volume of an underwater body for a given draft can be measured by using graphic or mathematical means. This is done for a series of drafts throughout the probable range of displacements the vessel is likely to operate. The values obtained are plotted on a grid in which the draft is measured vertically and tons of displacement is shown horizon tally. A smooth line is faired through the points plotted. This provides what is known as the curve of displacement versus draft, or the displacement curve.

RESERVE BUOYANCY

The volume of the watertight portion of the vessel above the waterline is known as reserve buoyancy. Reserve buoyancy can also be expressed as a percentage of the overall displacement of the vessel. It is calculated as the ratio of the volume of the above-water body to the volume of the underwater body. This means that reserve buoyancy may be stated as a volume in cubic feet, as a ratio (or percentage), or as an equivalent weight of seawater in tons.

FREEBOARD

Freeboard is a rough measure of reserve buoyancy. It is the distance in feet from the waterline to the weather deck edge. For consistent use, freeboard is calculated at the amidships section. Freeboard plus draft always equals the depth of the hull. When weight is added to a vessel, draft and displacement increase in the same amount that freeboard and reserve buoyancy decrease. It is essential to seaworthiness that the vessel retains a substantial amount of reserve buoyancy to prevent sinking.

CENTER OF BUOYANCY (B)

When a vessel is floating at rest in calm water, it is acted upon by two sets of forces: the downward force of gravity, and the upward force of buoyancy. When a vessel is at rest in calm water, the forces of B and G are equal and opposite, and the points B and G lie in the same vertical line. When the vessel is inclined, B and G move apart because B moves off the vessel's centerline as a result of the change in the volume of the underwater hull.

GRAVITY (G)

Gravity is a composite force. This means that gravity is made up of more than one thing. These include the weights of all portions of the vessel's structure, its equipment, cargo, and the personnel on board. When combined, the force of gravity is calculated as a single force. This force acts downward through the vessel's center of gravity (G). G is the point at which all weights of the vessel may be considered to be concentrated. The force of gravity is considered as acting straight downward, through the center of gravity, at right angles to the waterline.

BUOYANCY (B)

The force of buoyancy is also a composite force. This force results from the pressure of the water on the vessel's hull. A good example of this is placing an empty milk jug in a tank of water. Provided that the jug has the cap on, it must be held under the water to keep it from rising. These same forces act on the hull of the vessel when it is in the water. These horizontal pressures are always applied to the sides of the vessel, but they are canceled out by the weight of the vessel as it reaches a buoyant state. In other words, under normal conditions, they are equal forces acting in opposite directions in the vertical plane. This vertical pressure is calculated as a single force. The vessel will not sink any lower or rise any higher because it is in a state of equilibrium with the water it sits in. It is the force of buoyancy acting vertically upward through the center of buoyancy (B) that creates this equilibrium. B is the geometric center of the vessel's underwater hull.

The vessel may be disturbed from rest by conditions that tend to make it heel over at an angle. These conditions include such things as wave action, wind pressures, turning forces, impact of a collision or enemy hit, shifting of ballast on board, and the usage of fuel. These conditions exert heeling moments on the vessel that may be temporary or continuous. When a disturbing force exerts an inclining moment on the vessel, there is a change in the shape and position of the underwater body. The underwater volume is relocated, and its bulk is shifted in the direction of the heel (like water running downhill). This condition causes the center of buoyancy (B) to leave the vessel's centerline, and it shifts toward the direction of the heel. The center of buoyancy then moves to a new geometric center of the underwater body. As a result, the lines of action of the forces of buoyancy and gravity separate. This exerts what is termed as a moment on the vessel. This moment tends to restore the vessel to an even keel.

TORQUE EFFECT OF THE RIGHTING MOMENT

The moment produced is called a righting or restoring moment. This righting moment is caused by the two equal and opposite forces. Each is equivalent to tons of displacement magnitude and is separated by a measurable distance. This distance constitutes what is known as the LEVER arm of moment. It is the lever arm of moment that tends to restore the vessel to an even keel or an upright position. The moment is the product of a force tending to produce a rotation (torque) about an axis. If two equal and opposite forces are separated by a distance, the moment will become a couple. The righting moment of the vessel becomes the product of the force of buoyancy times the distance lever arm of moment. It may also be expressed as the force of gravity (weight of the vessel) times the lever arm of moment. The distance of the lever arm of moment is known as a vessel's righting arm.

When the vessel is upright, the waterline is WL, and the forces will act as shown in figure 1. When the vessel is inclined, the waterline becomes W1L1. This changes the shape and position of the underwater body. As a result, the center of buoyancy moves from B to a new position B1. Weight and buoyancy no longer act in the same vertical line. Figure 1 demonstrates that a righting arm (or a restoring moment) is now present. This tends to rotate the vessel toward its original position. The distance GZ is the righting arm.

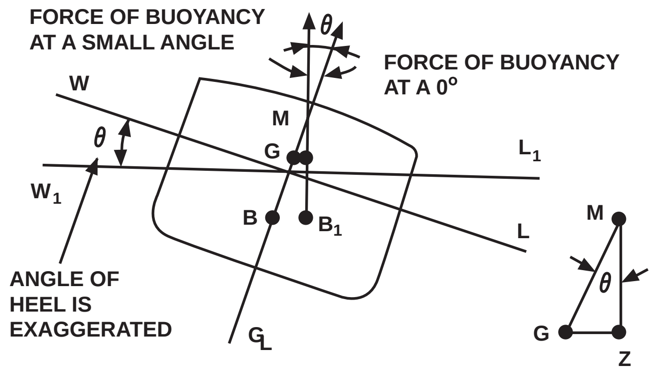


Figure 1. Initial Metacenter with Line of Action Buoyancy Angled Away From 0°

The vessel in Figure 2 develops positive righting arms from 0 degrees to 71 degrees. This series of angles through which the vessel has a positive righting arm is called the range of stability. It indicates the extreme angle to which the vessel can recover from a roll. If the vessel in the example rolls 70 degrees, it will recover and come back to the upright position. But if the extreme angle exceeds 71 degrees, the vessel will capsize. The chart indicates that upsetting moments develop beyond roll angles of 71 degrees.

UPSETTING MOMENT

It is possible for conditions to exist that do not permit B to move far enough in the direction the vessel rolls to place the buoyant force outboard of the force of gravity. The moment produced will tend to upset the vessel, and render it unstable. This produces what is called an upsetting moment.

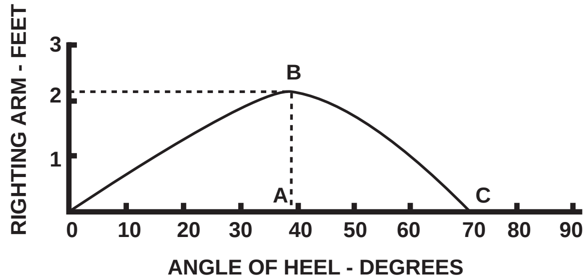


Figure 2. Stability Curve Indicating Maximum GZ

METACENTER (M)

The vessel's metacenter (M) is the intersection of two successive lines of action on the force of buoyancy. One of these represents the vessel on even keel, the other at a small angle of heel. The point where the lines intersect is the calculated initial position of the metacenter. When the angle of heel is greater than the angle used to compute the metacenter, M moves off the centerline. This path of movement is presented as a curve. The initial position of the metacenter is most useful in the study of stability, because it provides a reference point for when the vessel is upright and is most stable. In our discussion about the metacenter, we will refer to the initial position as M. The distance from the center of buoyancy (B) to the metacenter (M) when the vessel is on even keel is called the metacentric radius. M is a point established by the intersection of two successive lines of buoyant force as the vessel heels through a very small angle.

In this discussion, the term "initial stability" refers to the tendency of the vessel to right itself when inclined to small angles of heel, under 7 degrees, for example. To facilitate the determination of initial stability, the concept of metacenter is introduced. With the vessel at a given draft, the metacenter is the point of intersection of two successive lines of action of the force of buoyancy as the vessel is inclined through a very small angle. M designates the initial metacenter, that is, the intersection of the buoyant force at 0 degrees with the line of action of buoyancy at a small angle (0) away from 0 degrees. The distance between the center of gravity (G) and the metacenter (M) is called the metacentric height (GM).

METACENTRIC HEIGHT (GM)

Figure 3, view A, shows a vessel heeled through a small angle (the angle is exaggerated in the drawing), establishing a metacenter at M. GM is the distance from G to M. Z is the point at which a line, through G, parallel to the waterline, intersects the vertical line through B. The vessel's righting arm is GZ, which is one side of the triangle GZM. In this triangle GZM, the angle of heel is at M. The side GM is perpendicular to the waterline at even keel, and ZM is perpendicular to the waterline when the vessel is inclined. It is evident that for any given angle of heel, there will be a definite relationship between GM and GZ because GZ = GMsin. Thus GM acts as a measure of GZ, the righting arm. The vessel's metacentric height (GM) is not only a measure of the vessel's righting arm (GZ) but is also an indication of whether the vessel is stable or not. If M is above G, the metacentric height is positive. The moments which develop when the vessel is inclined, are righting moments, and the vessel is stable. This is shown in view A of figure 3. But, if M is below G, the metacentric height is negative. The moments that develop are upsetting moments, and the vessel is unstable. This is shown in view B of (figure 3).

INFLUENCE OF METACENTRIC HEIGHT

If the metacentric height (GM) of the vessel is large, the righting arms that develop at small angles of heel will be large. A large GM and large righting arms are desirable for resistance to damage. Such a vessel is considered stiff and will resist roll. However, if the metacentric height is small, the righting arms that develop will be small. Such a vessel is tender, and will roll slowly. At small angles of heel, large values of GM indicate large righting arms. Small values of GM reflect slowly developed righting arms. Vessels with very small GM tend to hang at the extreme angle of a roll longer before starting back.

A study of figure 4 indicates that when G is below M, GM is positive and righting arms develop. When G is above M, GM is negative and upsetting arms develop. This means that GM is an indicator of whether initial stability is positive or negative. This information is helpful in calculating stability if the vessel is damaged. Timing the roll is of little practical use in evaluating damaged stability. Knowledge of the relation between a period of roll and GM is useful in giving the general feel of the vessel's stability as it rolls. A vessel which has a slow roll, has low GM. A stiff vessel has high GM.

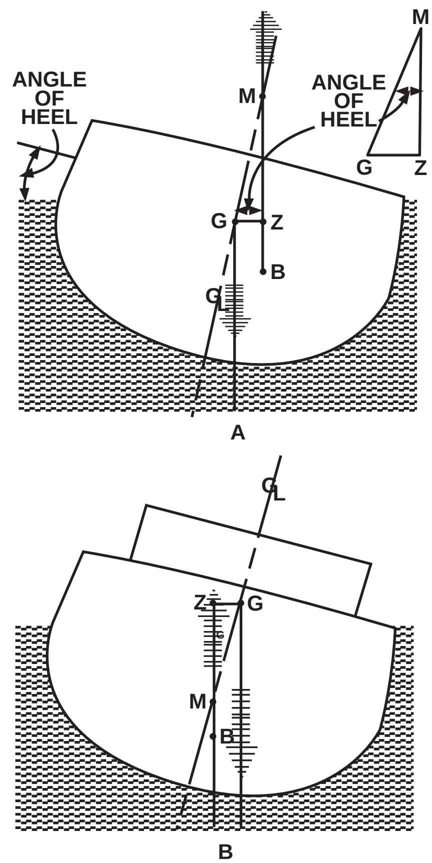


Figure 3. Calculating Metacentric Height

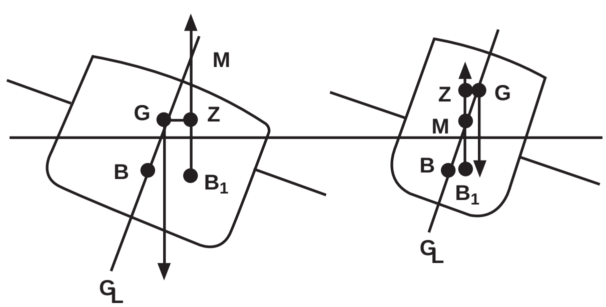


Figure 4. GM Indicating Initial Stability

ANGLE OF LIST

The angle at which the maximum righting arm occurs is also referred to as the angle of list. In figure 2, the maximum value of the righting arm occurs at point A on the graph. This is angle of heel of about 39°. The angle at which the maximum righting arm develops is significant because it is this angle of inclination beyond which the vessel cannot safely assume a permanent list, even under ideal conditions in calm water. A list this large could be incurred if the vessel is flooded or damaged. If the angle of list is exceeded, it is possible that the vessel will flounder.

DYNAMIC STABILITY

The force that causes the vessel to heel over is equal to the moment the vessel resists inclination (the righting moment) multiplied by the angle through which the moment acts. In other words, dynamic stability is equal to the righting moments multiplied by the angles of inclination. If the cause of the inclination is removed, dynamic stability becomes available in the form of energy that causes the vessel to return to its upright position. This is similar to the work done in compressing a spring. When pressure that pulls the spring apart is removed, the spring works to compress itself. This is the same way the vessel uses dynamic stability to continually right itself.

On the curve of righting moment (figure 5), the area between the curve and the base represents the moments (measured vertically) multiplied by the angles (measured horizontally) through which the vessel heels. The area under the curve represents the calculated dynamic stability of the vessel at that angle. It takes a large amount of force to heel the vessel, and that energy will become available to right the vessel when the cause of the inclination is removed. In figure 5 the dynamic stability at 25° is represented by the shaded area. The unshaded area under the curve is the reserve of dynamic stability, or what is left over. The unshaded area in figure 5 represents how much work needs to be done to heel the vessel until it capsizes. An example of this is constant wind heeling the vessel to some degree. A large wave heels the vessel in excess of 25°. The wind keeps pushing against the vessel, slowing the righting moment. Then another large wave hits the vessel. The extra energy the vessel must absorb, when heeled more than 25°, may overcome the righting moment and cause the vessel to capsize.

The righting moment of a vessel is W times GZ. It is the displacement times the righting arm. Righting moments are measured in tons-foot. Since the righting arm (GZ) is equal to GM times sine, it can be said that the righting moment is equal to W times GM times sine. Because of the relationship between righting arms and righting moments, stability may be expressed either in terms of GZ or in righting moments. Do not confuse righting arms with righting moments; they are not identical.

STABILITY CURVES

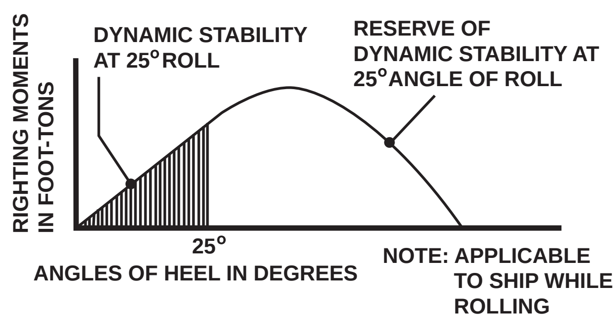


Figure 5. Curve of Righting Moments

When a series of values for GZ (the vessel's righting arm) at successive angles of heel are plotted on a graph, the result is a stability curve. The stability curve is called the curve of static stability. The word static indicates that it is not necessary for the vessel to be in motion for the curve to apply. If the vessel is momentarily stopped at any angle during its roll, the value of GZ given by the curve will still apply. To understand this stability curve, it is necessary to consider the following:

1. The vessel's center of gravity does not change position as the angle of heel is changed.

2. The vessel's center of buoyancy is always at the geometric center of the vessel's underwater hull.

3. The shape and position of the vessel's underwater hull changes as the angle of heel changes.

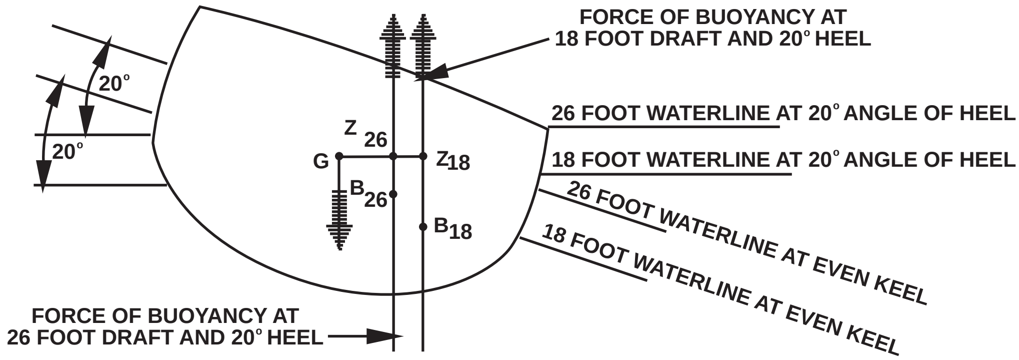


Figure 6. Effect of Draft On the Righting Arm

If these three facts are considered collectively, the position of G remains constant as the vessel heels through various angles, but the position of B changes according to the angle of inclination. When the position of B has changed so that B and G are not in the same vertical line, a righting arm GZ must exist. The length of this righting arm depends upon the angle at which the vessel is inclined as presented in figure 6. GZ increases as the angle of heel increases, up to a certain point. At about an angle of 40°, the rate of increase of GZ begins to level off. The value of GZ diminishes and finally reaches zero at a very large angle of heel.

A change in displacement will result in a change of draft and freeboard. Buoyancy (B) will shift to the geometric center of the new underwater body. At any angle of inclination, a change in draft causes B to shift both horizontally and vertically with respect to the keel. The horizontal shift in B changes the distance between B and G, and thereby changes the length of the righting arm (GZ). When the draft is increased, the righting arms are reduced throughout the entire range of stability. Figure 6 shows how the righting arm is reduced when the draft is increased from 18 feet (5.49 meters) to 26 feet (7.92 meters) when the vessel is inclined at an angle of 20°. A reduction in the size of the righting arm usually means a decrease in stability.

CROSS CURVES OF STABILITY

The position of the center of buoyancy at any given angle of inclination depends upon the draft. As the draft increases, the center of buoyancy moves closer to the center of gravity, thereby reducing the length of the righting arms. To determine this effect, the design activity inclines a line drawing of the vessel's lines at a given angle, and then lays off a series of waterlines on it. These waterlines are chosen at evenly spaced drafts throughout the probable range of displacements. For each waterline, the value of the righting arm is calculated, using an assumed center of gravity. A series of these calculations is made for various angles of heel, usually every 10 degrees. The results are plotted on a grid to form a series of curves known as the cross curves of stability.

EFFECTS OF LOOSE WATER

When a tank or a compartment in a vessel is partially full of liquid that is free to move as the vessel heels, gravity tends to keep the surface of the liquid parallel with the waterline. The surface area of the free liquid is referred to as free surface. The tendency of the liquid to remain level as the vessel heels is referred to as free surface effect. The term 'loose water' is used to describe liquid that has a free surface. It is not used to describe water or other liquid that completely fills a tank or compartment that remains confined and has no free surface effect.

FREE SURFACE EFFECT

Free surface effect in a vessel causes a reduction in GM. This is due to a change in the center of gravity caused by the movement of the liquid. This movement of liquid reduces the stability of the vessel. The free surface effect is separate from and independent of any effect that may result merely from the addition of the weight of the liquid. When free surface exists, a free surface correction must be included in stability calculations. However, when a tank is completely filled so that there is no free surface, the liquid in the tank may be treated as a solid. This means that the only effect of the liquid on stability is the effect of its weight at its particular location. To understand the actions that occur because of free surface effect, use a centerline compartment that is partially full of water, as shown in figure 7. To begin with, the vessel is floating on an even keel at waterline WL. Then the compartment is flooded to waterline W1. Assume that the water entered the compartment instantaneously, and that it is instantaneously frozen solid. The effects of this frozen body of water are the same as if a solid weight had been added. The vessel undergoes parallel sinkage and comes to rest at a new waterline W1L1.

Suppose that an outside force acts on the vessel, causing it to heel over at a small angle of list to a new waterline W2L2. If at the same time, the liquid is freed from its frozen state, it will run toward the low side of the compartment until the surface of the water in the compartment is parallel to the existing waterline W2L2. A wedge of liquid is thus shifted from one side of the compartment to the other. The center of gravity of the liquid is shifted from D to E. As the center of gravity of the liquid is shifted outboard, an additional inclining moment is created. This causes the vessel to list to a new waterline W3L3. The additional list, in turn, causes a further shift of the liquid in the compartment, and a further shift of the center of gravity of the liquid. As the center of gravity of the liquid shifts to F, another inclining moment is created, and the vessel lists even more. Eventually the vessel will come to rest with a waterline such as W4L4. This will occur when the righting moment of the vessel is equal to the combined effects of the original inclining moment created by the outside force and the inclining moment created by the shift of liquid within the compartment.

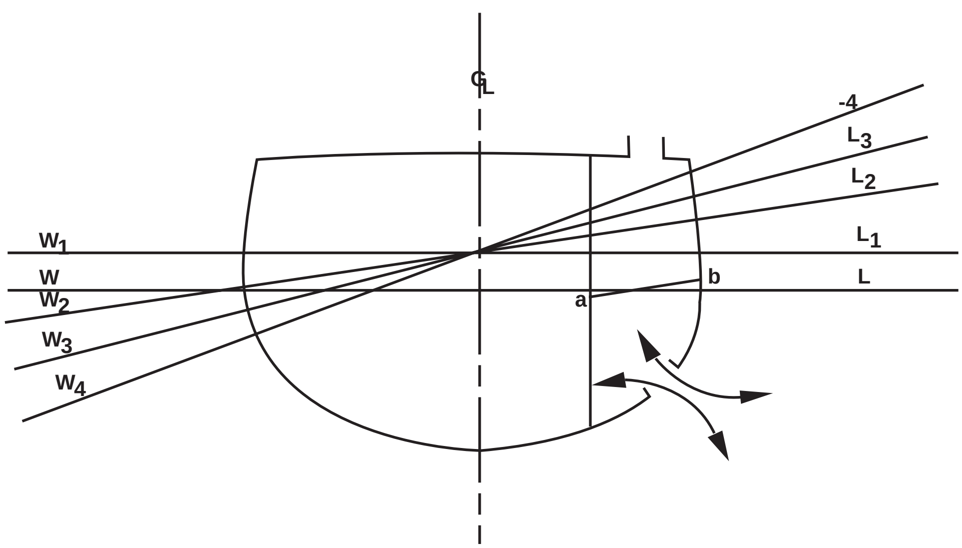


Figure 7. Effects of Free Surface

LOCATION OF FREE SURFACE

The free surface effect is independent of the location of the free surface within the vessel. A free surface at any given angle of heel will cause the same reduction in GM, and it will cause the same loss of stability no matter where it is in the vessel. The free surface effect does not depend upon the depth of the loose water in the tank or compartment, unless the loose water causes pocketing. Pocketing occurs when the free surface of the liquid comes in contact with the deck or the overhead and causes a reduction in the breadth of the free surface. The addition of loose water to the vessel alters the stability characteristics of the vessel. That is why bilges are kept dry, and tanks as close to empty or full as practical.

LONGITUDINAL STABILITY (TRIM)

Trim is measured by the difference between the forward draft and the after draft. When the after draft is greater than the forward draft, the vessel is trimmed by the stern. When the forward draft is greater than the after draft, the vessel is trimmed by the bow or trimmed by the head. As the vessel trims, it inclines about an athwartships axis that passes through a point known as the center of flotation (CF). The mean draft that is used to enter the draft scale to read a displacement curve is the draft amidships. When the trim is greater, the readings obtained from the curves of form must be corrected for trim. Longitudinal stability is the tendency of a vessel to resist a change in trim. The longitudinal metacentric height multiplied by the displacement is taken as a measure of initial longitudinal stability when trim is very small. A more accurate measure of the vessel’s ability to resist a change of trim is made in terms of the moment required to produce a change in trim of a definite amount. The moment to change trim 1 inch (MTI) is used as the standard measure of resistance to longitudinal inclination.

SUMMARY

This work package has introduced you to the basic terminology used for vessel stability. We reviewed the laws of physics and the trigonometry used to determine stability and buoyancy of a vessel. We also studied the effects of buoyancy, gravity, and weight shifts on vessel stability. There are other aspects involved in the study of stability that were not mentioned in this work package. This work package presents only the basics needed for damage control purposes.

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) STABILITY AND BUOYANCY CHARACTERISTICS AND CALCULATIONS

The stability characteristics required to ensure that the vessel will be seaworthy and capable of surviving the greatest practical amount of underwater damage is determined by such criteria as heeling effect of beam winds, high speed turns, and damage. The following are used to identify the basic stability characteristics of the vessel:

1. Initial stability. This characteristic refers to the tendency of the vessel to right itself when heeled or inclined at a small angle. Initial stability is measured by metacentric height (GM).

2. Range of stability. This characteristic refers to the angles of heel through which a vessel maintains a positive righting arm.

3. Angle of list at which maximum righting arm occurs. This characteristic is an indicator of hazardous conditions in heavy seas. If the vessel rolls beyond the maximum angle of the righting arm, it may capsize.

4. Dynamic stability. This characteristic refers to the amount of work that must be done to heel the vessel over. When the cause of the heel is removed, dynamic stability becomes the energy that returns the vessel to its upright position.

STABILITY REQUIREMENTS

In determining the stability characteristics required to ensure that the LT is seaworthy and capable of surviving the greatest practical amount of underwater damage, the following factors, among others, are considered:

1. Heeling effect of beam winds of typhoon force against the intact vessel

2. Residual stability after damage

3. Heeling effect of unsymmetrical flooding after damage

4. Reserve buoyancy after damage

5. The stability characteristics and the reserve buoyancy of the vessel is such that a satisfactory condition of stability and reserve buoyancy will exist after the flooding of any one compartment other than the engine room, providing:

   a. The specified limiting drafts are not exceeded before damage.

   b. The height of center of gravity (KG) is kept at or below the limiting value.

   c. A proper degree of watertight integrity is maintained. Specifically, the watertight doors must be closed and dogged.

STABILITY AVAILABLE

The Large Tug (LT) actually has excessive intact stability in all reasonable conditions of loading. This is indicated by the high metacentric height (GM) as shown in one of the typical conditions of loading. Because of this stability, the LT can withstand an unusual amount of damage without assuming a dangerously large angle of heel. The short natural period of roll observed in the LT is a function of its high initial stability. The motion in a seaway is apt to be quick and uncomfortable. The effect of loading cargo high in the vessel in an effort to relieve this condition will be negligible for any practical arrangement of loading. Particular care must be taken to secure all cargo adequately to prevent shifting. A change in course or speed, if tactically possible, may reduce the amplitude of rolling. Information used to evaluate the LT's stability is provided in the following documents:

1. Curves of Static Stability. The curves of static stability are an index of the vessel's stability for a given condition of loading. These properties include metacentric height (GM), maximum righting arm (GZ) and the angle of inclination at which it occurs, range of stability and dynamic stability. For the LT, the light condition and the full load departure condition represent the upper and lower limits of the operating range. On rare occasions, such as entering drydock, the vessel may approach light condition. The range of positive stability is adequate for all normal considerations.

2. Damage stability calculations. The damage stability calculations are based on a draft of 17 feet (5.2 meters) above the bottom of keel amidships before damage. Calculations indicate that the LT should be able to survive complete flooding of any one compartment, other than the engine room, without loss by foundering or capsizing.

DAMAGE RESISTANCE CHARACTERISTICS OF THE LT

Maintenance of the built-in damage resistance of the LT is as important for survival as are damage control measures after damage has been sustained. The damage resistance features built into this vessel are:

STRENGTH

The main deck, below the main deck, and the hull are the principal strength members. Together with the bulkheads and framing, the main deck and the shell carry the stresses imposed on the vessel by its weight and the action of the sea. These structural members resist damage and possess a sufficient margin of safety to permit the vessel to withstand considerable structural damage without failure.

WATERTIGHT INTEGRITY

Watertight subdivision is provided to halt the ingress of water into the vessel after damage, and to limit the spread of flooding. The vessel is designed with the following arrangement of subdivisions to ensure watertight integrity:

1. Transverse bulkheads are arranged to divide the vessel into sections so that it can withstand flooding of one major compartment (other than the engine room).

2. In order to avoid large heeling moments, longitudinal bulkheads are limited in number to prevent off-center flooding.

If flooding occurs at a substantial rate, the vessel is in jeopardy. Removal of floodwater is futile until the flooding is halted or slowed. Therefore, watertight integrity must be strictly maintained before damage occurs to ensure that flooding will remain localized. This is accomplished in the following manner:

Rigid closure discipline of watertight doors, hatches, vent ducts, etc. must be maintained before and during operations where the vessel may be exposed to damage. Open doors and hatches will permit flooding, fires, and other effects of damage to spread.

STABILITY

Adequate stability characteristics are provided to make the vessel seaworthy, and to keep it from capsizing after absorbing damage. Preservation of satisfactory stability characteristics requires adherence to liquid loading instructions, remaining within the specified limiting drafts, removal of unusual topside weights, and maintenance of a proper degree of watertight integrity.

PROPER DISPLACEMENT

Overloading has an adverse affect of reducing freeboard and reserve buoyancy. Limiting displacements and drafts are established for this vessel. See the Stability and Loading Data Booklet.

OPTIMUM MATERIAL AND PERSONNEL READINESS

Despite design and other precautions made before damage occurs, the survival of the vessel will often depend upon proper operation of damage control measures after damage occurs. Therefore, it is necessary to expend every effort to maintain the vessel in optimum material condition, and to train the entire crew for any eventuality.

DESIGN

Duplication and isolation of machinery, power plants, steering gear, steering control, and other vital systems increase survivability by reducing the probability of immobilization. Provision of emergency equipment having a separate power source is important in duplication. Isolation of equipment is obtained by structural boundaries, and/or vertical separation. For example, the EDG is on the 01 Level in its own watertight compartment. The hull of the vessel is compartmented in an effort to create double hull protection, and to provide a cushion to prevent unrecoverable hull damage in the event of a collision.

COMPARTMENTATION SERVES THE FOLLOWING FUNCTIONS:

1. Allows more effective control of fires and floods.
2. Strengthens the vessel’s structure.
3. Helps defend against a Nuclear, Biological, and Chemical (NBC) attack.
4. Segregates various ongoing activities.
5. Provides underwater protection by the use of tanks and voids to help control the vessel’s buoyancy and stability.

MEASURES TO RESIST FLOODING BEFORE DAMAGE

As much as ninety percent of the work involved in damage control is accomplished before any damage actually occurs. Much of this preparatory work consists of measures to toughen the vessel to resist flooding. The purpose of this section is to discuss these measures from the standpoint of buoyancy and stability.

COMBATING FLOODING

Speed and accuracy are required when combating flooding. To apply effective corrective measures, damage control personnel must be familiar with the equipment provided to control list and trim and to improve stability. Preparing damage control bills that establish procedures is recommended. These might include a drainage bill, a jettison ship bill, and a flooding effect bill as described in the paragraphs that follow.

DRAINAGE BILL

Since the vessel's drainage facilities (including portable pumping equipment) provide means to suppress free surface and remove weight, give thought to assigning a priority to removing loose water and high weight before low weight and solid flooding. Damage control personnel should also be aware of the fact that removal of flooding water from one side of the vessel is of great benefit in correcting off-center weight. But, this may be disastrous to a damaged vessel with negative GM and symmetrical flooding. Always calculate the overall effects of any removal of weight from the vessel

JETTISONING BILL

The jettisoning of topside weights involves time, seamanship, and a probable loss of mission capability. A jettisoning bill should establish the following:

1. A sequence that begins with the more easily removed and less vital weights. The bill should specify the approximate gain in stability from removing each of the weights involved in order to give responsible officers some idea of the relative importance and results to be attained.

2. A plan of action and responsibility. In order to be totally effective, jettisoning must remove tons of weight from high levels. The problem of shifting and removing topside weights, cargo, or ballast is of large magnitude. It will take many hours of back-breaking work to remove significant weight and maintain seaworthiness. Speed is enhanced by a plan of action that outlines the responsibility for removals, the organization of the jettisoning teams, and preparation of the tools and methods.

FLOODING EFFECT BILL

The LT has two ballast tanks aft that make it subject to off-center flooding in the fully loaded condition due to collision or grounding. The Damage Stability Report indicates that flooding of the largest ballast tank will create a list when the vessel is in the fully loaded condition. While Coast Guard stability criteria is still met in this condition, it would not be safe to counter flood to remove the list because the additional weight will severely impact stability. The only practical means available is to put a fuel tank on the opposite side of the rupture in service, or transfer fuel from tanks on the damaged side, to tanks on the high side. In this situation, it is of value to calculate free surface effect (i/V), and compare these values to the liquid loading diagram. Vessels can prepare a flooding effect bill that consists of a tabulation of all the compartment numbers in the vessel with the value of free surface effect entered for each compartment. The calculations are of great value in predicting what the effects of flooding would be. This is provided so that those who use them understand that good judgment and common sense are usually better than any number that can be computed.

CREW TRAINING AND INDOCTRINATION

All crewmembers should be educated in the general effects of waterline or underwater damage. Since a single hit may wipe out an entire damage control team, the vessel may have to depend on personnel not assigned to damage control teams to confine flooding and fire, and to perform other emergency functions. Ships have been lost because crewmembers escaping from damaged areas left doors and hatches open, which permitted rapid spread of water and fire. The importance of keeping hatches and doors closed should be impressed on all crewmembers. These simple efforts are important to confine flooding and other damage.

MATERIAL PREPARATIONS

Material preparations vital in toughening the vessel to resist flooding include:

1. Maintaining the watertight integrity of the vessel's subdivisions

2. Classifying closures and fittings

3. Setting material conditions of closure

4. Providing of adequate operable damage control equipment

ADVERSE OVERLOADING EFFECTS

Operating at an excessively heavy displacement produces the following detrimental effects:

1. Reduced Speed. Increased displacement increases hull resistance and decreases propeller efficiency.

2. Reduced Cruising range. Increase displacement reduces cruising range by increasing the power required for a given speed.

3. Reduced Stability. Carrying excessive loads high in the vessel reduces stability.

4. Reduced Strength. Overloading increases the stresses imposed on the vessel. Extreme overloading, coupled with heavy weather, may lead to structural distress or failure.

5. Reduced Freeboard. Increased displacement reduces freeboard. Reduced freeboard decreases reserve buoyancy and the range of stability.

LIQUID LOADING

The Stability and Load Data Booklet contains the following conditions of loading for the vessel:

1. Light ship condition. This is not an operating condition. It consists of the weight of the vessel complete, ready for service in every respect, including permanent ballast (solid and liquid), and liquids in machinery at operating levels, but without any items of consumable or variable load.

2. Full-load departure condition. In this condition, the vessel is fully loaded for its primary mission at its point of departure.

3. Full-load arrival condition. In this condition 40% of consumables have been expended.

LOADING CONDITIONS

Detailed loading instructions are shown in the Stability and Load Data Booklet for the operating conditions. The following are considerations that affect loading conditions not specifically outlined in the Stability and Load Data Booklet. Each has a potential effect on stability, and thought must be given to each.

LIMITING DECK LOADS

Addition of topside weight reduces stability. Deck loads in excess of the normal loading of the vessel tend to impair the ability of the vessel to absorb damage. Weigh the added risk before permitting these limiting deck loads to be exceeded.

SELF INFLICTED DAMAGE

To afford access and provide for operating the vessel, watertight boundaries of above water compartments are pierced by openings such as doors, hatches, and scuttles. Maximum reserve buoyancy can be realized only when all openings are properly and tightly closed. Reserve buoyancy can be impaired by the crew's actions as well as by accidents or battle damage. The following actions will lessen the watertight integrity of the vessel:

1. Poor maintenance of watertight boundaries, closures, and fittings within the vessel

2. Failure to properly close fittings such as doors and hatches

ADDITIONAL TOPSIDE WEIGHT

Emergency topside loading of the vessel, taking aboard large numbers of survivors, or the icing-up of rigging and the superstructure will impair overall stability because of the consequent rise in the center of gravity as well as loss of freeboard. This will reduce the vessel's seaworthiness and ability to withstand damage. Decisions to carry emergency deck cargo must be made with full understanding of the dangers involved, and the increased hazard to the vessel in the event of damage. Location and magnitude of additional weights can be used to calculate the decrease in stability resulting from a deck load. It is possible that the vessel may be called upon to pick up large numbers of survivors. The resulting additional topside weight can be a matter of grave concern, particularly if the survivors all come topside and go to one side of the vessel simultaneously. Topside structure and rigging ices up in frigid weather, most heavily within 100 miles of the coast. The resulting reduction in stability makes it necessary to maintain the vessel in the most favorably ballasted condition. On the LT, icing is combated using hot water as well as mauls and axes. The weight increase high in the vessel will cause an appreciable rise in the center of gravity. If the icing is severe, the vessel may have negative initial stability and may roll or capsize.

STATUS BOARDS

Some vessels post a liquid loading diagram that shows the status of fuel and water tanks. Vessels have used photocopies of the subdivision diagram. Each day the Chief Engineer marks up a new copy so that levels are current. The value of having such a record available shows which compartments contained liquids before damage. It also provides a chart on which to mark up information during a flooding casualty. Liquid levels should be taken at least twice a day during 24 hour operation.

MEASURES TO SAFEGUARD STABILITY

The following measures are in place to ensure stability of the LT.

STANDARDS

The LT meets a single compartment standard in conformance with U. S. Coast Guard rules (other than the engine room).

STABILITY CONDITIONS

The draft and stability characteristics for maximum and minimum operating conditions are contained in the Stability and Load Data Booklet

WEIGHT AND MOMENT COMPENSATION

Any increase in the weight of the vessel must be avoided since the single compartment standard must be preserved. Compensation by weight removal is required before weight is added. The weight removal can be made from any level, provided trim adjustments are possible.

LIQUID LOADING INSTRUCTION

Adjustments for trim should be made using the stern diesel fuel tanks first.

WATERTIGHT INTEGRITY

The maintenance of watertight integrity is essential to developing full resistance to underwater damage. It is essential to maintain the watertight bulkheads and watertight doors.

PROCEDURE AFTER DAMAGE

1. Establish flooding boundaries as close to the area of damage as possible.

2. Dewater any flooded spaces above the main deck where the boundaries can be made sufficiently tight. The first action should be to drain off any flooding water that may have entered the boatswain's storeroom or crew berthing if they can be made sufficiently watertight.

3. Size up the situation before taking further action. There is every expectation of survival after any single compartment (other than the engine room) has been flooded, so long as the limiting drafts were not exceeded prior to damage. After damage, the principal danger is not the loss of stability, but the loss of reserve buoyancy. Under any condition of damage in which the vessel remains afloat, there is little danger of experiencing a negative metacentric height. The principal task is to regain additional buoyancy by halting the ingress of floodwater and removing excess weight.

4. Eliminate or reduce list. Since the ballast tanks are not cross-connected, the vessel will probably develop a list if one of the tanks is damaged. After the spaces above the main deck have been dewatered to the maximum extent possible, drain any low spaces that are partially full. This procedure may be applied to diesel fuel as well as any water that may have entered the lower spaces. If any spaces below the main deck are completely full, they are usually best left alone until all other dewatering operations have been carried out. Attention may now be turned to further reduction of list.

Since any list after damage will most likely be due to the shifting of weight rather than a negative metacentric height, there are several methods available for reducing list on the LT. These are indicated below in the approximate order of desirability for the LT. In general, any method that involves reduction of displacement should be favored over one that increases displacement, particularly if structural damage is severe or if bad weather is prevailing at the time. The purpose of this procedure is to apply a movement in the opposite direction to the unsymmetrical load of equal or smaller magnitude by:

1. Emptying a tank on the low side into the sea.

2. Shifting liquids from the low side to the high side.
3. Jettisoning topside weights on the low side.
4. Shifting solid weights (cargo) from the low side to the high side.

CAUTION

Avoid shifting weight to a substantially higher level or flooding spaces above the main deck. Excess weight high in the vessel causes a rise in the center of gravity and subsequent degradation of stability.

It is not always necessary to entirely eliminate list. In some cases, total elimination of list may be possible only by resorting to filling tanks on the high side. The consequent increase in displacement would probably offset any advantage gained from bringing the vessel upright. If the vessel is manageable, any additional list correction should be undertaken only after due thought has been given to the problem. Aboard a damaged vessel, it is better to reduce displacement.

MINIMUM ACCEPTABLE STABILITY

In order to resist the effects of damage, it is essential that the vertical height of the vessel's center of gravity (KG) be kept below a certain value. Calculations indicate that this value is reached when carrying maximum consumables, and the seawater ballast tanks are empty.

LIMITING DRAFT

Operating at displacements over the limiting value is detrimental to the safety and performance of the vessel. A limiting draft of 17.0 feet (5.2 meters) above the bottom of keel amidships (1,070 tons of displacement) has been assigned to the LT. The major factors responsible for the assignment of the above limit are based on the calculated reserve buoyancy and damaged stability requirements. Exceeding the draft limitations perpetuates a hazardous condition that may limit recoverability. The primary cause of exceeding the draft limitations is overloading.

DANGERS OF OVERLOADING

Overloading has adverse effects on the survival power and safety of the vessel by reducing reserve buoyancy and floodable length. If the drafts exceed the limiting values before damage occurs, one compartment flooding would probably result in flooding water coming over the main deck. Overloading reduces structural strength. Longitudinal strength is ample for all approved conditions of loading. Uniform loading of diesel oil and ballast throughout the length of the vessel will result in decreased bending moments and stresses in the hull and decks. Extreme overloading may raise stresses to a point where structural cracks or even failures will occur, especially in heavy weather. If the limiting displacement is exceeded, the reserve of strength available to withstand the effects of damage is reduced. If excess cargo is carried high in the vessel, the rise in center of gravity reduces the metacentric height, righting arms, range of stability, and dynamic stability.

Overloading also reduces speed. Increased resistance at large displacements cuts down the speed obtainable from a given horsepower. During overloading, substantial increases in horsepower are required to maintain an economical cruising speed as compared to a non-overloaded condition. Overloading shortens the cruising radius because of the increased fuel consumption for a given mileage. Finally, overloading reduces dryness by increasing the vessel’s draft. An increased draft reduces the freeboard to the weather deck. This gives a wetter and less efficient vessel in rough weather. The possibility of superstructure damage and damage from heavy water coming on board during an overloaded condition is a real possibility.

STABILITY AND LOAD DATA BOOKLET

The Stability and Load Data Booklet contains guidance on loading, tank usage, securing of weather tight closures, and stability calculations used to establish the stability of the vessel to realistic and satisfactory accuracy. This booklet is normally maintained and used by the vessel master.

CURVE OF RIGHTING LEVERS

Refer to the Stability Calculations for the curve of righting levers for various vessel load conditions.

STANDARD CONDITIONS OF LOADING

Refer to the Stability and Load Data Booklet for conditions of loading information and calculations.

END OF WORK PACKAGE

Chapter 6

Fire
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) INTRODUCTION

INTRODUCTION

Fire is a constant potential hazard aboard the vessel. All possible preventive measures must be taken to prevent fires from starting. If a fire does start, it must be immediately reported to the bridge, and then it must be rapidly extinguished. Often a fire will start in conjunction with other damage. The damage can be caused by a storm, an accident, or faulty equipment. A fire can cause more damage than the initial casualty if it is not immediately extinguished. In fact, a fire could cause the loss of the vessel even after the original damage has been repaired or minimized. It is important to know how to identify the different classes of fires, how to extinguish them, and how to use and maintain the fighting systems and equipment. The more you learn, the better able you will be to contribute to the safety of the vessel.

Most fires escalate from small points of ignition. Welding slag can ignite cable insulation or other material. An electrical switchboard fault can cause a fire anytime. Fire and explosions can result from battle damage. Whatever the cause, if proper actions are taken immediately, most fires can be quickly extinguished. Smoke, toxic fumes, and heat created by fire can incapacitate personnel, damage equipment, and reduce visibility. The byproducts of fire can also severely hamper firefighting efforts. This work package outlines the effects of various fire hazards, prescribes the equipment and systems recommended to combat fire types, and presents an outline from which to create firefighting procedures and training to combat fires aboard the vessel.

CHEMISTRY AND PHYSICS OF FIRE

COMPONENTS OF FIRE

The three basic components that are required for any fire to continue burning are fuel, heat, and oxygen. If any one of these components are removed, the fire will go out. The components of fire form what is known as the “fire triangle” (figure 1). Removal of any one side of the triangle causes the fire to go out. If you remove either the fuel, heat, or oxygen, the fire will go out. This gives the knowledgeable firefighter a choice as to what can be done to confront a specific type of fire. The type of firefighting agent that the firefighter has at hand determines which component he is going to remove. Fires aboard vessels are categorized into four classes. The classes are determined by the general types of fuel involved. It should be kept in mind that most fires will involve a variety of combustibles and may be a combination of class types.

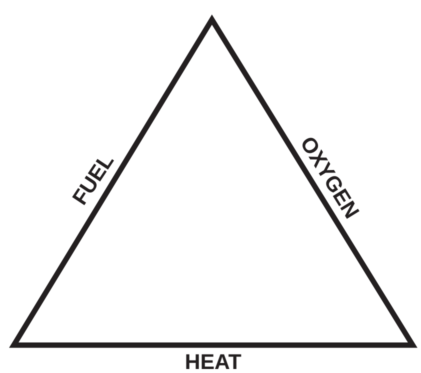


Figure 1. Fire Triangle

COMBUSTION

Another name for fire is combustion. Combustion is a rapid chemical reaction that releases energy in the form of light and heat. Most combustion involves rapid oxidation. Oxidation is the chemical reaction by which oxygen combines chemically with the elements of the burning substance. Even when oxidation proceeds slowly, such as a piece of iron rusting, a small amount of heat is generated. But, this heat usually dissipates before there is any noticeable rise in the temperature of the rusting material. With certain types of materials, slow oxidation can turn into fast oxidation if heat is not dissipated. This is known as “spontaneous combustion”, and it results in fire. Materials identified as subject to spontaneous combustion are normally stored in a confined space away from other materials where the heat can be dissipated at a rapid rate. Materials like oil soaked rags, vegetable fats, and solvents are subject to spontaneous combustion.

HEAT

For a combustible fuel or substance to catch on fire, it must have an ignition source, and it must be hot enough to burn. The lowest temperature at which a flammable substance gives off vapors that will burn is known as the flash point. The temperature at which a fuel will continue to burn after it has been ignited is known as the fire point. The fire point is usually a few degrees higher than the flash point. The ‘auto-ignition’ or ‘self-ignition point’ is the lowest temperature to which a substance must be heated to give off vapors that will burn without the application of a spark or flame.

The auto-ignition point is the temperature at which spontaneous combustion occurs. The auto-ignition point is usually at a much higher temperature than the fire point. The range between the smallest and the largest amounts of vapor in a given quantity of air that will burn or explode when ignited is called the flammable range or explosive range. For example, let’s say that a substance has a flammable range of from 1% to 12%. This means that either fire or explosion can occur if the atmosphere contains more than 1% but less than 12% of the vapor of this substance. In general, the percentages referred to in connection with flammable or explosive ranges are percentages by volume.

FUEL

Fuels take on a wide variety of characteristics. A fuel may be a solid, liquid, or even a vapor. Some fuels are heated by electrical current as it passes through wires. Some of the fuels you will come into contact with are rags, paper, wood, oil, insulation, paint, solvents, and magnesium metals. Any item that can burn is a potential fuel source for a fire. It is the fuel of the fire that determines the class of fire.

OXYGEN

The oxygen side of the fire triangle refers to the oxygen content of the surrounding air. Ordinarily, a minimum concentration of 15% is needed to support flaming combustion. However, smoldering combustion can take place in an atmosphere with as little as 3% oxygen. Air normally contains about 21%. A general rule of thumb to remember is if you can breathe, there is enough oxygen to support a fire. If a fire suddenly goes out, it may have suffocated from oxygen starvation. There may still be enough heat and fuel present to ignite the fire if the oxygen content is increased. This is why it is so important to secure ventilation during a fire aboard the vessel.

CLASSES OF FIRE

Remember that fires are classified according to the nature of the combustibles that fuel the fire. Proper classification of a fire is important because it determines the manner in which the fire must be extinguished. Fires are classified as being either class ALPHA, class BRAVO, class CHARLIE, or class DELTA fires.

Class ALPHA (A) fires are those that occur in such ordinary combustible materials as wood, cloth, paper, upholstery, and similar materials. These materials are solid combustibles such as cable insulation, clothing, paper, plastics, upholstery, wool, rags, or bedding. Class A fires are usually extinguished with water, using high or low velocity fog or solid streams. Class A fires leave embers or ashes and must always be overhauled.

Class BRAVO (B) fires are those that occur in the vapor air mixture over the surface of flammable liquids such as gasoline, diesel fuel, paints, solvents, hydraulic oil, lubricating oil, cooking fat, and greases. Aqueous film-forming foam (AFFF), FM-200, or dry chemical powder are the best agents used to extinguish class B fires. The agent used will depend upon the circumstances of the fire. This class of fire can occur when leaks in pressurized piping spray oil on hot surfaces, or from malfunctioning electrical components within the oil systems. A fire in the deep fat fryer results from the overheating of cooking oil and the subsequent ignition of the fat.

Class CHARLIE (C) fires are those that occur in electrical equipment. Nonconducting extinguishing agents, such as chemical powder and FM-200 are used to extinguish class C fires. Class C fires are fires in energized electrical equipment. These fires have occurred due to shorts, arcing or sparks associated with loose connections, deteriorated wiring, oil soaked wiring, and negligence in maintenance of electrical equipment. When the affected equipment is completely deenergized, the fire becomes either Class A or Class B. If dry chemical powder is used, it leaves a residue that is difficult to remove.

Class DELTA (D) fires occur in combustible metals such as magnesium, titanium, and sodium. Special techniques have been developed to control this type of fire, but these methods are not always practical. If possible, immediately jettison the burning material overboard. Most class D fires are fought by applying large amounts of water to the burning material to cool it. The fire is stopped when the heat side of the fire triangle is removed. A magnesium fire can be smothered by covering the material with a large volume of dry sand. Magnesium is used in signaling devices such flares. As a combustible, it burns with a dazzling white flame of very high temperature, and it can quickly burn through a steel deck and work its way into areas that are very inaccessible. Water sprayed directly onto a magnesium fire may actually add oxygen and hydrogen to the fire, because the fire's extreme temperature causes the water to breakdown chemically.

PRODUCTS OF COMBUSTION

The products of combustion are fire gases, flame, heat, and smoke. These products have a variety of physiological effects on humans, the most important being burns and the toxic effects, that result from the inhalation of heated fire gases.

FIRE GASES

The term "fire gases" refers to gaseous products of combustion. Most combustible materials contain carbon, which produces dangerous carbon monoxide when the air supply is poor. Unless the fuel and air are premixed, the air supply in the combustion zone is usually poor. When materials burn, numerous other gases are formed, such as hydrogen sulfide, sulfur dioxide, ammonia, hydrogen cyanide, phosgene, hydrocarbons, and hydrogen chloride. Gases formed by a fire depend on many variables, principally the chemical composition of the burning material, the amount of oxygen available for combustion, and the temperature. Several variables determine whether the gaseous products of combustion will have a toxic effect on an individual, including concentration of gases in the air, the time of exposure, type of activity, and the physical condition of the individual. The toxic effects on persons inhaling fire gases are greater during a fire because the rate of respiration is increased by exertion, heat, and an excess of carbon dioxide. The primary cause of loss of life in fire deaths is inhalation of heated, toxic, and oxygen deficient fire gases. Examples of these are:

Carbon monoxide is not the most toxic of fire gases, but is always one of the most abundant. In a confined smoldering fire, the percentage of carbon monoxide (figure 2) is usually greater than in a well ventilated, brightly burning fire.

Ammonia is formed when acrylic plastic or phenolic and melamine resins are burned. Exposure to 0.25% to 0.65% ammonia gas for one-half hour can cause death.

Hydrogen cyanide is highly toxic and is formed when urethane, nylon, or melamine are burned. Breathing a concentration of 0.3% is fatal. It can also be absorbed through the skin, causing the same results. The characteristic bitter almond odor sometimes warns of hydrogen cyanide presence.

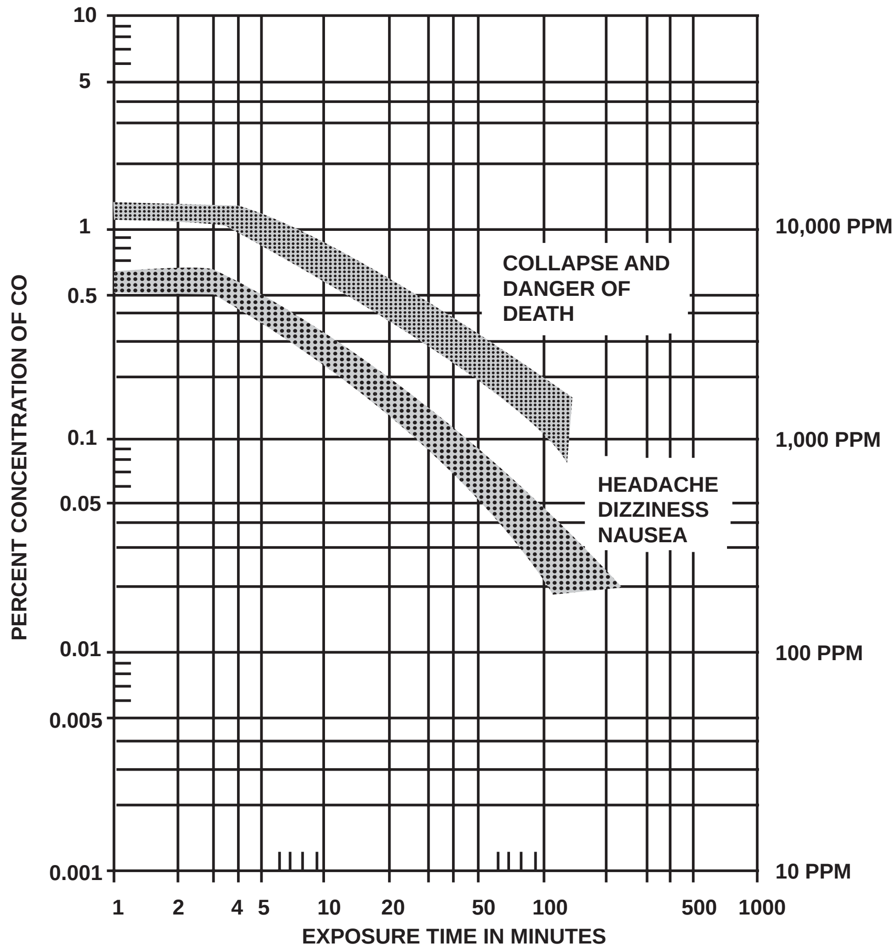


Figure 2. Graph of Hazards Because of Exposure to CO

Hydrogen chloride is a fire gas produced during the combustion of chlorine-based plastics such as Polyvinyl Chloride (PVC) electrical cable insulation. It is absorbed in smoke and, when breathed, desorbed as hydrochloric acid deep in the lungs. It can cause death due to lung edema.

Phosgene gas is highly toxic and is produced when PVC, refrigerant, or other chlorinated compounds are involved in a fire.

FLAME

The burning of materials in the presence of a normal oxygen-rich atmosphere is generally accompanied by flame. For this reason, flame is considered a distinct product of combustion. Burns can be caused by direct contact with flames or heat radiated from flames. It is rarely separated from the burning materials by an appreciable distance. In certain types of smoldering fires without evidence of a flame, heat, smoke, and gas can develop. Air currents can carry these elements far in advance of the fire.

HEAT

Heat is the combustion product most responsible for the spread of fire. It poses dangers that range from minor injury to death. Exposure to heated air can cause heat exhaustion, dehydration, blockage of the respiratory tract and burns. Exposure to temperatures above 130 ºF (54.4 ºC) without respiratory protection is extremely hazardous. One or two breaths of moisture-saturated air at such temperatures can cause serious respiratory system damage.

SMOKE

Smoke is matter consisting of very fine solid particles and condensed vapor. These combustion products usually evolve from the combustible with sufficient velocity to carry with them droplets of flammable tars, which appear as smoke. Smoke provides the warning of fire and simultaneously contributes to the fear of those in the smoke by the nature of its blinding and irritating effects. Smoke causes eyes to water, which impairs vision and also causes irritation to the respiratory tract and uncontrollable coughing.

ASH

Ash is the residue of burned materials. It can contain any chemical that results from the burning of basic fuel such as hydrogen chloride and carbon fibers. It may also contain residue from fire extinguishing agents such as dry chemicals.

FIRE HAZARDS OF MATERIALS

Several materials than can support a fire are briefly discussed here.

CABLE INSULATION

Most cable insulation contains a large quantity of Polyvinyl Chloride (PVC), which will sustain combustion at 680 ºF (360 ºC) when decomposed in a fire. PVC will liberate hydrogen chloride and hydrogen cyanide gases when heated to about 390 ºF (198.9 ºC). These gases interfere with vision, cause intense respiratory irritation, and may cause death due to lung edema 12 to 36 hours later. The best way to extinguish this type of fire is to bring water to bear in the form of water fog. In the interim, the dry chemical extinguisher is effective against this type of fire. If power to the affected cables is completely deenergized, this type of fire is considered a Class A fire. However, bear in mind that electrical insulation and components are plastics. When heated, these plastics can become liquid, and may display Class B characteristics.

DIESEL FUEL

Diesel fuel has a flash point of 140 ºF (60 ºC) and an autoignition temperature of 400 ºF (204.4 ºC). When ignited, it will produce a heavy black smoke. The fire should be attacked using dry chemical extinguishers. Low-velocity water fog should be available when setting the reflash watch.

HYDRAULIC OIL

Hydraulic oil has a flash point of about 400 ºF (204.4 ºC) and an autoignition temperature of over 650 ºF (343.3 ºC). If hydraulic oil at 3,000 PSI (206.8 bar) is atomized from a leak in a pipe, it will readily burn if exposed to an ignition source. Laboratory tests indicate that the oil mist fire will continue to burn even if the ignition source is removed when the oil is at the normal operating temperature of 110 ºF (43.3 ºC) to 130 ºF (54.4 ºC). A hydraulic oil fire can ignite surrounding combustibles, such as cable insulation, and produce intense heat once its ignition temperature has been reached. Such a fire will cause a pressure increase in a sealed compartment. Hydraulic oil spray/mist fires should be attacked with dry chemical fire extinguishers. If the fire is an oil mist, the extinguisher should be aimed at the base of the fire until the fire is extinguished. This will interrupt the fuel flow to the fire. If the fire cannot be extinguished by dry chemical extinguishers, water should be brought to bear. Dry chemical extinguishers do not cool a fire, therefore, reflash can be expected. Low velocity water fog should be available when setting the reflash watch.

OIL MIST

If an oil leak mist accumulates before an ignition source is introduced, later ignition can result in an explosion. It is important to secure and/or depressurize the source of the leak as soon as possible and avoid actions that could cause an arc, sparking, or open flame before the mist is dispersed.

VEGETABLE OIL

The vegetable oil used in cooking has a smoke point of 420 ºF (215.6 ºC), a flash point at about 440 ºF (226.7 ºC), and an autoignition temperature of about 600 ºF (315.6 ºC) when fresh. The respective temperatures are much lower if the cooking oil has been used. Dry chemical fire extinguishers should be used to fight this fire, applying the chemical in short bursts of about three seconds. The range exhaust hood damper should be closed immediately. As soon as a fire hose with a low velocity fog applicator is charged, apply water fog simultaneously with a three second extinguisher discharge if the fire is still burning. Repeat the procedure if the oil reignites. Low velocity fog should be maintained available for the reflash watch.

GASOLINE

Fires involving gasoline can be extinguished only by smothering. The flammable vapors that continue to evolve from these fuels at ordinary temperatures can easily be reignited, causing the fire to begin all over again. Dry chemical agents provide a more permanent smothering effect and should be utilized to avoid reignition. Since water does not mix with these fuels, nor stop the evolution of flammable vapors, water alone usually causes flammable fuel fires to spread dangerously.

PAPER PRODUCTS

Paper products constitute one of the larger fire loads on the vessel. The best way to fight this type of fire is good housekeeping. Keeping the vessel clean of excess paper refuse reduces the potential for a large fire. Paper products are a common class A material. They burn rapidly, and at high temperatures. If a paper fire does occur, water is the preferred extinguishing agent, but use whatever method is available. A dry chemical extinguisher will put out the fire, but it does not cool the material, and reflash is likely. If the fire starts in a trash can, use dry chemical to extinguish the flames, then cover the can with a metal lid to prevent reflash.

BASICS OF FIGHTING FIRE

While firefighting techniques cannot be set forth in any chronological pattern, the following basic rules apply to nearly all situations. Detailed firefighting instructions are outlined in FM 55-502:

1. The first and most important action is to pass the word and sound the alarm. All crewmembers must be alerted to the potential danger of fire. All stations should man the phones to the most practical extent possible. Communication is vital to survival and fighting the fire.

2. Isolate the fire. Close all doors, hatches, and vents, and secure blowers. All flammable liquid system piping in the affected area should be isolated if feasible.

3. Shut down electrical circuits in the compartment where the fire is located and in adjacent spaces to be sprayed or flooded.

4. Bring required firefighting equipment to the scene.

5. Lead out two hoses from different plugs, when practical, to the area of the fire; rig one hose with an applicator, and charge both hoses.

6. Station a crewmember with an OBA, gloves, and head lamp, to control the nozzle for each of the two separate hoses.

7. Station a backup crewmember with electrically safe rubber gloves and head lamp, either to relieve the crewmember on the nozzle, or to perform rescues.

8. Set fire boundaries in surrounding compartments and topside by rigging extra hoses to cool decks, overheads, and bulkheads, and by removing combustible materials. Consider using the countermeasure washdown system to remove heat from the hull.

9. Have a team prepare the P-100 portable pump. The P-100 can be used to supply firefighting water if needed. It can also be rigged to dewater a space when the fire is out.

10. Consider stationing crewmembers at the arms room sprinkler controls.

11. Combat the fire from the best position possible to protect personnel. Approach a topside fire from windward, if possible. Consideration should also be given to approaching the fire from the bottom, if possible.

12. In compartments fully involved with fire, the firefighter should reduce the heat and flame before entering by liberal application of water fog through doors and air ports into upper areas of the compartment. In such a fire, the greater part of the water fog so applied will turn to steam. Steam smothers fire and reduces heat. The firefighter should stand clear of openings since there may be a violent outward rush of hot gases and air.

13. In determining the number of hose lines to be used, the firefighter should be guided by the extent and intensity of the fire. The vessel's pumping capacity is not unlimited, and every gallon of water released reduces stability and freeboard. The all-purpose nozzle permits the firefighter to use water fog and still have a solid stream available when needed. A solid stream with the all-purpose nozzle at 100 PSI (6.9 bar) will discharge 250 gal/min (946.3 L/min), while high-velocity fog will discharge only 117 gal/min (442.9 L/min). Every gallon of water put on a fire must be removed to preserve ship stability.

14. It may be impossible to approach a fire in a normal manner due to heat intensity or a blocked hatch. In such a case, it may become necessary to cut an access hole large enough to insert an equipment nozzle in order to apply an extinguishing agent.

15. Send out investigators to check surrounding areas. Inspection and reporting must continue until the fire is out and the danger is over.

16. Keep the phone talker as close to the scene as possible.

17. Make continuous progress reports to the pilothouse. These shall include:

    a. Location of fire

    b. Class of fire

    c. Electrical power secured

    d. Fire boundaries set (location)

    e. Fire under control

    f. Fire out

    g. Reflash watch set

    h. First oxygen and explosive tests

    i. Fire overhauled

    j. Second oxygen and explosive tests

    k. Compartment desmoked

    l. Third oxygen and explosive tests

    m. Compartment safe to enter

n. Electrical circuits and ventilation systems tested

o. Amount of damage done

p. Electrical power restored or isolated

CLEARING SMOKE

WARNING

Crewmembers without OBAs must not enter a compartment prior to the compartment being tested as safe to enter. Serious personal injury to crewmembers could result.

As smoke is secondary in nature to fire, the primary objective must be to extinguish the fire and then remove the fumes. Smoke will be present in a fire, so breathing protection must be worn. Visibility will be reduced, so know the vessel. A fire that occurs above the weather decks will not limit the crew's visibility, mobility, or breathing ability as easily as a fire that occurs below decks. Fires that occur above the weather decks can be fought from the windward side. Doors and portholes can provide access to some interior spaces.

Problems encountered by firefighters in the below deck spaces are more difficult to overcome. Accessibility to the fire may be limited, so it is possible the fire may be attacked from a single direction. Smoke and fumes will be present in the space. This impairs vision, and limits the number of crew that can actually attack the fire due to availability of protective equipment. The primary objective must be to extinguish the fire. Generally, there are no effective means for combating smoke or fumes during the progress of an interior fire.

Do not ventilate until the fire is completely out. Ventilation should not be attempted to improve visibility. All ventilating system closures are secured in the area where a fire exists. Ventilation ducts that remain open to a compartment where there is a fire can quite easily cause the fire and fumes to spread to other areas of the vessel. Keep in mind that even opening an access to the compartment for entry can cause a draft that can feed a fire. Ventilation closures are provided to prevent the spread of fire to other parts of the vessel. Use them.

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) FIREFIGHTING EQUIPMENT

FIREFIGHTING BASICS

HEAT TRANSFER

Heat from fire is transferred by conduction, radiation, or convection. Conduction is the transfer of heat from one body to another by means of direct physical contact. For example, heat on a stove is conducted because the pot is in direct contact with the burner. Wood is ordinarily a poor conductor of heat, but metals easily conduct heat. Since most ships are constructed of metal, heat transfer by conduction is a potential hazard. Fire can move from one zone to another, one deck to another, and one compartment to another by means of conduction. In many cases, the application of water halts the transmission of heat by conduction. Fog is the most effective means of halting heat conduction. Fog patterns coat surfaces more efficiently than solid streams. Fog uses less water, so runoff is reduced, and vessel stability is easier to maintain.

Heat radiation is the transfer of heat from one source to another across space. No material substance is involved. Heat travels outward from fire in the same manner as light. When heat contacts a body, it is absorbed, reflected, or transmitted. Absorbed heat increases the temperature of the absorbing body. For example, radiant heat rises, and that heat is absorbed by the overhead. This increases the temperature of the overhead. Heat radiates in all directions unless it is blocked by an insulating barrier. Radiant heat extends fire by heating combustible substances in its path. The heat causes the substances to produce vapors, and the vapors can ignite. Radiant heat will raise the temperature of combustible materials near and around the fire. Fires spread as a result of heat radiating from bulkheads and decks. Intense radiated heat makes approaching a fire extremely difficult. Firefighters must wear protective clothing to shield against radiated heat.

Convection is the transfer of heat through the motion of circulating gases or liquids. Heat is transferred by convection through the motion of smoke, hot air, and heated gases produced by a fire. When heat is confined, convected heat moves in predictable patterns. The fire produces gases that are lighter than air. These gases rise toward high parts of the vessel. Heated air also rises. As these heated combustion products rise, cool air takes their place. The cool air heats up, then it rises to the highest point it can reach. This is a normal pattern for convected air. Convection action causes rapid heat up of air and gases in an enclosed compartment. Water sprayed in the form of high velocity fog effectively reduces heat transfer by means of convection.

Hot smoke and gases originating at a fire on a low deck will travel horizontally along passageways and then upward by way of ladder and hatch openings. Flammable materials are heated along the path the hot smoke and gases travel. To prevent the spread of fire, the heat, smoke, and gases should be released into the external atmosphere. The structural design of any vessel makes it difficult to cut openings through decks, bulkheads, or the hull for ventilation. It is imperative that the fire be confined to the smallest possible area. Doors and hatchways should be kept closed when they are not in use. If a fire is discovered, attempts should be made to close off all openings to the fire area until firefighting personnel and equipment can be brought into position to fight the fire.

COMPARTMENT FIRE DYNAMICS

A compartment fire normally experiences four different stages: growth, flashover, fully developed fire, and decay. In the growth or pre-flashover stage, the average space temperature is low, and the fire is localized in the vicinity of its origin. High local temperatures exist in and around the burning materials, and smoke from the fire forms a hot upper layer in the space. It is during the growth stage that rollover can occur. Rollover is the formation of a flame front of burning gases across the overhead of a confined space. Rollover takes place when unburned combustible gases from the fire mix with fresh air in the overhead and burn at some distance from the seat of the fire. Rollover differs from flashover in that only the gases are burning, not the flammable contents of the space.

Flashover is the period of transition from the growth stage to the fully developed fire stage. Flashover occurs in a short period of time, and may be considered as a separate event. It normally occurs when the upper smoke layer temperature reaches 1100 °F (600 °C), and the radiant heat flux at the deck reaches 20 kilowatts per square meter (kW/m^2). The most obvious characteristic of flashover is the sudden spread of flame to all remaining combustibles in the fire space. This effect can seem explosive to personnel in direct contact with the fire, and survival of personnel who have not escaped from the compartment is unlikely.

In a fully developed fire, all combustibles in the space have reached their ignition temperature, and they are burning. During this stage, the burning rate in the compartment is normally limited by the amount of oxygen available in the air for combustion. Flames may emerge from any opening. Unburnt fuel in the smoke may burn as it meets fresh air in adjacent compartments. Structural damage to exposed steel normally occurs as it is heated to extreme temperatures. A fully developed fire will normally be inaccessible by hose teams, and may require extinguishment by indirect attack. A compartment can reach the fully developed fire stage very quickly in a machinery space flammable liquid fire. Explosions from enemy weapon-induced fire typically produces this type of fire. Eventually, the fire consumes all available fuel, combustion slows down, and the fire will go out in the decay stage.

BACKDRAFT

If a fire self extinguishes because of a lack of oxygen, vapors formed from flammable liquids above their flashpoint may still be present in the compartment. If fresh air is introduced, and the vapor rich air is still above its ignition temperature, the three elements of the fire triangle are again present, and the mixture can ignite quite explosively. This phenomenon is known as backdraft and is an unusual occurrence.

FIRE SPREAD

If a fire is attacked early and efficiently, it can be confined to the area in which it started. If it is allowed to burn unchecked, it generates great amounts of heat that travel away from the fire area. Additional fires will ignite wherever fuel and oxygen are available. Steel bulkheads and decks and other fire barriers delay, but they do not prevent, heat transfer. When a compartment is fully involved in fire, fire quickly spreads to other compartments through openings such as doorways, vent ducts, and wire ways. It also spreads to adjacent compartments by heat conduction through the bulkheads. Fires normally spread faster vertically to the space above than to adjacent horizontal spaces. If fire is allowed to extend to grouped cables, a fire that feeds on electrical insulation and generates a toxic dense black smoke can occur.

THEORY OF EXTINGUISHMENT

A fire can be extinguished by removing the fuel, removing the oxygen, or removing the heat (cooling). Another method of extinguishment is flame inhibition. One way to remove the fuel from the fire is to physically drag it away. It is often possible to move nearby fuels away from the immediate vicinity of a fire so that the fire does not extend to these fuels. Sometimes the supply of liquid or gaseous fuel can be cut off from a fire. When a fire is being fed by a fuel line, it can be extinguished by closing the proper valve. A pump supplying liquid fuel to a fire can be shut down to remove the fuel source and extinguish the fire. Fire involving acetylene or propane can be extinguished by shutting the valve on the cylinder.

A fire can be extinguished by removing its oxygen source, or by reducing the oxygen level in the air to below 15 percent. Any fire can be stopped with a smothering action that deprives the fire of oxygen. For example, fire in a galley trash container can be snuffed out by placing a cover tightly over the container. This blocks the flow of air to the fire. As the fire consumes the oxygen in the container, it starves, and it goes out. Aqueous Film Forming Foam (AFFF) systems act by placing a thin film over flammable liquids. The film excludes oxygen, and it prevents the formation of flammable vapors. AFFF also cools the liquid surface to reduce vapor formation.

Water is the most effective means of removing heat from ordinary combustible materials such as wood, paper, and cardboard. The cooling action of water can ultimately stop the release of combustible vapors and gases associated with the burning of solid fuels. When fire is attacked with a hose line, one gallon (3.78 liters) of water can absorb approximately 10,000 BTUs (180 kW) of heat when the water is fully vaporized. When water vaporizes to steam, it expands approximately 1,700:1. This action greatly reduces heat in an enclosed space. Water delivered in the form of high velocity fog easily achieves this effect.

BREAKING THE COMBUSTION CHAIN REACTION

Flaming combustion occurs in a complex series of chemical chain reactions. Once the chain reaction sequence is broken, a fire can be extinguished rapidly. The extinguishing agents used to chemically attack the chain reaction and inhibit combustion are dry chemicals and FM-200. These chemical agents directly attack the molecular structure of compounds formed during the flame producing, chain reaction sequence. The breakdown of these compounds adversely affects the flame producing capability of the fire, and the attack is extremely rapid. It should be understood that these agents do not cool a fire or a flammable liquid heated above ignition temperature. The chemical extinguishing agent must be maintained on the fire until the fuel has cooled. A cooling medium such as water should be used to rapidly cool any flammable liquid. In the engine room, the FM-200 system employs a water washdown system that serves this purpose.

EXTINGUISHING AGENTS

The fire extinguishing agents available aboard the large tug (LT) are dry chemical, water, AFFF, and FM-200. Dry chemical, water, and AFFF are covered in detail in this work package. FM-200 is covered in detail in WP 0013 00. Most fires start small, and are usually discovered by the alert crew on the vessel. A small fire is easily extinguished if the appropriate method, type, and amount of extinguishing agents are readily available and promptly applied. Even a very minor fire has the potential to become major, so the crew must react as if every fire is a major one. The vessel is loaded with combustibles, and the ability to escape is limited. As soon as a fire is detected, it must be reported. Reporting the fire is crucial. It is the responsibility of the person discovering the fire to report it first, then take action to extinguish it.

DRY CHEMICAL

The purpose of the dry chemical extinguisher is to provide a ready means of placing an extinguishing agent on a fire. The dry chemical dispensed from portable extinguishers provides the fastest means for fighting any fire on the LT. Dry chemical extinguishers are designed to put out class A, class B, and class C fires. Dry chemical powders do not smother the fire or cool it. Instead, they inhibit the chemical reaction of the fire by suspending fine particles that temporarily interrupt the fire triangle. In effect, the chemical places a temporary screen between the heat, oxygen, and fuel, and maintains this screen long enough for the fire to be extinguished. The effect is temporary, because no heat or oxygen is removed. If the chemical settles and not enough time has passed for the heat to dissipate, reflash will occur. Reapplication of the dry chemical will continue to temporarily put out the fire, but water in the form of low velocity fog is best during reflash.

The dry chemical is carried in ten-pound portable extinguishers on board the LT. When fighting a surface fire, it is best to aim the discharge at the base of the flames and apply the chemical in a rapid side-to-side sweeping motion, while gradually progressing toward the base of the fire. The dry chemical discharge causes a clouding effect that reduces visibility and makes breathing difficult. Small class A and class B fires are quickly extinguished by dry chemical extinguishers, but unless the ignition source or fuel is removed, flash-back is experienced. Although it is the most effective hand held extinguisher in combating an oil spray fire, a backup fire hose with low velocity fog applicator should always be made available as quickly as possible. Dry chemical can be used simultaneously with water. The chemical will halt the fire, but water dissipates the chemical cloud. If not for the quick cooling action of the water, the fire would reflash.

Dry chemical is also effective on class C fires. In some cases, the panel does not even need to be completely open for the chemical to have an effect. The CO_2 propellant in the extinguisher will force the chemical powder into the smallest openings. Typically, dry chemical can be forced into almost any opening that smoke can come from. Sometimes opening a smoking panel can cause an instant blazing fire. As a general rule, attempt to secure power to any smoking panel before opening it. Once power is removed, it will be easier to cool the panel, and shock hazards are reduced.

The effective range of the extinguisher is from 13 to 22 feet (4 to 6.7 meters). Dry chemical is capable of covering large areas, but the residue left behind is difficult to remove. When combating a fire, a quick squeeze on the nozzle grip will give some assurance that the chemical is not caked and will knock down some of the smoke. If no chemical is expelled, quickly turn the extinguisher upside down, and strike the top against a solid surface. This will un-cake the powder. The dry chemical fire extinguisher should not be laid sideways when in use, because this will allow the gas propellant to be released without releasing any dry chemical. If two portable extinguishers are expended, and little or no progress is made in extinguishing the fire, use low velocity fog. Low velocity fog is superior to dry chemical in putting out all major fires, but using fog on a class C fire may present a shock hazard.

The following is a basic procedure for using a portable extinguisher:

1. The discoverer reports the fire, and the alarm is sounded.

2. Carry the extinguisher to the scene of the fire.

3. While in route to the fire, pull the locking pin (figure 1, item 1), and push down on the handle (figure 1, item 2) to charge the extinguisher.

4. If possible, approach the fire from the windward side. Hold the cylinder (figure 1, item 3) in one hand, and the nozzle (figure 1, item 4) in the other.

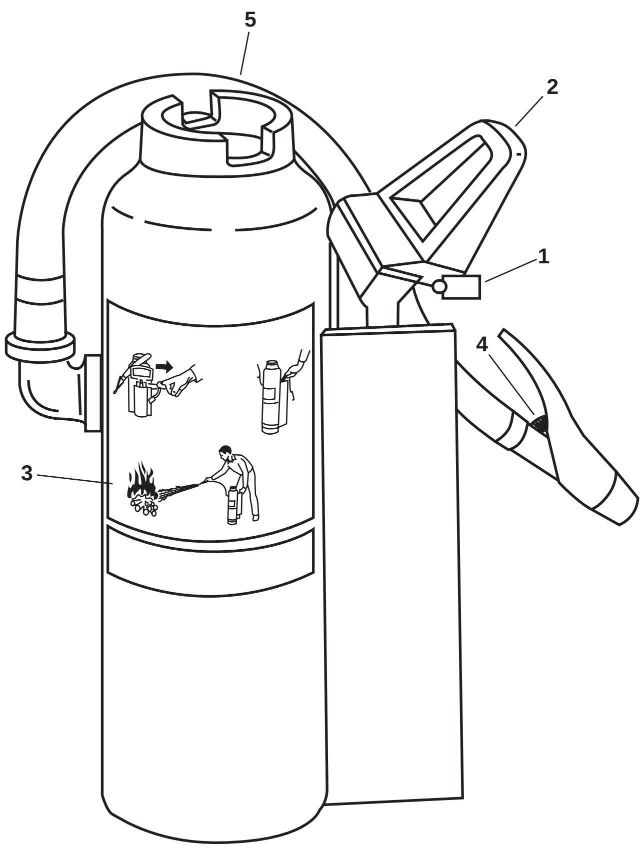


Figure 1. Portable Dry Chemical Extinguisher

5. Squeeze the grip on the nozzle firmly (figure 1, item 4), and direct the dry chemical at the base of the fire in a wide sweeping side-to-side motion. The extinguisher has a range of about 13 to 22 feet (4 to 6.7 meters).

6. Extinguish all of the flames in your area before moving in further. If the fire appears to be too large, or if there is a possibility of being surrounded by flames, wait for assistance before going any further.

7. Do not economize on the dry chemical. Use as much as needed to extinguish the fire. Remember that if two extinguishers do not put out the fire, use a fire hose.

8. Get a fire hose to the scene as soon as possible, and use it for the reflash watch.

9. After a dry chemical extinguisher has been used, invert the cylinder (figure 1, item 3), squeeze the dicharge lever, and tap the nozzle on the deck. This releases any chemical in the cylinder (figure 1, item 3), and any chemical in the hose (figure 1, item 5) and nozzle (figure 1, item 4). By inverting the cylinder, further discharge of the dry chemical is prevented. Dry chemical in the hose and nozzle will cake up and cause clogging.

WATER

The primary purpose of water during firefighting is to act as a cooling agent. While water does have a smothering effect on fire, the part of the fire triangle water attacks best is heat. Water lowers the temperature of the burning substance below its ignition temperature, and the sea provides an inexhaustible supply of water. If the temperature of a fire is lowered below the ignition temperature of the fuel, the fire will be extinguished. Water is most efficient when it absorbs enough heat to raise its temperature to 212 °F (100 °C). Water at this temperature boils, and boiling water absorbs even more heat when it changes to steam. This results in lowering the temperature of the hot surface area of the burning material.

This is why water in the form of low velocity fog is most effective at fighting fires onboard the vessel. Fog is less dense, and it absorbs heat more easily. The surface area of water fog is greater than solid stream, and this is why fog reduces heat so efficiently. Tests have shown that the all purpose nozzle with the low velocity fog applicator is the best tool for putting out fires. Fog also provides cooling protection to the firefighters, and it uses less water than other means. Fog is best for producing steam, and it is the steam that has the smothering effect on fire. Refer to WP 0006 00 for additional information on the various water delivery methods.

AQUEOUS FILM FORMING FOAM (AFFF)

Aboard the LT, AFFF can be expended from the fire monitors and from portable 5 gallon AFFF canisters. The primary purpose of AFFF is to rapidly extinguish class B fires. AFFF is highly effective at smothering large class B fires involving oil, gasoline, and jet fuels. AFFF is known as “lightwater,” and is a synthetic, film-forming foam that can float on the surface of fuel and oil. The AFFF proportioning equipment generates a white foam blanket. The film prevents evaporation and reignition of combustion once the fire is extinguished by the foam. This unique action of AFFF stems from the ability of the film to float on liquids that are lighter than water (hence the nickname “lightwater”). AFFF also has a self-healing capability, in that scars in the film layer caused by other firefighting activities rapidly reseal themselves.

Petroleum liquids like fuels and oils float on top of water, and fires involving these liquids are difficult to extinguish with water because hydrocarbon fuels float on water. As AFFF exits the nozzle or applicator, the mixture spontaneously forms the foam. It is the foam blanket coating of liquid that actually puts out the fire. The foam blanket then acts as a thermal and evaporation barrier that inhibits reflash of the fire. The "film-forming" characteristic refers to the aqueous layer formed from the foam mixture that continues to float on the surface of the flammable liquid even after the foam has dissipated. Even liquids not ignited are protected by this action.

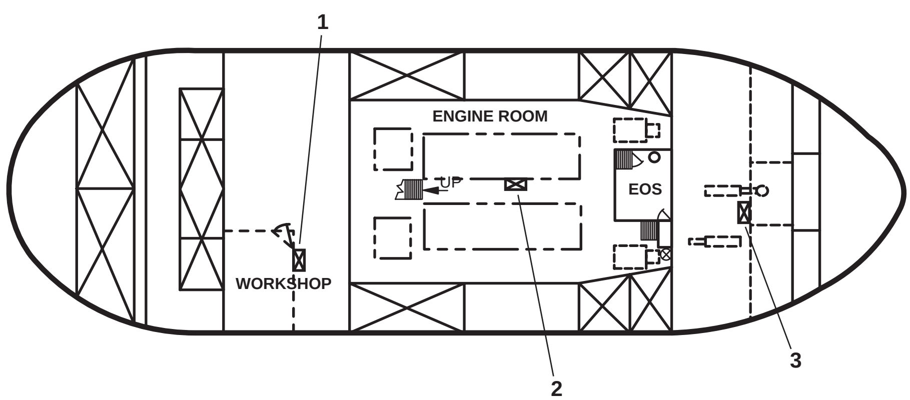
AFFF can also be used to extinguish class A fires. But as it is no more beneficial than water, it is not recommended for use on class A fires. The use of AFFF requires additional equipment, and the LT is fitted with a tank, a pump, a proportioner, and piping specifically for this purpose. AFFF is stored in its own reservoir on the vessel in concentrate form, and it is pumped through a proportioner into the fire main at the rate of 6 parts foam concentrate to 94 parts raw water. This means that the 525-gallon reservoir aboard the LT is capable of producing 13,334 gallons of AFFF. One or more monitors shooting AFFF will expend the ready service reservoir in just less than nine minutes.

FIRE STATIONS

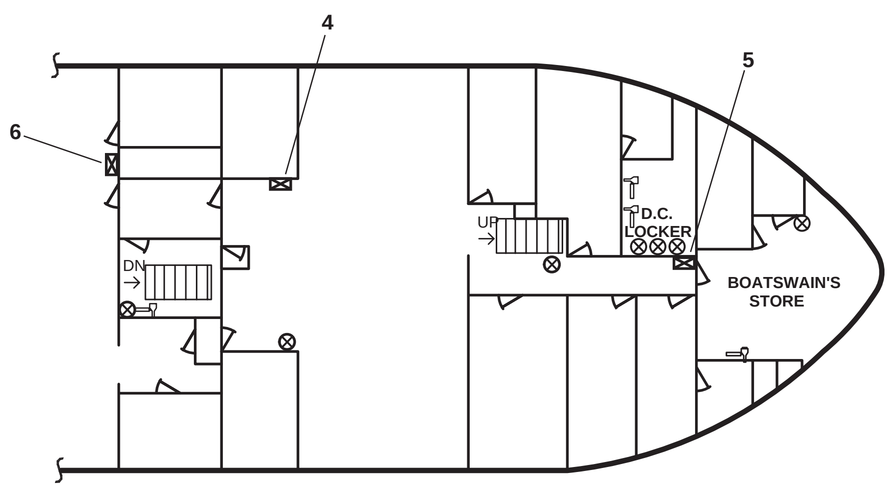
The purpose of the fire stations is to make pressurized fire fighting water available to multiple locations on the vessel. The fire stations are capable of shooting 70 gallons (265 liters) of water per minute (in a solid stream) about 75 feet (23 meters) when pressurized to 100 PSI (6.9 bar). There are 11 fire stations located throughout the vessel. Each is provided with 50 feet (5.2 meters) of 1-1/2 inch diameter high pressure fire hose, a spanner wrench, and an all purpose nozzle. The fire stations are located as follows:

INTERNAL FIRE STATIONS:

Number		Location
1	(figure 2, item 1)	AMS-2, Starboard side aft of steering hydraulic station, Frame 14
2	(figure 2, item 2)	Engine Room, Amidships between main engines, Frame 32
3	(figure 2, item 3)	AMS-1, Forward bulkhead between auxiliary engines, Frame 54
4	(figure 2, item 6)	Main Deck, Weather, Port side below stack, Frame 21
5	(figure 2, item 4)	Main Deck, Crew's Mess, Frame 28
6	(figure 2, item 5)	Main Deck, Amidships outside damage control center, Frame 53



BELOW MAIN DECK

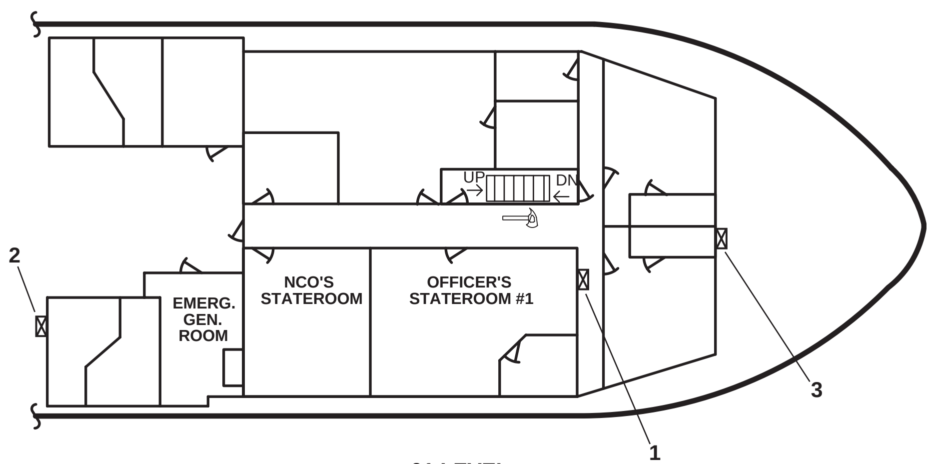


MAIN DECK

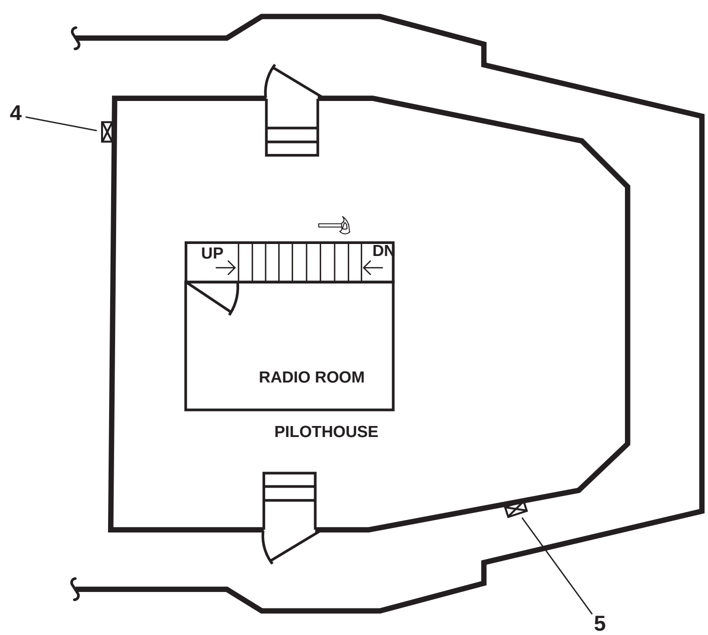
Figure 2. Main Deck and Below Main Deck Fire Station Locations

EXTERNAL FIRE STATIONS:

Number		Location
7	(figure 3, item 2)	01 Level, Weather, STBD side aft of stack, Frame 24
8	(figure 3, item 1)	01 Level, Starboard side aft of Captain's Cabin, Frame 45
9	(figure 3, item 3)	01 Level, Weather, STBD, Frame 54 (removed when underway)
10	(figure 3, item 4)	02 Level, Weather, Port side aft of pilothouse, Frame 37
11	(figure 3, item 5)	02 Level, Weather, STBD side, Frame 50



01 LEVEL



02 LEVEL

Figure 3. Pilothouse and 01 Level Fire Station Locations

FIREFIGHTER'S ENSEMBLE

The LT is equipped with seven sets of special protective clothing called the Firefighter's Ensemble. Each ensemble is equipped with special coveralls (figure 4, item 1), an antiflash hood, a helmet (figure 4, item 2), gloves (figure 4, item 3), and boots (figure 4, item 4). The purpose of the ensemble is to protect the firefighter from short duration flame exposure, heat, and falling debris. The safety of the firefighter depends on proper wearing of the ensemble. All hose teams must practice donning and removing the ensemble. The firefighter's ensemble is not a proximity suit. Prolonged contact with flames will cause the protective clothing to transmit dangerous heat to the body, or may cause the clothing itself to burn, which could result in serious injury or death to the firefighter.

The coverall (figure 4, item 1) is a one piece jumpsuit style, and consists of an outer shell, a vapor barrier, and an inner fire-retardant liner. The knees, bottoms of the thigh pockets, and bottoms of the legs are reinforced with leather for extra protection. Reflective marking strips around the upper arms, the lower legs, and the torso highlight the outline of the firefighter so that he or she can be seen in dense smoke or dim light. The antiflash hood provides radiant heat protection to areas of the head, neck, and face (except the eyes). The hood is designed to be worn with the Oxygen Breathing Apparatus (OBA). The helmet is designed to protect the head from flame exposure, heat, and falling objects. The helmet (figure 4, item 2) shell material is heat resistant fiberglass. The helmet has a long rear brim, faceshield with a chin strap, adjustable suspension, reflective markings, and ear flaps that cover the side of the head and neck. Gloves (figure 4, item 3) are provided to protect against abrasion, short duration flame exposure, and heat. The gloves can be used to close hot valves in an emergency. The gloves are made of leather and an aluminized fabric with a waterproof vapor barrier and a fire-retardant liner. The boots have steel safety toes and puncture-proof steel insoles. The boots (figure 4, item 3) also provide protection from hot or boiling water.

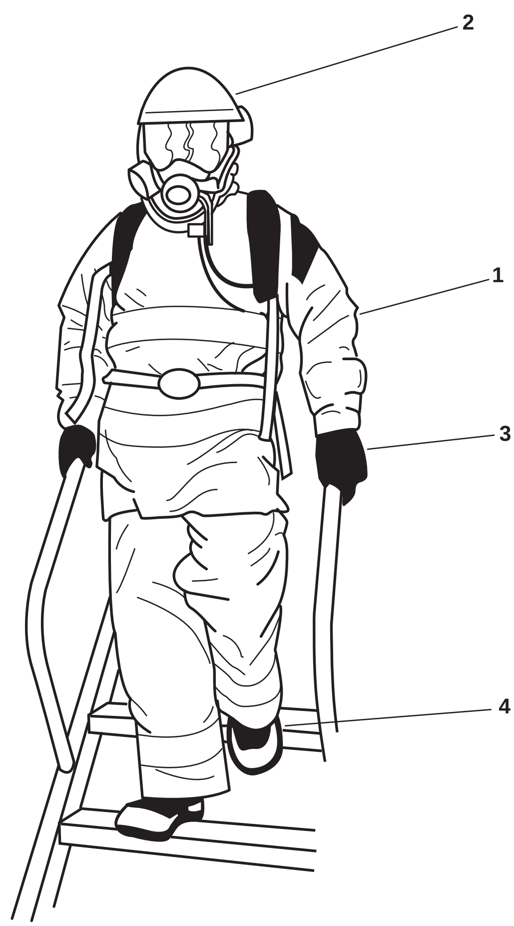


Figure 4. Firefighter's Ensemble

OXYGEN BREATHING APPARATUS (OBA)

Six Type A-4 OBAs are stored in the damage control locker, along with replacement canisters. The OBA is a completely self-contained breathing apparatus. It produces its own oxygen, and it enables the wearer to breathe independently of the outside atmosphere. Oxygen is produced from a high heat chemical reaction, and it allows the wearer to enter compartments, voids, or tanks that contain smoke, dust, fire, or those that have low oxygen content. Components of the A-4 OBA are as follows:

1. Facepiece (figure 5, item 1). The OBA facepiece contains the eyepiece, the speaking diaphragm, and the head straps. The eyepiece is a one piece clear lens. The speaking diaphragm enables the OBA to be used to talk to others and to use other communication devices such as sound powered telephones or microphones. The head straps hold the facepiece snug against the face. Properly adjusted straps are necessary to ensure an airtight seal against the face of the wearer.

2. Breathing Bag (figure 5, item 2) and Tubes (figure 5, item 3). The OBA has a breathing bag and two breathing tubes that control the flow of breathable and unbreathable air. The breathing bag contains the oxygen that is generated by the canister. One breathing tube transports the oxygen from the breathing bag to the facepiece. The other breathing tube transports the exhaled air back to the canister. The tubes are made out of corrugated rubber. They control the directional flow and temperature of the breathable air generated by the OBA. The tubes have quick disconnects, are sized differently, and are color coded. This prevents the possibility of incorrect connections.

3. Timer (figure 5, item 5). The timer is located at the top of the breastplate assembly. The bell of the timer is designed to ring for 8-10 seconds. When setting the timer, always remember to go fully clockwise then back to the desired time setting. The bell is not fully wound unless the timer was placed in the fully clockwise position.

4. Breastplate Assembly (figure 5, item 4). The breastplate assembly houses the plunger assembly (figure 5, item 6), the canister guard and holder (figure 5, item 7), and the handle (figure 5, item 8). The action of the handle causes the plunger to pierce the foil seal on the canister (figure 5, item 11), and it actuates the seating mechanism that properly positions the canister within the housing. The outside of the breastplate assembly is insulated to protect the wearer from heat generated the oxygen canister.

5. Combination Valve Assembly (figure 5, item 10). The combination valve assembly directs the flow of air through the canister to the breathing bag.

6. OBA Canister (figure 5, item 9). The OBA canister is painted green. The green canister is considered a working canister and is the only canister authorized aboard the vessel. The rubber gasket provides an airtight seal when the canister is in the operating position in the OBA. The copper foil seal (figure 5, item 11) protects the chemicals from moisture until the canister is ready for use. An installed chlorate candle (figure 5, item 12) produces oxygen for about 5 minutes, and is needed until normal oxygen generation becomes self-sustaining. The moisture and carbon dioxide from the exhaled breath activates the chemicals in the canister. The chemicals in the canister cleanse exhaled breath of moisture and carbon dioxide, and produce oxygenated air for breathing. The wearer's exertion determines how long the canister will produce oxygen. The more active the wearer is, the faster the chemicals will be expended. When involved in hard work, such as fighting a fire, the canister will last for about 30 minutes. The wearer should replace expended canisters only when in an uncontaminated compartment.

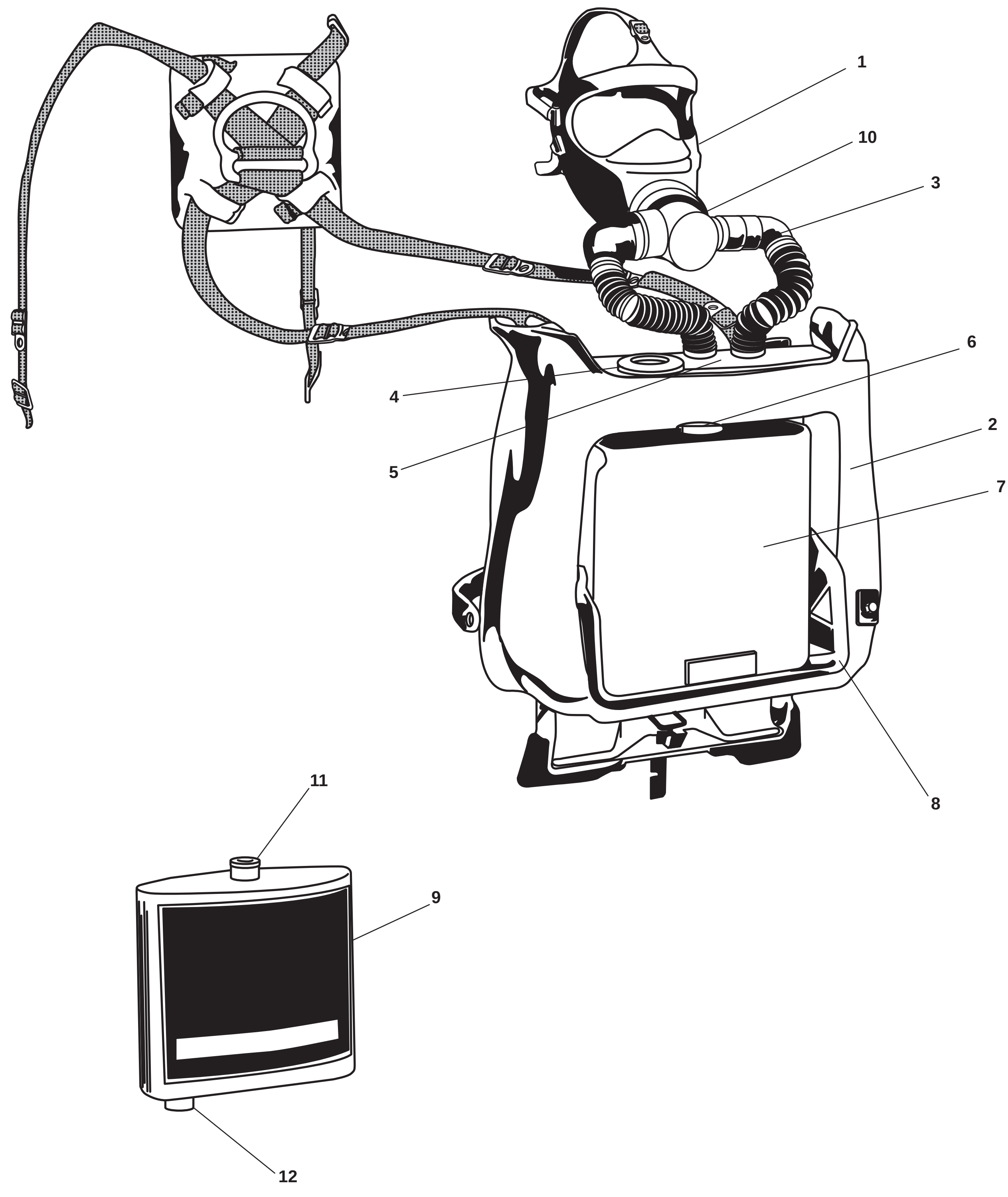


Figure 5. Type A-4 Oxygen Breathing Apparatus (OBA)

All crewmembers should know and understand the use of each component of the OBA. The arrows in figure 6 indicate the airflow path through the OBA. When the wearer exhales, moist breath passes through the exhalation tube (figure 6, item 1), into the valve housing to the bottom of the canister (figure 6, item 2). The moisture from the breath causes the chemical reaction to take place as the inhaled gasses are forced upward through the chemical. The carbon dioxide is absorbed, and the moisture present reacts with the chemical to give off oxygen.

Generated oxygen passes into the breathing bag (figure 6, item 3), through the inhalation tube (figure 6, item 4), and is drawn up into the facepiece (figure 6, item 5) by the normal breathing action. Direction of the air flow is determined by the check valves (figure 6, item 6) in the inhalation and exhalation passages. A pressure relief valve (figure 6, item 7) in the breathing bag allows the release of excess pressure. The pressure buildup is generally caused by the air expanding due to the heat caused by the oxygen canister.

Before the OBA is stowed, the facepiece should be protected to prevent scratches and abrasions. All OBA equipment and canisters must be stored in a cool, dry place. The service life of the OBA will be lengthened if it is stored in temperatures ranging from above freezing to 110°F (43°C), and out of direct sunlight. Condensation should not be in contact with a stored OBA. The OBA is normally stowed in its own container in the damage control locker. These lockers have provisions for correctly stowing the OBA in a ready service position. Ensure that the facepiece is properly protected to prevent scratching or scarring of the lens. The flash hood may be used to cover and protect the lens of the facepiece. Canisters should be stored with the concave side down.

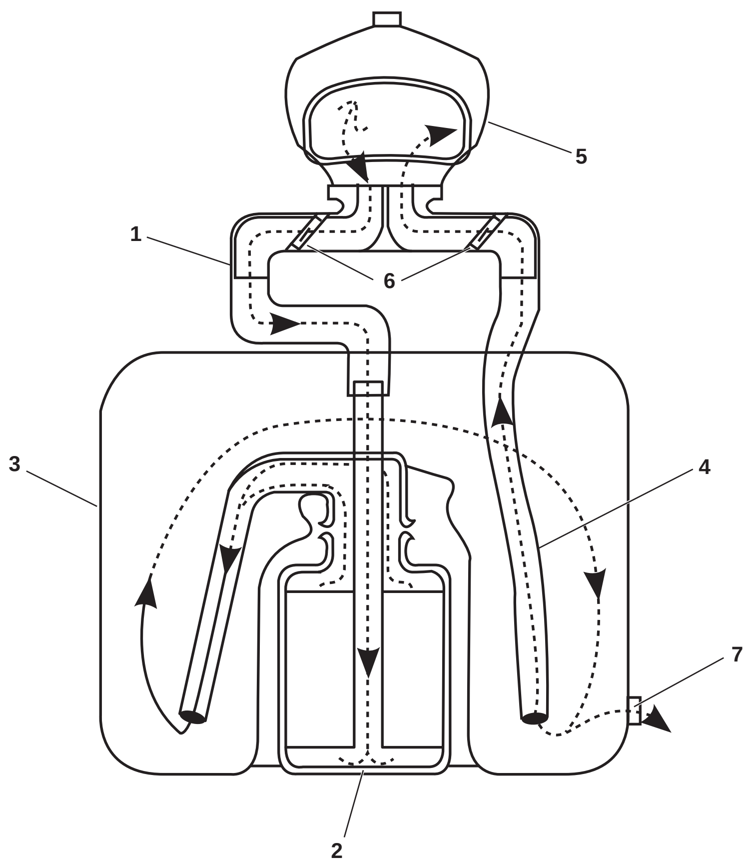


Figure 6. OBA Airflow

DISPOSAL OF USED CANISTERS

Dispose of expended OBA canisters as outlined in FM 55-501.

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR
INLAND AND COASTAL LARGE TUG (LT)
FIRE SUPPRESSION AND SPRINKLER SYSTEMS

FM-200 FIRE SUPPRESSION SYSTEM

SYSTEM DESCRIPTION

The purpose of the FM-200 Fire Suppression System is to provide fire protection to the engine room and AMS 1. The system is a manually actuated, stand-alone, total flooding fire suppression system, and is capable of extinguishing class A, class B, and class C fires. It consists of storage cylinders containing FM-200 extinguishing agent, control heads, discharge nozzles, and manual pull boxes. During actuation of the FM-200 Fire Suppression System, a 60-second delay in agent discharge will be experienced. During the 60-second delay, the horns will sound, strobes will flash (figure 1), the FM-200 alarm bell (figure 2) will sound, and discharge warning lights will be illuminated (figure 3). Actuation of the FM-200 system will result in automatic shutdown of the following equipment and systems:

1. SSDG 1 and 2
2. Bow Thruster Engine
3. Pump Drive Engine
4. Engine Room Supply Fan 1 and 2
5. Engine Room Exhaust Fan 1 and 2
6. AMS 1 Supply Fan
7. Fuel Oil Transfer Pumps

Upon actuation, the FM-200 system will automatically secure all powered ventilation systems and diesel engines except for the main engines and the EDG. Shutdown of the main propulsion engines is not necessary because they draw intake air from outside the protected space. Upon shutdown of the SSDGs, the EDG should start, and it will place itself on line within 45 seconds. If the automatic shutdown system fails, the powered ventilation systems can be secured from the Heating, Ventilation, and Air Conditioning (HVAC) emergency stop station located in the engine room vestibule on the main deck at frame 23. If necessary, secure the auxiliary diesel engines locally using their respective emergency stop switch.

Due to the nature of decomposition of fire suppressant chemicals, immediate evacuation of the engine room and AMS 1 must be accomplished when the FM-200 system is actuated. In order to assure limited exposure to dangerous gasses, the FM-200 System is equipped with a 60-second time delay. When the system is actuated remotely by the manual pulls, the warning horns sound, and beacons flash an immediate warning. This serves to inform personnel that the FM-200 system will actuate in 60 seconds. The interior manual pull box (figure 4) is located on the main deck in the engine room vestibule, and the exterior manual pull box (figure 5) is located on the main deck weather deck on the bulkhead foward of the towing machines.

The FM-200 system can also be actuated locally in AMS 2 at the FM-200 cylinders. If the situation is extreme, the 60-second time delay can be overridden locally. The override (figure 6, item 1) is located on top of the time delay cylinder in AMS 2. When the time delay override lever is pulled, the 60-second time delay is negated, and FM-200 will immediately discharge into the protected areas. This procedure should only be performed under extreme circumstances with the authority of the watch officer or scene commander. In this mode, FM-200 will be discharged immediately.

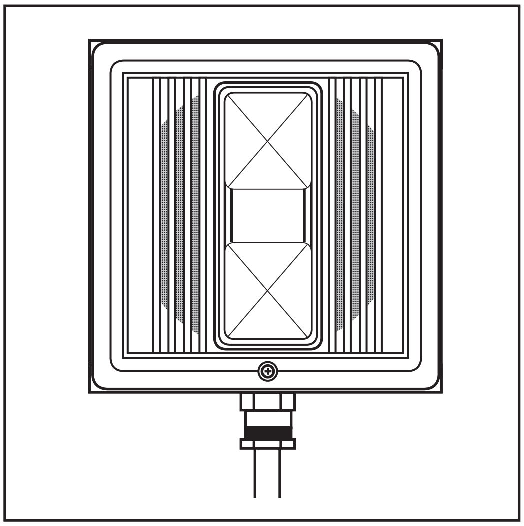


Figure 1. FM-200 Horn/Strobe

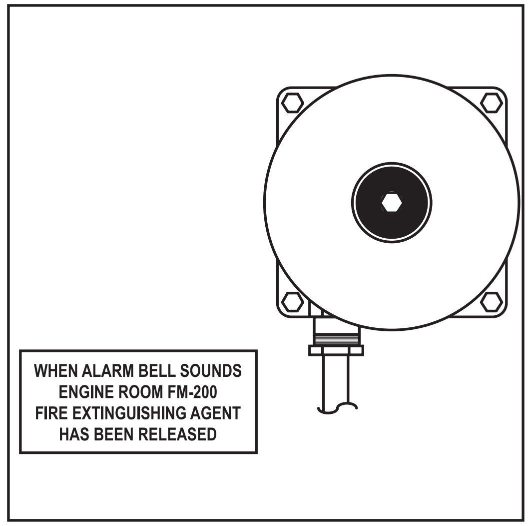


Figure 2. FM-200 Exterior Alarm Bell

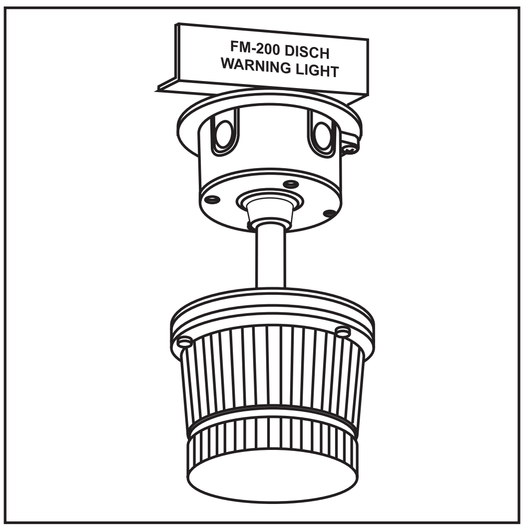


Figure 3. FM-200 Discharge Warning Light

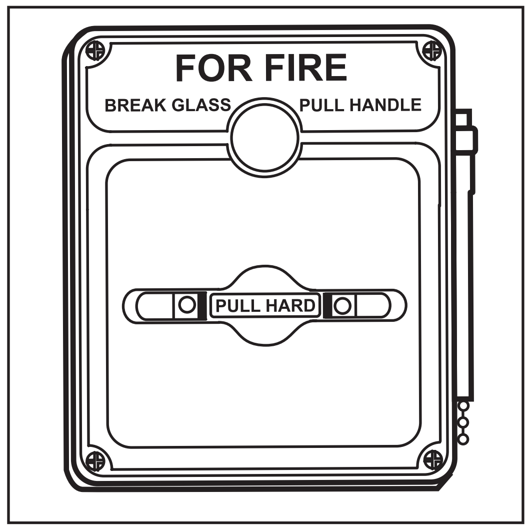


Figure 4. FM-200 Interior Manual Pull Box

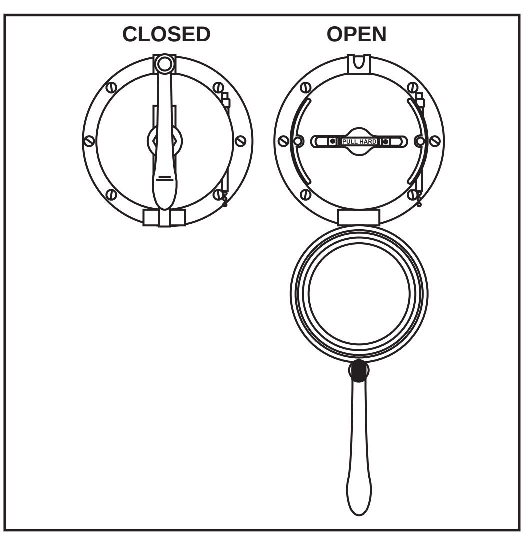


Figure 5. FM-200 Exterior Manual Pull Box

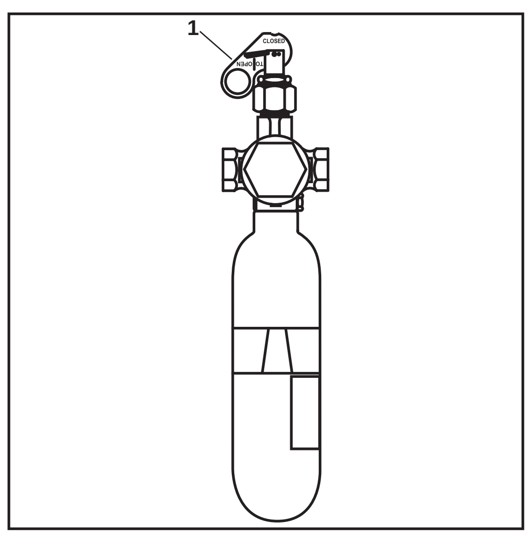


Figure 6. FM-200 60-Second Time Delay Override

FM-200 FIRE SUPPRESSION SYSTEM ACTUATION

The following steps must be accomplished prior to system actuation:

1. Evacuate all personnel from the engine room and AMS 1.

2. CLOSE the watertight doors between the engine room, AMS 1, and AMS 2 (TM 55-1925-273-10).

3. Align fire and general service pump 1 as the online fire pump (TM 55-1925-273-10).

CAUTION

> FM-17 and/or FM-15 supplies raw water to various shipboard systems including the refrigeration plant, the air conditioning plant, and the water maker. Failure to secure power to these systems prior to closing the valves will cause damage to the equipment.

4. CLOSE the following valves:

    a. FM-17, FIRE/G.S. PMP NO. 1 DISCH TO G.S. (figure 7, item 1).

    b. FM-15, FIRE/G.S. PMP NO. 2 DISCH TO G.S. (figure 7, item 2).

5. OPEN WWS-1 (figure 8, item 1), located in the main deck vestibule, starboard side, to activate the Engine Room Water Washdown System (ERWWS).

6. CLOSE the following:

    a. Port engine room supply fan intake damper (figure 9, item 1) located on the forward side of the port stack.

    b. Port engine room exhaust fan outlet damper (figure 9, item 2) located on the forward side of the port stack.

    c. STBD engine room supply fan intake damper (figure 10, item 1) located on the forward side of the starboard stack.

    d. STBD engine room exhaust fan outlet damper (figure 10, item 2) located on the forward side of the starboard stack.

    e. AMS 1 supply fan intake hinged cover (figure 11, item 1) located on the foredeck.

    f. AMS 1 exhaust hinged cover (figure 12, item 1) located on the foredeck.

    g. Engine room entrance door located in the main deck vestibule (figure 13, item 1).

    h. EOS emergency escape scuttle (figure 14, item 1) between EOS and the main deck passageway.

    i. AMS 1 emergency escape scuttle (figure 15, item 1) between AMS 1 and the damage control center.

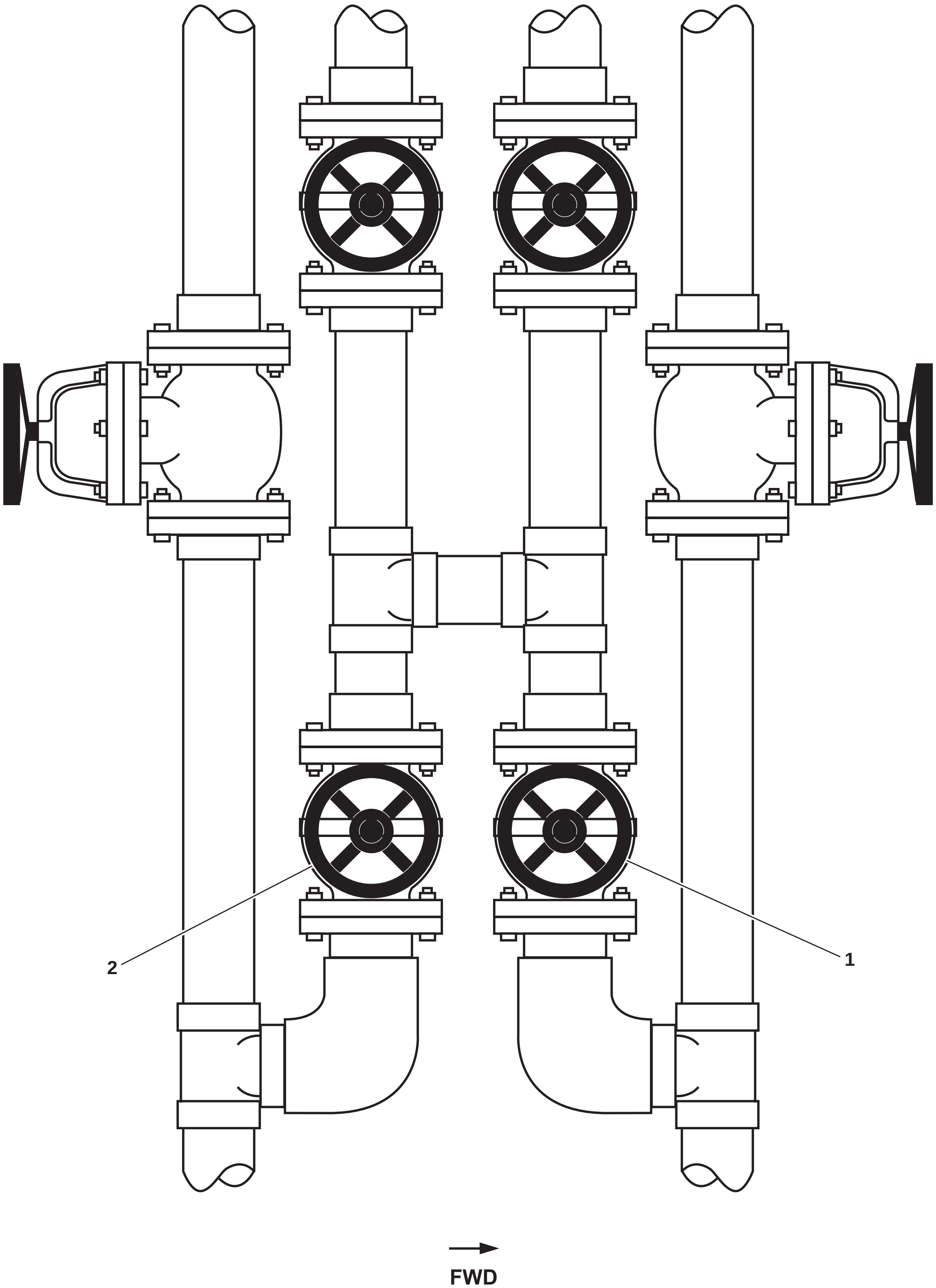


Figure 7. Fire and General Service Pump Valves

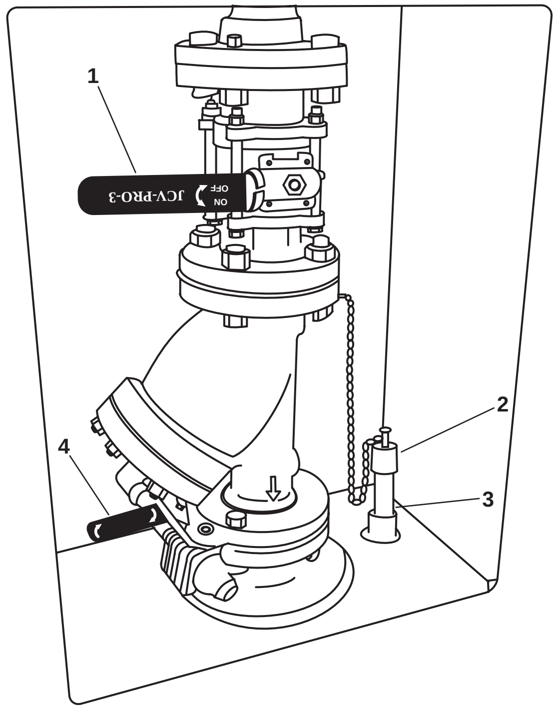


Figure 8. Engine Room Water Washdown Station

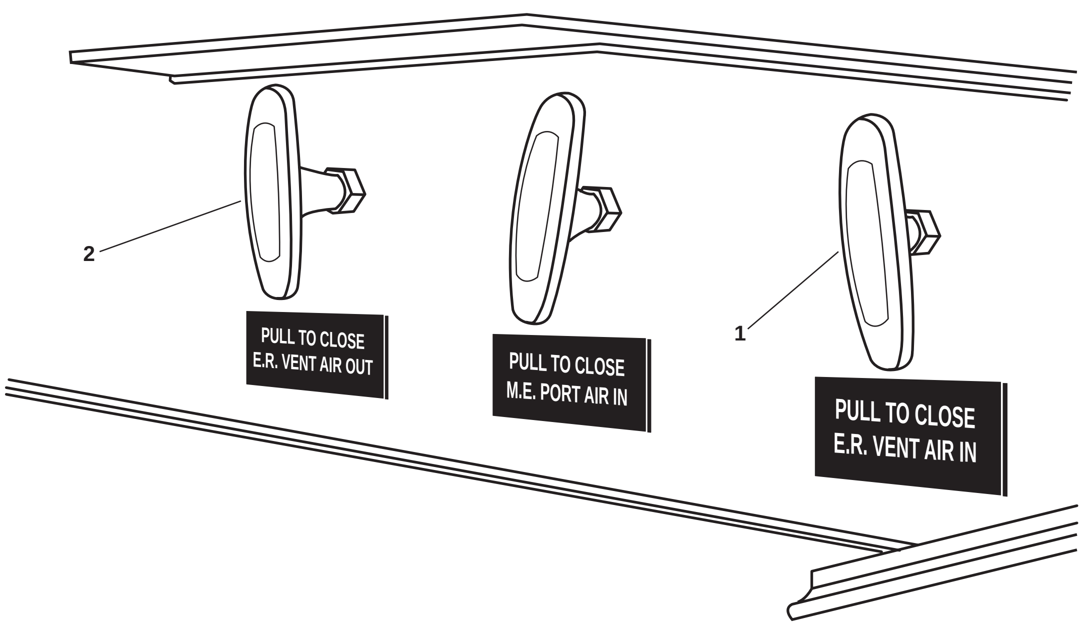


Figure 9. Port Engine Room Fire Flap Quick Release T Handles

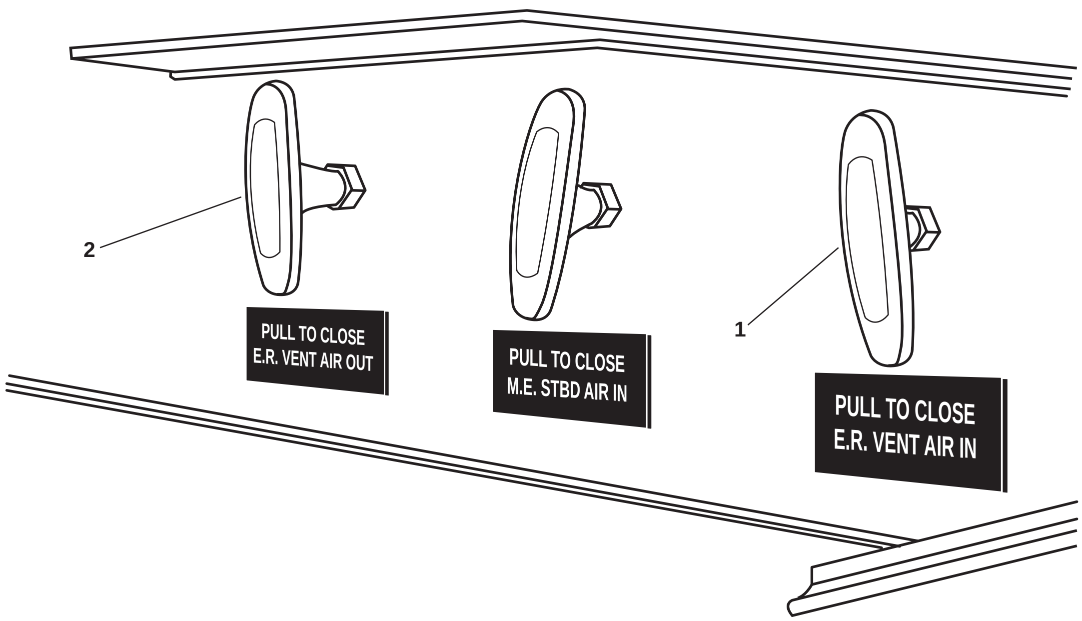


Figure 10. STBD Engine Room Fire Flap Quick Release T Handles

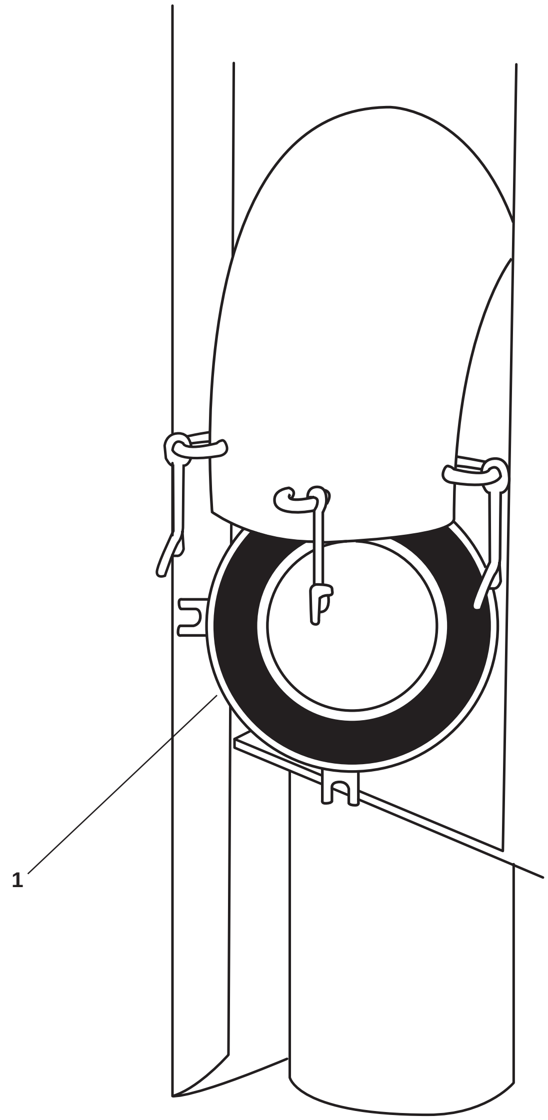


Figure 11. AMS 1 Supply Fan Intake Hinged Cover

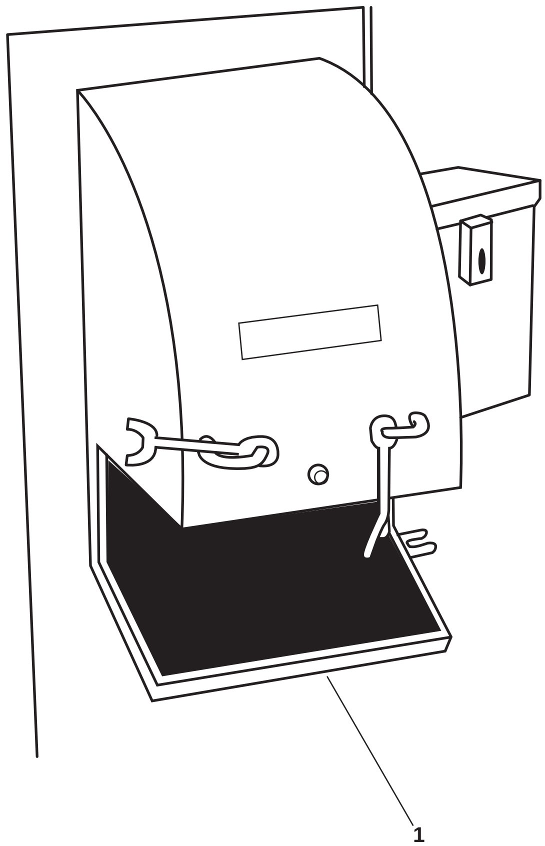


Figure 12. AMS 1 Exhaust Hinged Cover

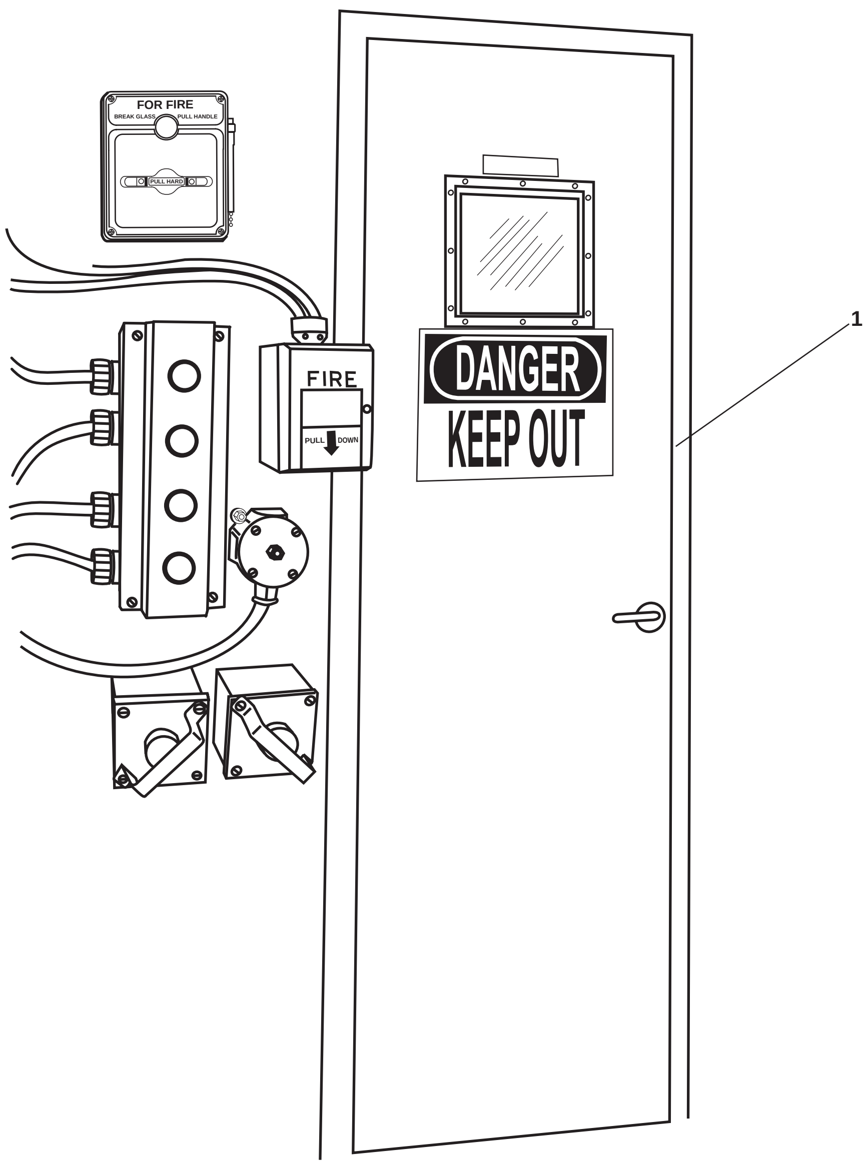


Figure 13. Engine Room Entrance Door

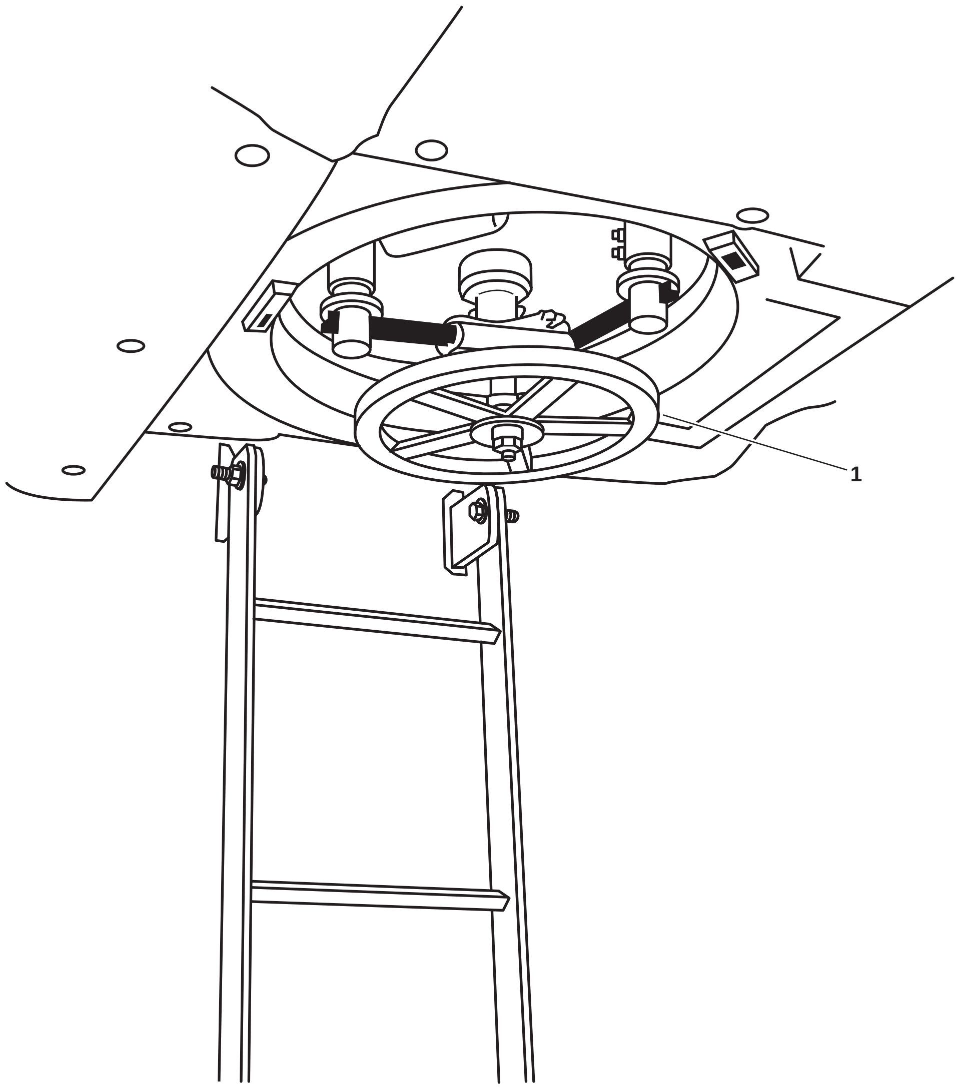


Figure 14. EOS Emergency Escape Scuttle

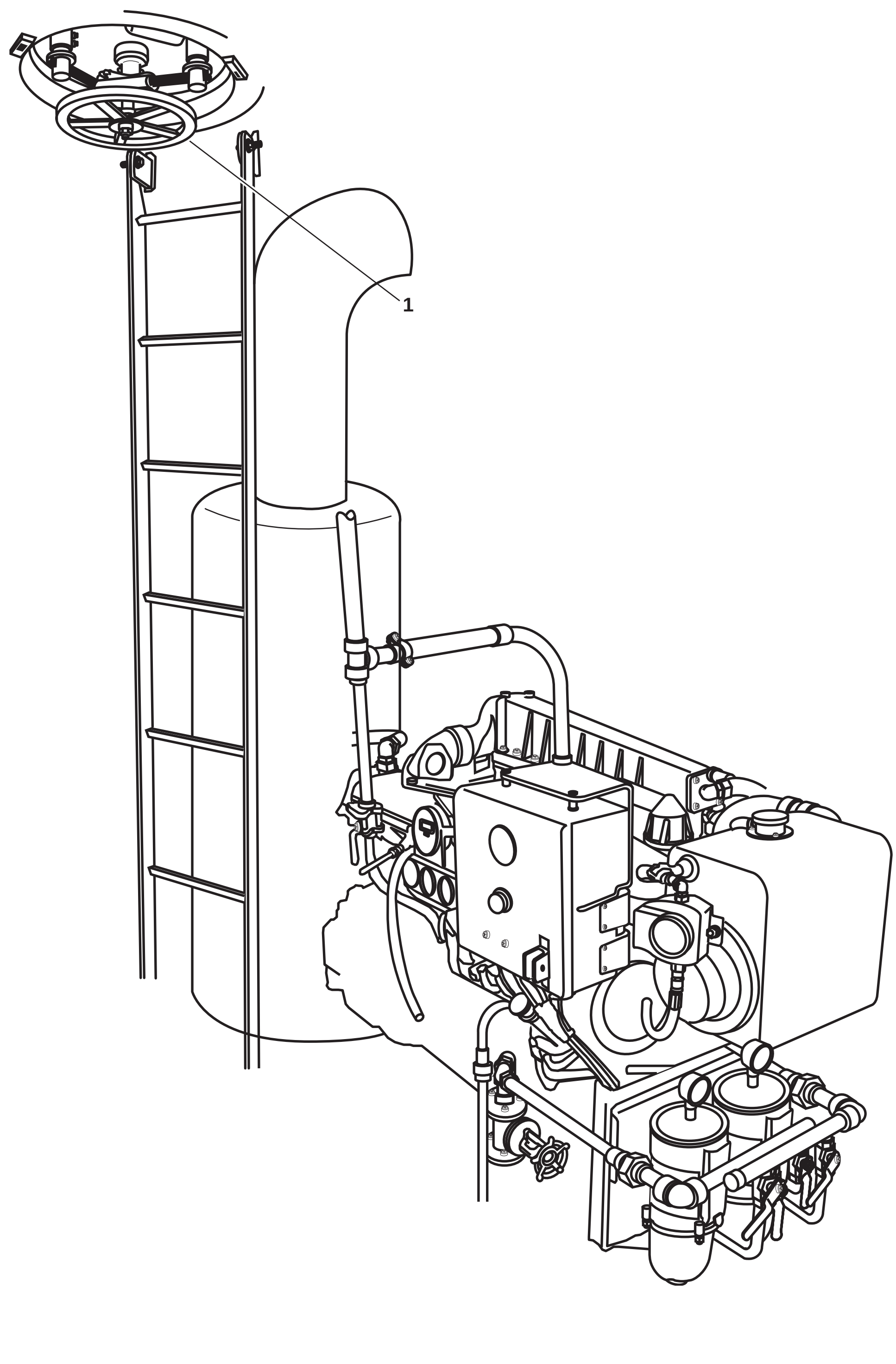


Figure 15. AMS1 Emergency Escape Scuttle

NOTE

The ERWWS will shut down once the FM-200 system has been activated. Restart fire and general service pump 1 remotely (pilothouse), once the emergency generator has come online.

7. Break the glass on one of the FM-200 manual pull boxes (figure 16 or 17, item 1). Pull boxes are found in the following locations:

   a. Engine room vestibule, main deck, 01 level, frame 23.

   b. Main deck, on the weather deck, starboard of the engine room vestibule entrance door, frame 21. This exterior watertight pull box requires opening the watertight cover to expose the glass.

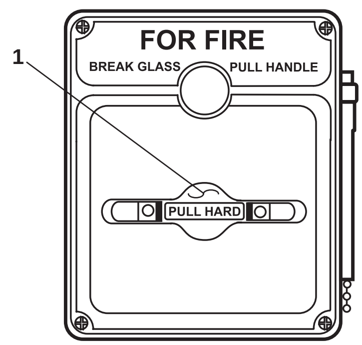


Figure16. Interior FM-200 Manual Pull Box

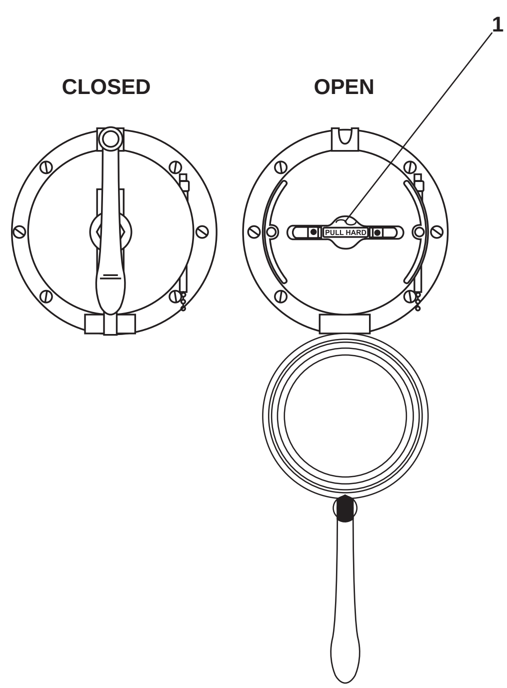


Figure 17. Exterior FM-200 Manual Pull Box

8. Pull the handle (figure 16 or 17, item 1) to actuate the FM-200 system. The handle is designed to require less than 40 pounds (18.14 kg) force and 14 inches (35.6 cm) of pull to operate. If the FM-200 system fails to actuate, proceed to the FM-200 cylinder location, AMS 2, frame 22, and follow the emergency discharge instructions posted at the FM-200 cylinder location and in WP 0006 00. Enter and evacuate AMS 2 using the emergency escape scuttle.

9. Verify that the emergency generator has come online and start fire and general service pump 1 at the remote start located in the pilothouse.

10. Wait a minimum of fifteen minutes after FM-200 system actuation before initiating reentry procedures. The water washdown system should be allowed to operate continuously during this time. Allow no one to enter the protected spaces until reentry procedures are complete and permission is granted to do so.

11. Actuation of the FM-200 fire suppression system will result in the automatic shutdown of the auxiliary engines and ventilation fan motors affecting the protected spaces. Verify that the following fans, engines, and pumps are shut down:

    a. Fan Motors:

        (1) Port engine room supply fan

        (2) Port engine room exhaust fan

        (3) Starboard engine room supply fan

        (4) Starboard engine room exhaust fan

        (5) AMS 1 supply fan

    b. Engines:

        (1) SSDG 1

        (2) SSDG 2

        (3) Pump drive engine

        (4) Bow thruster engine

    c. Pumps:

        (1) Fuel oil transfer pump 1

        (2) Fuel oil transfer pump 2

REENTRY PROCEDURES

WARNING

Following a fire and actuation of the engine room fire suppression system, the engine room may contain a dangerous level of Hydrogen Fluoride (HF) gas, which is dangerous to humans. Do not reenter the engine room until the post-fire re-entry procedure has been performed. Death or serious injury can result from unprotected entry into this space prior to completion of the post-fire re-entry procedure.

1. Wait at least 15 minutes after extinguishing the fire before performing this procedure. The natural decay rate for HF gas is approximately 15 minutes after a fire is extinguished.

2. Perform HF gas sampling as follows:

    a. Remove the cap (figure 8, item 2) from the HF sampling port (figure 8, item 3) located in the main deck vestibule.

    b. Zero the stroke counter (figure 18, item 1).

    c. Install the rubber hose (figure 18, item 2) on the pump by sliding one end of the rubber hose over the tube holder (figure 18, item 3).

    d. Break off both tips (figure 18, item 4) of the detector tube (figure 18, item 5) using the breaker (figure 18, item 6) on the sampling pump (figure 18, item 7).

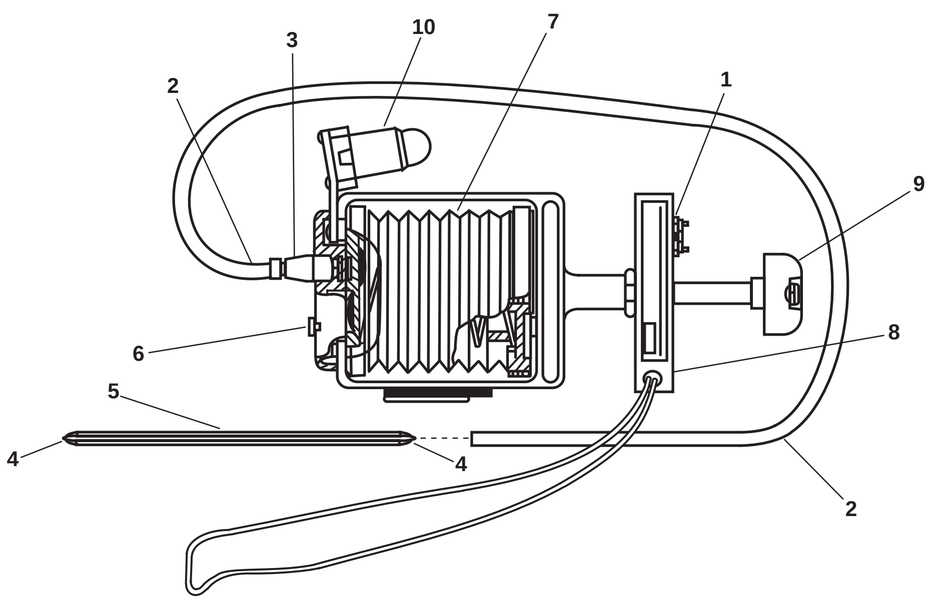


Figure 18. Sampling Pump

e. Install the detector tube (figure 18, item 5) into the rubber hose (figure 18, item 2) with the arrow on the detector tube pointing toward the sampling pump (figure 12, item 7)

f. Insert the detector tube (figure 18, item 5) into the HF sampling port (figure 8, item 3). Ensure that all of the rubber hose (figure 18, item 2) is inserted into the HF sampling port.

NOTE

Determine the number of strokes required for a proper sample by checking the detector tube instructions that are in the box of detector tubes or the detector tube itself. The tube will be labeled as n=(number of strokes).

g. With all four fingers on the handle (figure 18, item 8), fully press the knob (figure 18, item 9) with the palm of the hand until the stroke counter (figure 18, item 1) changes number.

h. Release the knob (figure 18, item 9).

i. Verify that the end of stroke indicator (figure 18, item 10) has turned a high visibility yellow. Once the pump has consumed 100cc of the sample, the end of stroke indicator will return to its black color.

j. Repeat steps f, g, h and i until the proper number of strokes has been preformed.

k. Remove the detector tube (figure 18, item 5) from the HF sampling port (figure 8, item 3).

l. Install the cap (figure 8, item 2) on the HF sampling port (figure 8, item 3).

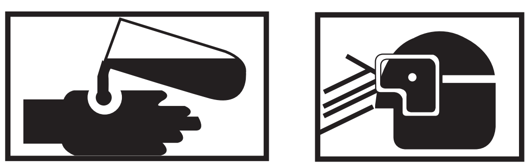
m. Observe the color of the detector tube, read the scale printed on the detector tube, and record the reading.

n. Remove the detector tube (figure 18, item 5) from the hose (figure 18, item 2).

o. Wait two minutes and repeat steps a-n above.

p. When three consecutive readings of 3 parts per million (ppm) are obtained, the engine room is safe for reentry.

WARNING



Residue from FM-200 fire suppression is a minor irritant to the skin, the eyes, and the respiratory tract. All personnel who may come in contact with this residue must wear Personal Protective Equipment (PPE), which prevents the FM-200 residue from contacting the skin, eyes, and/or respiratory tract.

3. After ensuring that no reflash risks exist, the engine room must be ventilated in accordance with the following procedure:

a. If explosive or flammable gases are present, desmoke using the water-driven blower. Desmoke using the water-driven blower until no flammable gases are detected.

b. If no explosive or flammable gases are present, desmoke using the ventilation exhaust fans in high speed.

c. When the smoke has cleared, restart the ventilation supply fans in high speed.

d. When all smoke is cleared and air quality is at normal levels, return all ventilation fans to their normal operating speed.

e. Ventilate the engine room for at least 15 minutes before proceeding to the cleanup phase.

4. After the engine room has been ventilated and has cooled down, wash down the engine room interior and all equipment with fresh water.

NOTE

Bilge water that has been exposed to FM-200 fire extinguishing agent in extinguishing a fire shall be classified and treated as hazardous waste.

5. Use the oily water collection system to remove all contaminated bilge water from the engine room. Discharge this contaminated water only to a suitable treatment facility.

6. Return the equipment to the desired readiness condition.

SPRINKLER SYSTEMS

INTRODUCTION

There are three sprinkler systems installed on the LT. The three sprinkler systems are the Water Washdown System (WWS), the Washdown Countermeasure system (WDCM), and the arms locker drenching system. The WWS aids the FM-200 system by cooling the engine room. The WDCM provides protection against Nuclear, Biological, and Chemical (NBC) attack. The arms locker drenching system provides the arms locker with sprinkler protection. These systems are described in the paragraphs that follow.

WATER WASHDOWN SYSTEM (WWS)

The purpose of the WWS is to quickly reduce the temperature in the protected space to minimize the production of HF gas generated as a result of FM-200 agent contact with hot surfaces and flame above 1300 °F (704.4 °C). The sprinkler water also acts to keep smoke particulate down and expedites ventilation of the compartment when the fire is out. The WWS is not designed or intended to be a stand-alone fire extinguishing system. It is designed to be used in conjunction with the installed FM-200 fixed fire extinguishing system. Use of the WWS reduces the risk of HF exposure by reducing temperatures within the protected space. In order to achieve full benefit of its design, the WWS should be operated for a minimum of 15 minutes when the FM-200 system is employed to extinguish a fire.

The WWS is constructed of all stainless steel components. In order to operate the WWS, the fire main must be charged, and as a minimum, fire and general service pump 1 must be online at maximum operating pressure. To provide an adequate volume of raw water for the WWS, valves FM-17 and FM-15 must be CLOSED prior to activation of the WWS. The engine room and AMS 1 WWS requires a minimum of 145 gal/min (548.9 lit/min) at 104 lb/in^2 (7.17 bar) to operate as intended.

Activation of the WWS is accomplished by opening WWS-1 (figure 8, item 1). WWS-1 is located in the engine room vestibule on the main deck at frame 25. The WWS shall be activated prior to actuation of the FM-200 Fixed Fire Extinguishing System. The WWS is a Hydrogen Fluoride (HF) gas mitigating water washdown system that provides general overhead coverage to the protected spaces. The WWS consists of simple overhead sprinkler heads (figure 19) piped directly to the fire main. The WWS receives raw water directly from fire and general service pump 1. The pump is powered by the EDG switchboard.

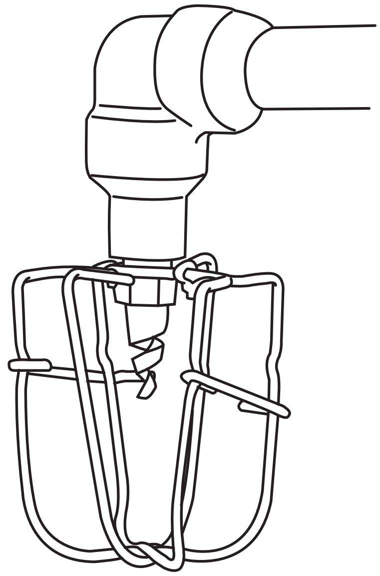
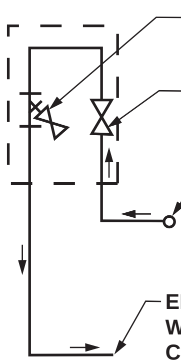


Figure 19. Water Washdown System Sprinkler Head

When the FM 200 Fire Suppression System is actuated to extinguish fire, allow the WWS to operate for a minimum of fifteen minutes. During the WWS operating period, valve WWS-2 (figure 8, item 4) should be OPENED for ten seconds every three minutes. WWS-2 is the engine room WWS strainer blow off, and this will flush foreign matter from the in-line strainer basket during operation of the WWS. The WWS operating instructions (figure 20) are posted above the WWS station valves, in the main deck vestibule.

ENGINE ROOM WATER WASHDOWN SYSTEM (WWS)

WWS CONTROL STATION



VALVE LEGEND

WWS-1 ENG RM WWS CONTROL VALVE
WWS-2 ENG RM WWS STRAINER BLOW OFF

FIRE MAIN IMPACT

DURING OPERATION OF WWS RESIDUAL CAPACITY OF THE EMERGENCY (NO. 1) FIRE AND SALTWATER SERVICE PUMP IS INADEQUATE TO BE USED FOR ANY OTHER PURPOSE.

OPERATING INSTRUCTIONS

A. START-UP PROCEDURE

1. ENSURE FIRE MAIN SYSTEM HAS BEEN PRESSURIZED (SEE FIRE MAIN SYSTEM OPERATION PLACARD).
2. UNLOCK VALVE WWS-1.
3. OPEN VALVE WWS-1.

NOTE: IF Y STRAINER IS CLOGGED, SEE BLOW OFF PROCEDURE.

4. OPERATE FOR MINIMUM OF 15 MINUTES.

B. SECURING PROCEDURE

1. CLOSE VALVE WWS-1.
2. LOCK VALVE WWS-1.
3. SECURE FIRE MAIN SYSTEM (SEE FIRE MAIN SYSTEM OPERATION PLACARD).

BLOW OFF PROCEDURE

1. OPEN VALVE WWS-2 MOMENTARILY.
2. CLOSE VALVE WWS-2.

Figure 20. Water Washdown System Operating Instructions

WASHDOWN COUNTERMEASURE SYSTEM (WDCM)

The purpose of the WDCM is to provide the vessel with protection against Nuclear, Biological, and Chemical (NBC) contaminants. The WDCM is capable of forming a protective umbrella of raw water over the superstructure by routing pressurized raw water through various sprinkler fittings (figure 21) located on the weather decks of the vessel. If time allows, the vessel should be wet down prior to an NBC attack. The wetted exterior would cause the NBC agents to be washed immediately overboard. The washdown system is more effective as a preventive measure than as a decontamination measure. Another benefit of using the washdown countermeasure system is that it cools the external superstructure of the vessel. This aids in removing excess heat from the vessel in the event of fire.

1. Verify that the fire main is pressurized.

2. Activate the WDCM system by OPENING WDCM-11 located in AMS 2, overhead, port side.

3. Secure the WDCM system by CLOSING WDCM-11 located in AMS 2, overhead, port side.

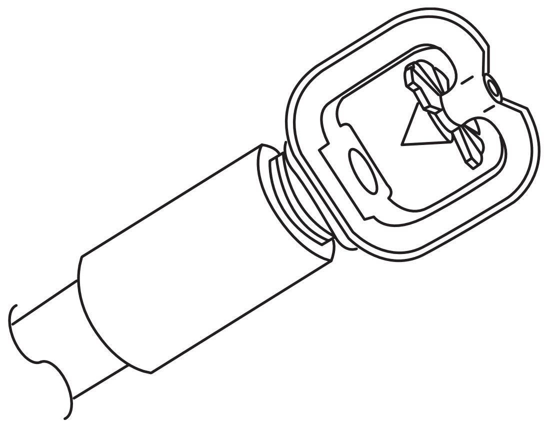


Figure 21. Washdown Countermeasure System Sprinkler Head WDCM Operation

ARMS LOCKER DRENCHING SYSTEM

The arms and ammunition storage locker is equipped with a drenching system designed to cool the contents in case of fire in, near, or around the locker. When a high temperature condition is detected, the temperature sensor in the arms locker causes an alarm condition. Personnel investigating the alarm must determine if conditions warrant activating the arms locker drenching system. The arms locker drenching system must be activated manually. Local activation is accomplished by opening the valve (figure 22, item 1) located in the overhead of the boatswain's locker. The arms locker drenching system can also be activated by using the remote operator (figure 23), located at the anchor windlass on the 01 level weather deck, on the port side.

Temperature stability in ammunition and pyrotechnic storage areas is essential to prevent decomposition and deterioration of stored devices. Ready service lockers and other ammunition stowage spaces are designed to maintain temperatures within prescribed limits under normal operating conditions. The stability of smokeless powder decreases at temperatures in excess of 100 °F (37.8 °C). Stowage in airtight spaces at temperatures of 70 °F (21.1 °C) or less is necessary to ensure normal life of any service ordnance. Mechanical cooling is necessary if temperatures will exceed 100 °F (37.8 °C). If mechanical cooling is not provided, artificial methods, such as water spray or wet canvas covers can be used to reduce the high temperature.

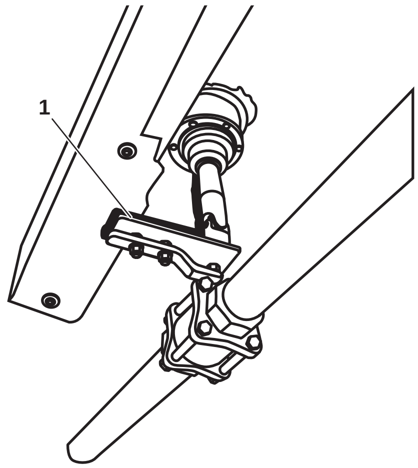


Figure 22. Arms Locker Drenching System Actuation Valve

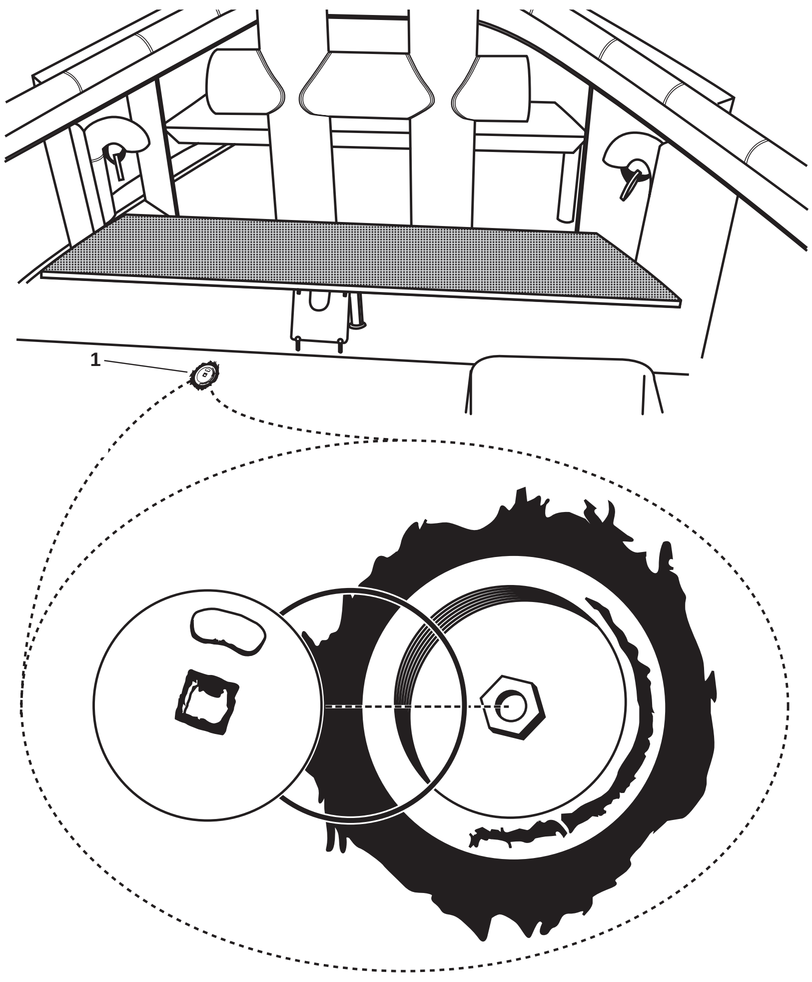


Figure 23. Arms Locker Drenching System Remote Operator

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) VENTILATION

Ventilation systems are a potential means of flooding, and they can also contribute to the spread of fire and dangerous fumes. The supply and exhaust ducts, bulkhead and deck penetrations, supply and exhaust fans, and other components afford opportunities for progressive flooding and the spread of fire.

VENTILATION OF FM-200 FITTED SPACES

The engine room and AMS 1 are fitted with a FM-200 Fire Suppression System. When FM-200 is released into the spaces, the ventilation systems serving these spaces are automatically secured to prevent dilution of the FM-200 agent, and to prevent its removal from the spaces. The ventilation supply and exhaust systems are provided with interlocking switches that shut down the ventilation fans when the FM-200 system is actuated. The SSDGs, Bow Thruster Engine, and the Pump Drive Engine are also shut down automatically. This is accomplished automatically by pressure-operated switches that secure power via electric relays. Actuation of the FM-200 system is indicated by a yellow beacon and by pressure-actuated horns in the protected spaces.

WATERTIGHT CLOSURES

Ventilation ducts that pierce watertight bulkheads or decks below the main deck are fitted with watertight closures at the penetrations. When ducts pierce the decks, they are constructed watertight up to the main deck. The LT is designed so that there are no penetrations of the main transverse bulkheads below the main deck level. In the event of a Nuclear, Biological, or Chemical (NBC) attack, all ventilation fans and blowers must be secured in order to prevent contaminants from entering the vessel. Ventilation should not be restored until the vessel is clear of the contaminated area and has been decontaminated.

SMOKE CLEARANCE

Smoke is always present in a fire, and it should always be considered by the firefighter when combating a fire. The primary objective must always be to extinguish the fire. When that has been accomplished, steps must be taken to remove the remaining smoke and fumes. Although smoke and fumes are hazardous to personnel, the hazard is completely avoided by the use of an air mask. The reduction in visibility by smoke is a hazard that must be endured until the fire is completely extinguished.

Fire that occurs in the open on weather decks does not present such a serious smoke problem. This type of fire can often be fought from the windward side, so the smoke is carried away by the wind. The problems confronted by the firefighter in a below deck space are more difficult because ventilation is secured. This means that smoke and fumes are present. The firefighter's objective must be to extinguish the fire despite these difficulties. It is vital that ventilation remain secured until the fire is completely out, overhauled, and cooled.

Generally, there are no effective means for combating smoke or fumes during the progress of an interior fire. It is dangerous to use ventilation to improve visibility during a fire below decks. Confined spaces retain high temperatures, and any available fresh air can cause an explosive reflash. The prevention of this known fire hazard resulting from the use of ventilating systems is of greater concern than any probable improvement in visibility. All ventilating system closures are secured when a fire exists. Not only should ventilating system closures be secured, but electrical systems to blowers and similar devices should be deenergized also.

Open ventilating ducts, particularly in vertical systems, act as vents for the fire. This prolongs the life of the fire and contributes to the difficulty of bringing it under control. Any movement of air increases the risk of spreading the fire by the combustion of dust and other debris that collects in the ventilating systems. Ventilation ducts open to a compartment on fire can easily become the vehicle for spreading fire and fumes to areas which otherwise would be unaffected. Combustible gases or fumes passing a sparking motor could easily explode and cause further damage and additional fires.

Firefighters must take extreme care when entering the compartment for the purpose of fighting the fire. The open access in combination with an open ventilation duct will cause a natural draft. Ventilating system closures are provided for preventing the spread of smoke and fumes, as well as for preservation of watertight integrity and reserve buoyancy.

VENTILATION PRECAUTIONS

When it is determined that the fire is completely extinguished and overhauled, the affected spaces must be ventilated by natural or forced means. In spaces above the waterline, natural ventilation can be utilized by opening exterior doors and portholes. Below deck spaces will require either the installed systems or portable ventilating fans for clearing compartments of smoke and fumes. However, the following precautions must be observed before ventilating any spaces involved in fire:

1. Verify that the fire is completely extinguished, overhauled, and cool.
2. Post a reflash watch with a charged fire hose. Maintain the reflash watch until the space is properly ventilated.
3. Investigate ventilation systems to make sure they are free from fire or smoldering material.
4. Have personnel standing by to secure the ventilation in case of reflash.
5. Check compartment for explosive vapor or fumes before using electrical ventilation.
6. If no explosive vapors are present, and with permission of the Chief Engineering Officer, open the ventilation system closures, and start the exhaust fans to remove smoke from the affected spaces.
7. If explosive gases are present, use the water-driven blower to remove the explosive gases from the affected spaces. When the explosive gases are removed, open the ventilation system closures, and start the exhaust fans and remove smoke from the affected spaces.

NOTE

Bear in mind that it is the exhaust systems that must be used for clearing compartments of smoke and fumes. The use of exhaust systems will create a condition that prevents the smoke and fumes from spreading to other compartments. Use of the ventilation supply systems will force smoke and fumes into adjacent spaces. Refrain from using the ventilation supply fans until the smoke and fumes are removed from the vessel.

8. When all smoke and fumes are removed from the vessel, restart ventilation supply fans.
9. With permission from the Watch Officer or Chief Engineering Officer, secure the reflash watch.

PORTABLE VENTILATING BLOWERS

CAUTION

The blowers aboard the LT are explosion proof when assembled by the factory. The explosion proof quality may not be present after performing maintenance on the blower. Where there is a possibility of explosive vapors being present, the water-driven blower should be used in lieu of the electric-driven blower.

Portable ventilating blowers are considered auxiliary equipment. They are not as efficient as permanent ventilating systems, but they are safe for use when explosive vapors or fumes are present. When it is unsafe to use the permanent systems, only portable ventilating blowers should be used. The blowers onboard the LT are fitted with explosion proof motors. These motors are explosion proof when assembled by the factory. The explosion proof quality may not be present if maintenance was performed on the blower. If there is a possibility of explosive vapors being present, the water-driven blower should be used in lieu of the electric-driven blower to remove explosive vapors from affected spaces.

END OF WORK PACKAGE

Chapter 7

Shoring
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) SHORING

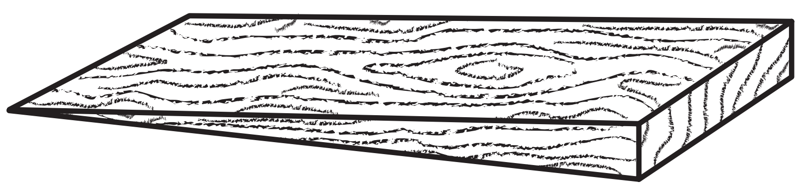
The purpose of shoring aboard vessels is to support ruptured decks, to strengthen weakened bulkheads and decks, and to strengthen decks and bulkheads against sea pressure. Shoring can also be used to support hatches and doors, and to provide support for equipment that has broken loose. There is no single set of guidelines for determining the need for shoring. Sometimes the need for shoring is obvious. Examples are loose machinery or damaged hatches. There are times when the need for shoring is not so obvious. Weakened supports under machinery may not be easily noticed. Although shoring is sometimes done when it is not really necessary, the general rule is, if in doubt, shore it.

SHORING MATERIALS

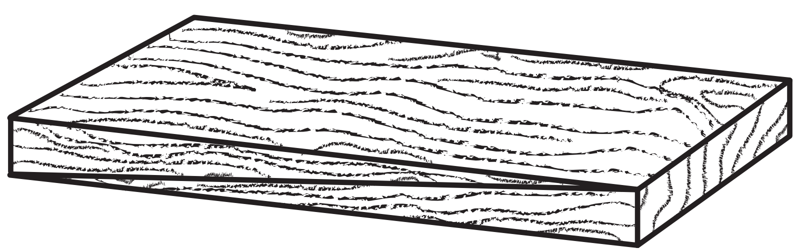
The vessel is outfitted with only the most basic shoring materials. These materials are metal shores and wooden wedges. A shore is a portable beam. A wedge is a block that is triangular on the sides and rectangular on the one end. The vessel is outfitted with shoring tools such as hammers, sledges, axes, hatchets, chain falls, welding machines, oxyacetylene cutting outfits, and chisels. The Basic Issue Item (BII) and Components of End Item (COEI) lists indicate the quantity of the gear that the vessel should carry on board.

WEDGES

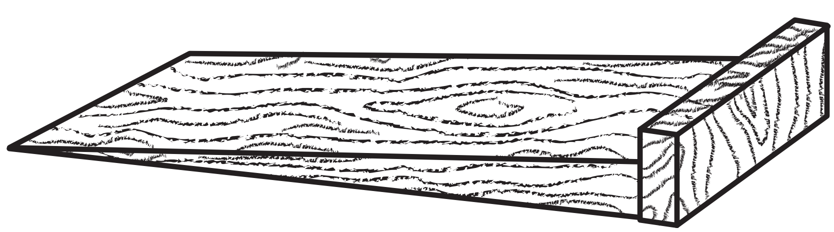
Wedges (figure 1) are made from softwoods like fir and yellow pine. They are cut with a coarse saw, and are left rough and unpainted. This allows the wedges to absorb water and hold better than if they are smooth and painted. A few hardwood wedges are kept on hand for special uses, because hardwood resists crushing better



TAPER OF A WEDGE



2 WEDGES FORM A SQUARE BLOCK



USE A BLOCK FOR DRIVING

Figure 1. Examples of Wedges

than soft wood. Wedges should be approximately the same width as the metal shores they are used with. As a general rule, a wedge should be about six times long as it is thick. Blunt (shorter) wedges do not provide adequate resistance to slippage. This means that if a wedge is 2 inches thick at the butt end, it should be at least 12 inches long.

Steel wedges are more valuable for prying things apart than for actual shoring. Steel wedges may be used in conjunction with wooden wedges to take some wear and pressure off of the wood. Steel wedges can also be welded in place to give the metal shores a stronger foothold when making emergency repairs.

METAL SHORES

There are two types of telescoping metal shores approved for use, and the LT carries six of each. The shores are made of steel, and consist of two telescoping, square steel tubes. Four spring loaded locking devices (figure 2, item 1), a swivel baseplate (figure 2, item 2), and a screwjack (figure 2, item 3) are on the outer tube (figure 2, item 4). A swivel baseplate (figure 2, item 5) is on one end of the inner tube (figure 2, item 6). Each of the four sides of the outer tube has a spring loaded locking device. The locking devices are used to make large size adjustments to the shore. The screw jack at the end of the outer tube is used for fine size adjustment, and to

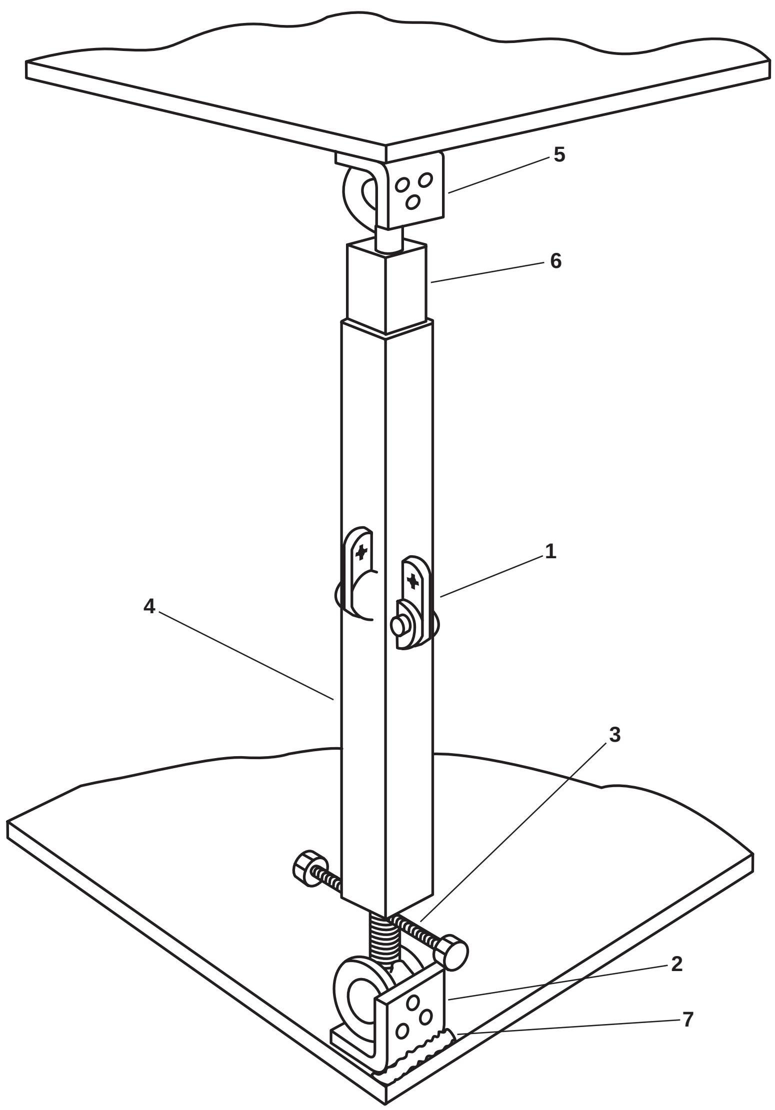


Figure 2. Example of a Metal Shore

apply pressure after the shore is installed. The hinged baseplates are easily adjusted to the desired angle, and allow easy placement of the shore into almost any position. The baseplates can even be welded (figure 2, item 7) in place if necessary. Metal shores can be fitted in place before engaging the locking devices and applying pressure with the screwjack. This greatly expedites the shoring process.

The metal shores are used to make temporary repairs to reinforce the structure of the vessel, and they must be maintained in good operating condition. The tubes must slide easily, and the swivel joints must move freely. The threads of the screw jack must not have any paint on them. The swivel joints and screw jack threads must be clean and greased. The holes and slots for the locking devices must be open and free of paint and debris. The steel shores are available in two models.

1. Model 3-5. Model 3-5 is adjustable from a minimum of 3 feet, plus or minus 3 inches, to a maximum of 5 feet, plus or minus 3 inches. It will support a maximum vertical load of 20,000 pounds when closed to within 1 inch of the screw jack. It will support a maximum vertical load of 12,000 pounds when fully extended.

2. Model 6-11. Model 6-11 is adjustable from a minimum of 6 feet, plus or minus 3 inches, to a maximum of 11 feet, plus or minus 3 inches. It will also support a maximum vertical load of 20,000 pounds when closed to within 1 inch of the screw jack. It will support a maximum vertical load of 6,000 pounds when fully extended.

GENERAL SHORING RULES

Most shoring is done to support bulkheads that are endangered by structural damage or weakness caused by a collision or by the pressure of flooding water. The pressure on the bulkhead of a flooded compartment is tremendous. Expert shoring is required to hold such bulkheads in place. Some of the general rules to remember in connection with shoring bulkheads are as follows:

1. Always allow a large margin of safety. Use MORE shores than you think you need, rather than fewer. Spread the pressure. Make full use of strength members by anchoring shores against beams, stringers, frames, stiffeners, stanchions, barbettes, and so forth. Place the shoring against the bulkhead at an angle of 45° or 90° if at all possible.

2. Do not attempt to force a warped, sprung, or bulged bulkhead back into place. Place the shores so that they will hold the bulkhead in its warped or bulging position. When possible, strengthen the main shores with auxiliary shores.

3. The same general rules apply to shoring a hatch or a door. However, the entire hatch or door should be shored, and the pressure should be spread over both the hatch cover and the supporting structure. Remember that hatches and doors are the weakest part of the bulkhead in which they are installed. Shoring doors and hatches may be complicated by the presence of scuttles and quick-acting handwheels. A basic rule is to put as many points of pressure on the closure as there are dogs on the closure, if at all possible.

4. The success of any shoring job depends largely on the way the shores are wedged. As the shoring job progresses, check carefully to ensure that all of the wedges are exerting about the same amount of pressure on the shore. Use as few wedges as possible to obtain satisfactory results. Always drive the wedges in uniformly from both sides so that the shore end will not be forced out of position. Lock the wedges in place so that they will not work loose and cause the shoring to slip. If necessary, fashion metal wedges from available metal, and weld the metal wedges in place.

END OF WORK PACKAGE

Chapter 8

Flooding
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) INTRODUCTION TO FLOODING

Typically, flooding is caused by factors that are very noticeable to the crew. Collision or grounding are typical examples. However, some flooding events are subtle, and if left undiscovered will eventually cause the vessel to sink. Damage control teams should be drilled to take action automatically to halt flooding. In addition to the water weight, flooding can potentially cause further damage to the vessel. Flooding water coming into contact with the electric bilge and fire pumps can greatly reduce the damage control capabilities of the LT by permanently damaging the pump motors. It is imperative that priority be given to halting flooding and removing loose water. Other considerations for high flooding are the restoration of stability to the vessel. Damage control teams should be drilled to make prompt, accurate reports to the bridge on the nature of the flooding so that better decisions are made to combat the flooding casualty. Combating flooding takes priority over putting out fires.

FLOODING LOAD

Seawater weighs approximately 64 pounds (29 kg) per cubic foot. Sea pressure at any point is equal in all directions, and the deeper the water, the greater the pressure. This means that a bulkhead 20 feet (6.1 meters) wide and flooded to a depth of 5 feet (1.5 meters) is subjected to a total pressure of 16,000 pounds (7257.5 kg). A bulkhead 8 feet (2.4 meters) high and 20 feet (6.1 meters) wide, flooded to a depth of 15 feet (4.6 meters) would have a total pressure of 112,640 pounds (51 092.6 kg) on it. These examples should give an idea of the pressures that must be contained during flooding. If the vessel remains entirely motionless in all three planes, the pressure at any given point will remain constant, and the problem would be relatively simple to overcome. But the sea is constantly moving the vessel, and the pressures and loads are constantly varied. Any structure at sea requires continual observation and inspection to assure integrity.

FLOODING LOAD SAGGING

The load on the vessel is increased by the presence of flooding water. The increase in stress caused by this augmented load depends on both the amount and the location of the flooding. Damage and flooding in the middle of the vessel increases sagging stresses. This increases the tension at the bottom, and the compression at the top, of the hull girder. In other words, the vessel would be more likely to fold in on itself like a pocketknife. Measures to correct trim caused by damage in the middle are needed to reduce sagging stresses. This is accomplished by one or all of three of the following methods:

1. Pump liquid in the amidships region directly overboard. This can be either flooding water or liquid contained in intact tanks.

2. Transfer liquids from the amidships tanks to tanks at the ends of the vessel without bringing on any extra weight (counterflooding).

3. Counterflood the high end of the vessel.

FLOODING LOAD HOGGING

It should be understood that flooding one end of the vessel produces trim, and it increases hogging stresses. Hogging stresses are increased tension at the top and compression at the bottom. This is the opposite of sagging, and it is like opening a pocketknife past its hinged stopping point. Measures for the correction of trim to reduce hogging stresses are:

1. Transfer liquids toward the amidships region.

2. Pumping liquid near the damaged area directly overboard. This could be flooding water or liquid in intact tanks.

3. Flood amidships tanks.

COUNTERFLOODING

At times, counterflooding may be required to halt listing or to gain safe righting moments. However, counterflooding can be dangerous, and it can result in the loss of the vessel if not properly accomplished and controlled. A recommendation by the engineer to counterflood shall be accomplished only with the approval of the vessel master, and only when all aspects have been carefully considered.

FLOODING BOUNDARY

A flooding boundary is established by locating the bulkheads and decks, which are dry and likely to remain dry. The next action is to advance that flooding boundary toward the original point of damage by preventing further flooding of dry or partially flooded compartments. It is important to close in on the damage from all sides. Even though a flooding boundary has been established, there is no indication that the boundary will remain safe. Action must be taken by the damage control team to advance the flooding boundary back toward the point where the damage occurred. Many vessels have been lost as a result of enemy action. Few of them sank as a result of the initial damage. Most of them went down hours later as a result of progressive flooding, fire, and collapsing bulkheads. Had the flooding and fire boundaries been established when and where they were possible, and had the damage been confined to its original area, many of those ships would have survived.

Everything possible must be done to prevent further flooding. It is human weakness to attack obvious damage while ignoring hidden damage. Hours can be wasted by damage control teams trying to patch large holes in compartments already flooded when it is the smaller holes in the interior bulkheads that may be allowing progressive flooding. It is these smaller holes in the lower levels that are often overlooked, and will cause the vessel to sink. In most cases, it would be better to plug interior holes first in order to maintain a known level of watertight integrity.

NATURE OF DAMAGE

The nature of damage sustained depends on the cause of the damage. Not all damage is inflicted by an enemy. Collisions, groundings, and storms have caused damage so severe as to threaten the survival of vessels. Self-inflicted damage such as a snagged towline may stem from lack of preparation, failure to follow procedures, or neglect. Either way, the result is disastrous. Other causes of damage to stability are excessive icing on the weather decks, excessive deck loads, improper removal of ballast, and overloading as a result of neglected bilges.

ABOVE WATER DAMAGE

Flooding damage can be sustained in an above water attack in several ways: penetration of boundaries, blast effect, and fragment attack.

1. Penetration. For penetration, most missiles and shells are fitted with a strong case. The velocity of the missile or shell causes it to penetrate deep into the interior of the vessel. Every boundary the missile or shell penetrates leaves a hole that flooding water can penetrate.

2. Blast. Blast effect is obtained by filling the interior of missiles or shells with a bursting charge. The amount of blast produced varies with the weight and explosive capability of the charge. In a lightly constructed vessel, an armor piercing shell may pass through several boundaries (bulkheads or decks) before detonating. Occasionally, such weapons pass completely through a small vessel and detonate in the air beyond.

3. Fragments. The extent of fragment or splinter damage depends both on the thickness (and type) of case and the effectiveness of the bursting charge. The fragments projected from a missile that undergoes high order detonation often have velocities as high as 3,000 or 4,000 feet per second. They may penetrate two or three successive boundaries in a vessel of light construction. Additionally, the blast of its explosion tears loose portions of vessel’s structure, and hurls them throughout the vessel.

BELOW WATER DAMAGE

The types of below water damage are:

1. Grounding. The most probable damages from grounding are holes and cracks in the hull, and damaged piping. The emergency repairs to cracks or holes in the underwater hull involve patches and plugs. Emergency repairs to damaged piping involve application of the appropriate patch, plugging or blanking.

2. Collision. Damages and repairs will be similar to the actions described in the grounding incident.

3. Mine or torpedo hit. If the LT should strike a mine or be struck by a torpedo, the outcome would be catastrophic. Even though the attack occurred below the water line, above water damage will also be sustained. For example, a U. S. Navy frigate struck a mine in the Persian Gulf in the late 1980s. The mine blew a hole 20 feet (6.1 meters) in diameter in the bottom of the ship. It also fractured every deck from the keel to the pilothouse except the 2nd deck. The ship had to restore complete structural integrity before it could even be towed back to port.

4. Snagging the towline in a propeller. Snagging the towline in a propeller leads to loss of mobility, damage to the towline, and damage to the propeller. Since the LT has no diving capability, it will be necessary to lift the towline on board, secure it to an appropriate fitting, cut the damaged end with the oxy-acetylene torch, and request assistance from the nearest maintenance facility.

5. Allowing another ship to cross the towline and snag it. Again, the LT has no capability to send divers to remove the towline from the snagging ship. The LT vessel master will have to decide his/her course of action, which should commence with a request for assistance from the nearest maintenance facility.

Damage control teams must be prepared to isolate damage quickly and use the damage control pipe and tank patching kits expeditiously to restore watertight integrity. Once flooding has been halted, the engines and generators should be brought back online. Then hull systems such as the fire main and bilge pumping systems can be repaired and used. Structural damage may include warping and holes in decks and bulkheads that can't be repaired without assistance. Any closed fittings that leak and open fittings that cannot be closed are a risk that must be overcome in order to ensure survival.

PLUNGING

A multitude of minor leaks can lead to a condition called plunging. Loss of vessels by plunging occurs more often in the merchant or auxiliary type than in the combatant type, although some destroyers have sunk in this manner. The auxiliaries have larger compartments, and the flooding of these compartments at the end leads to major trim problems. When the trimming moment becomes greater than the maximum longitudinal righting moment, the vessel will plunge, and sink. The best way to correct this problem is to remove weight at the heavy end of the vessel. In a flooded vessel, this requires the ability to pump water out faster that the flooding brings it in. If time allows, halt or slow the flooding by patching the hole.

INVESTIGATING FLOODING DAMAGE

When inspecting for damage, inspect thoroughly. When an underwater explosion occurs alongside or close aboard, all voids, tanks, and lower compartments on the vessel must be investigated. Plating may be torn loose or cracked, seams may be parted, and bulkheads may be penetrated. Further damage can occur at a considerable distance from the principal point of impact. Internal flooding may spread over a large area through watertight fittings damaged by shock, or through neglected watertight fittings. Secondary casualties may not be apparent during initial investigation.

If flooding water is on the opposite side of a bulkhead that is cracked, water coming through the cracks may be easily detected. However, if flooding has not yet reached the area, the damage may not be visible, and if a proper inspection is not accomplished, it will not be noticed until a degree of progressive flooding has occurred. Personnel assigned as inspectors must exercise care to prevent open doors, hatches, and scuttles from being fouled in any manner that would prevent or delay the ability to secure the opening. Should the motion of the vessel cause a door or fitting to swing, it is preferable to assign personnel to tend to the fitting or door while it is open, then secure it when it is no longer required to be open.

STRUCTURAL DAMAGE

Flooding is usually the result of structural damage below the waterline. It is vital to prevent progressive flooding, and to remove as much of the water as possible in order to restore buoyancy and stability and to return the ship to an even keel. Investigation of structural damage must cover a considerable area surrounding the immediate scene of damage. All levels on decks above and below the principal casualty must be inspected. Investigators must look for damage such as fragment holes, ruptured pipe lines, warped or fractured frames and stanchions, cracks, open seams, leaky stuffing tubes, bent shafts, improperly closed fittings, and severed electric cables. They must note quickly any damage, which in itself could be hazardous to the vessel. This immediate recognition of danger to the vessel requires experienced and knowledgeable personnel. Therefore, inspectors should be the most experienced and knowledgeable personnel the situation allows.

HIDDEN DAMAGE

The complete picture of a damage situation rarely is fully evident. Some damage may not necessarily be within the immediate area. Shock, blast, fragmentation and other forces cause additional damage, which, because of remoteness from the scene of the prime damage and not immediately apparent, could be overlooked during the period immediately following the initial damage. The inspection of the vessel for damage, therefore, must not be focused solely upon the prime damage area. Open circuit-breakers and failure of operating gear could indicate hidden damage which in itself could be as hazardous to the vessel as the prime damage. Hidden damage could be in an adjacent compartment. Investigators must understand that damage is likely to occur in compartments adjacent to the one in which the primary damage occurred.

An investigation of watertight fittings is necessary because of any potential structural damage. This is accomplished in a systematic manner by visual examination as the investigator passes from one area of the vessel to another. It should be understood that no watertight door, hatch, air fitting, oil fitting, cap, plug, scuttle, or manhole is to be opened until it is known definitely that the compartment on the other side is either completely dry, or so little flooded that opening the closure will not permit flooding to spread. Failure to do so could cause additional flooding. To do a thorough damage control investigation, it might be necessary to open one or more watertight doors or hatches.

It is unwise to open any such closures below the waterline in the vicinity of damage unless soundings indicate the compartment is sufficiently dry, and only after permission is obtained from the vessel master. One mistake and the vessel could be lost. Tapping on a bulkhead with a hammer will often disclose the presence of water on the other side. The exact height of the water may be judged by variation in the tones produced when the bulkhead is struck at different levels. Damage control team members should occasionally tap the bulkheads for practice to train their ears to the sound of bulkheads around undamaged areas. The tones will vary appreciably with the thickness of the plate.

A dangerous, but often necessary, method of testing a compartment for flooding is to slowly slack off on the hinged side of some of the dogs that hold a hatch or door closed. There is a slight amount of clearance around the hinge pins. As the dogs are loosened, any water present will begin to seep between the gasket and the knife-edge of the sill. Control is maintained by means of the hinges and the dogs opposite the hinges. This method cannot be used with quick acting doors and scuttles. Crewmembers must not loosen the dogs on the edge of the door away from the hinges. To do could result in having the door buckle or fly open, and another compartment would be needlessly flooded.

HOLES AT WATERLINE

Holes in the hull at, or just above, the waterline are dangerous because they may not appear to be of immediate consequence. However, they destroy reserve buoyancy and, should the vessel roll in a heavy sea or lose buoyancy, the holes become submerged. This admits flooding water above the center of gravity. This is dangerous because this condition reduces stability, and the flooding water presents a large free surface. It is vital to plug these holes at once, with priority being given to holes at the waterline on the low side.

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) STRUCTURE RELATED FLOODING

The vessel's ability to resist sinking after sustaining damage depends largely on the vessel's compartmentation and watertight integrity. When these features are properly maintained, flooding can be isolated within a limited area. Without compartmentation or watertight integrity, the vessel is almost certainly doomed if it is severely damaged and damage control teams are not properly trained or equipped. The compartmentation of the vessel is a major feature of its watertight integrity. Compartmentation divides the interior hull into smaller spaces by the use of structural members. A discussion of basic vessel design follows.

FROM KEEL TO FRAME

The keel (figure 1, item 1) is the backbone of the vessel. The keel is the structural member that runs the entire length of the bottom of the vessel. It is usually shaped like an I-beam. All structural members used in constructing the hull are attached to the keel. The structure consists of transverse frames and floors. The floors (figure 1, item 2) run outboard from the keel to the turn of the bilge. This is where they are attached to the transverse frames that extend upward to the main deck. Frames, running parallel with the keel, are known as longitudinal frames (figure 1, item 3). From the turn of the bilge up the sides, they are called stringers. The network of floors and longitudinal members resembles a honeycomb, and this is known as cellular construction. Cellular construction greatly strengthens the bottom of the vessel. When plating covers the honeycomb structure, double bottoms are formed (figure 1, item 4). The tanks created between the inner and outer bottoms are used for liquid stowage. The forward end of the keel is extended upward in the stem (figure 2, item 1). The after end has a similar extension, called the sternpost (figure 2, item 2). The part of the stem above water is the bow (figure 2, item 3).

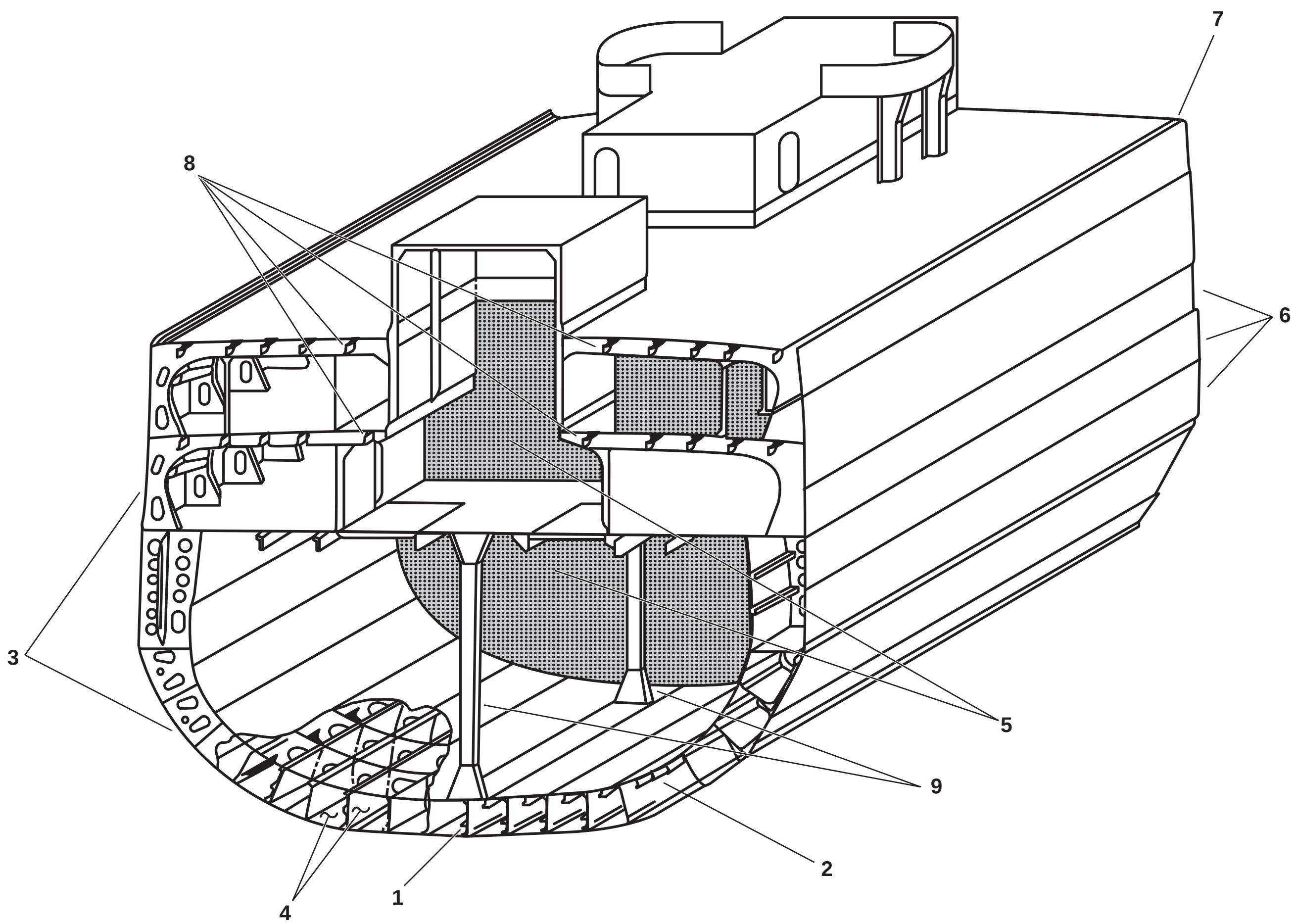


Figure 1. Basic Vessel Structure

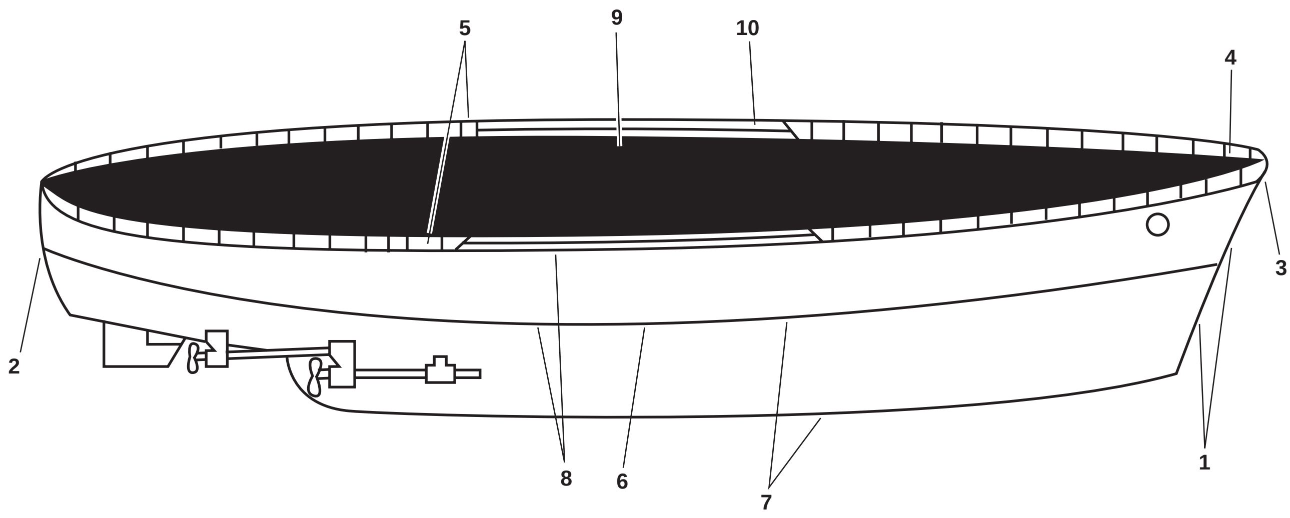


Figure 2. Hull Terms

BULKHEADS, TANKS, AND VOIDS

The interior of the vessel is divided into compartments by vertical walls called bulkheads. Most bulkheads are merely partitions, but transverse watertight bulkheads (figure 1, item 5) are spaced at appropriate intervals. These structural bulkheads extend from the keel to the main deck and from side to side. They provide extra stiffening and partition the hull into independent watertight sections. The spaces created along the double bottom (figure 1, item 4) and up the sides of the vessel are either tanks or voids. Tanks are often filled with oil or water, while voids have no fittings, and are usually left empty. During a collision or a torpedo hit, these outer tanks will most likely rupture. But, they will absorb enough energy to keep the watertight bulkheads intact. This helps to isolate flooding to areas where the primary damage occurs.

FRAMES TO FREEBOARD

Hull plating is fastened to the framework in longitudinal rows, called strakes (figure 1, item 6). The bottom of the keel (figure 1, item 1) forms the center strake. The upper edges of the sides that join the main deck are called the gunwales (figure 1, item 7). The foremost part of the vessel, where the gunwales join the stem, is known as the eyes (figure 2, item 4). Aft, where the gunwales curve inward to the sternpost, is known as the port and starboard quarters (figure 2, item 5). The water level along the hull of the vessel is known as the waterline (figure 2, item 6). The vertical distance from the keel to the waterline is the vessel's draft (figure 2, item 7). Freeboard is the distance from the waterline to the main deck (figure 2, item 8).

DECKS TO COMPARTMENTS

The floors of the vessel are called decks. Decks divide the vessel into layers, and they provide additional hull strength and protection to the internal spaces. The lower surface of each deck forms the overhead of the compartment below. Compartments are the spaces within the vessel. A steel deck is made of strakes (figure 1, item 8). Strakes are the beams that run fore and aft that decks are attached to. Decks are also supported by transverse frames and longitudinal girders. Vertical steel pillars called stanchions (figure 1, item 9) provide deck support in large open spaces like the engine room. Decks are usually arched from the gunwale to the centerline to provide drainage of water and to strengthen the deck. Any deck or part of a deck exposed to the weather is called a weather deck (figure 2, item 9).

DIFFERENT PURPOSES OF DECKS

Bulwarks (figure 2, item 10) are the solid fencing along the gunwale of the main weather decks. Bulwarks are fitted with freeing ports called scuppers. Scuppers allow excess water to run off during heavy weather. A deck that extends from side to side and stem to stern is a complete deck. The uppermost complete deck is called the main deck. The damage control deck is the lowest deck having access through all main transverse bulkheads from forward to aft. On the LT, the main deck acts as the damage control deck. Ladders lead from one deck level to another. They may or may not be covered by hatches. Since the compartments are both above and below the waterline, the greater the number of watertight compartments, the greater the resistance to sinking.

STRUCTURAL DAMAGE

Severe flooding can result from structural damage below the waterline. It is vital to prevent progressive flooding and to remove as much of the water as possible in order to restore buoyancy and stability. Investigation of structural damage must cover a considerable area surrounding the immediate scene of damage. Personnel must investigate not only on the same level, but also the decks above and below the principal casualty. Investigators must look for damage such as fragment holes, ruptured pipe lines, warped or fractured frames, stanchions, cracks, open seams, leaky stuffing tubes, bent shafts, improperly closed fittings, and severed electric cables. Finally, investigators must quickly note any standalone damage that could be as hazardous to the vessel as the prime damage.

METHODS OF REPAIRING HOLES

The two general methods of repairing a hole are to either put something into the hole, or put something over the hole. In either case, the goal is to reduce the area through which water can enter. Although several methods exist that can be used for this purpose, each method requires the use of basic plugging materials. In an emergency, these materials can consist of almost any item that will slow the ingress of water. These include wooden plugs and wedges, shoring, wooden box patches, rags, pillows, mattresses, blankets, kapok life jackets, metal plate patches, flexible sheet metal patches, fabricated steel box patches, bucket patches, and welded steel patches. The basic rule of the sea is to use whatever is needed to stop the water. Any rupture, break, or hole in the outer hull can allow seawater to enter the vessel. If flooding continues uncontrolled, the vessel will sink.

Wooden plugs (figure 3) provide the most simple method of repairing small holes. Plugs made of soft wood are effective if the hole is no larger than 2 x 3 inches. General rule: If your fist can’t fit through the hole, it can be plugged. The vessel has a large assortment of conical, square-ended, and wedge-shaped wooden plugs. The plugs should not be painted, as unpainted soft wood absorbs water and grips better. Combinations of conical, square-ended, and wedge-shaped plugs can be used to get better conformation with the shape of the hole. Plugs can be wrapped with cloth before being inserted into the hole. The cloth helps the plugs to grip better and fill gaps between plugs. Wooden plugs will not always make a watertight fit, but caulking with rags and smaller wedges will help reduce the ingress of water so that the pumps are more effective. Most wooden plugs are inserted from inside the vessel because outside plugs cannot be tended readily. They are often knocked out by the action of the sea and do not hold up as well over extended periods of time.

Pillows (figure 4, item 1) and mattresses have been rolled up and shoved into holes. They have also been rolled around wooden plugs to increase their size and to provide rigidity. Wrapping plugs in a blanket sometimes helps. However, such plugs must be inspected often as they have a tendency to be torn out of the holes by the action of the sea. Feather pillows do not make effective patches or gaskets because when the feathers get wet, they collect in a lump at one end of the cover, and the patch collapses. Additionally, if the case rips, the feathers can clog the pump strainers. Life jackets are more effective, and folded blankets can be used in place of pillows.

There may be materials on board that will allow the crew to fabricate patches made with steel plate. This type of patch is called a plate patch (figure 4, item 2). Plate patches require gasket material to effectively stop the leaking. Strips of rubber will work on flat surfaces, but a far better gasket is a thick tube of canvas stuffed with cloth. It can be secured to the plate with machine screws, washers, and nuts, but the holes through the plate must be reamed, so the screws will not hold the plate away from the vessel. The gasket can also be held in place with retainer strips. At the center of the inner side weld is a ring or eyebolt to secure a line, which holds the patch close to the skin of the vessel.

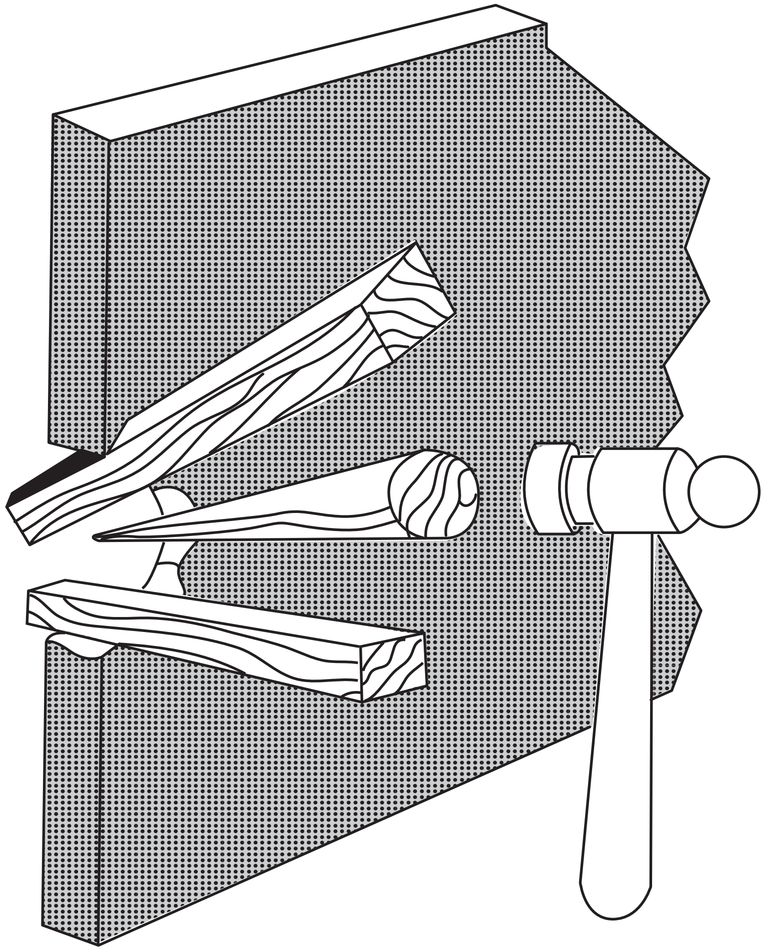


Figure 3. Use of Wooden Plugs and Wedges

Another method used is to drill a hole through the center of the plate and to insert a line or wire through the hole, with the outboard end knotted. Larger sizes are very heavy, and it may be necessary to weld an eye at the top center to secure a handling line, which also can act as the vertical support with the patch in place. Similarly, eyes may be welded in place at the forward and after ends for securing guys. This patch is lowered over the side by the handling and supporting line. A crewmember inside the vessel reaches out through the shell hole, grabs the center line, and pulls the patch tight against the vessel's side. The center line then is made fast to a stanchion. The vessel carries a fair amount of material from which most patches can be improvised. Items such as mattresses, mess tables, joiner doors, deckplates, and gratings can be used.

Sometimes it is desirable to place the patch inside the vessel. This makes it accessible, and reduces the danger of having it knocked away by sea action. For inside patches, mattresses are preferred because they hold their shape better while being placed, they are thicker, and they adjust better to protruding edges. Two thicknesses of crew mattresses generally will be more effective than a single mattress. The mattresses should be backed with joiner doors, steel plates, or wooden plates made from tables. Metal shores can be used to hold them in place. Holes or cracks can also be stuffed with rags and wedges.

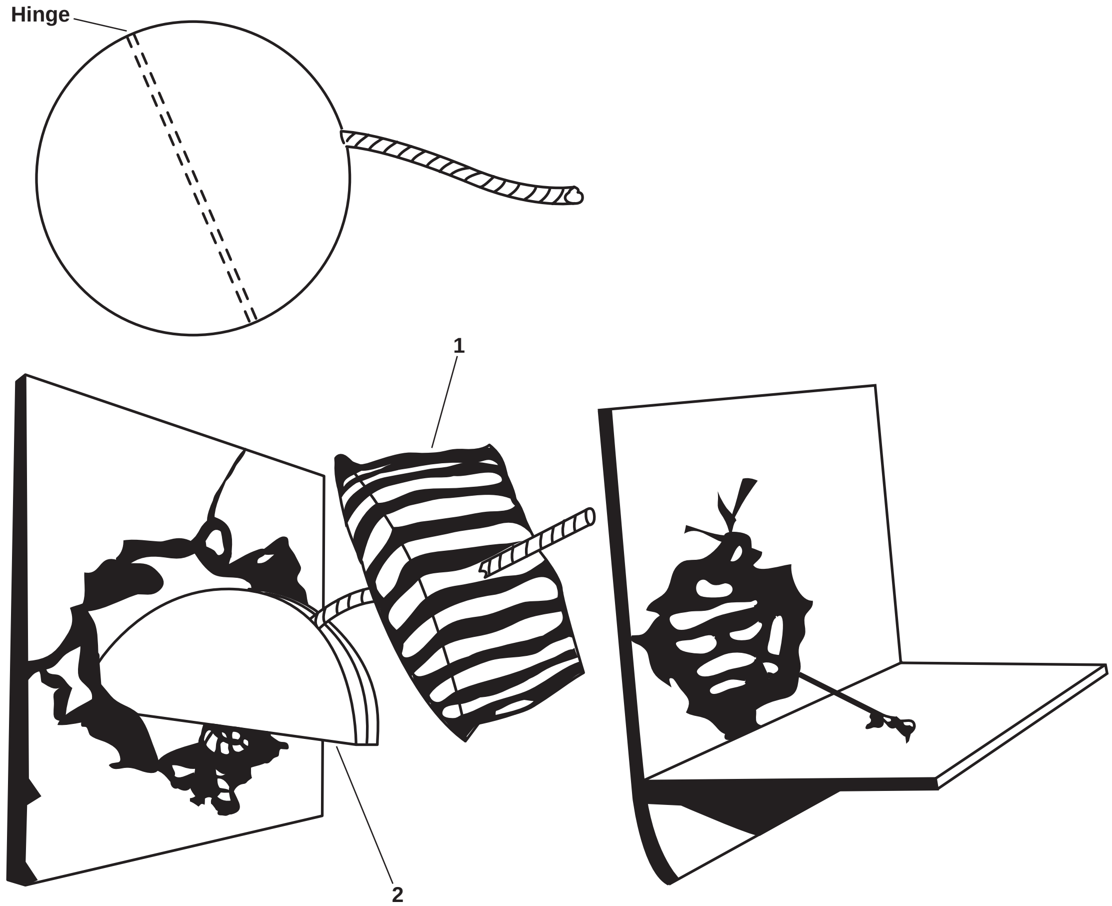


Figure 4. Using a Pillow on a Plate Patch

THE USE OF HOOK BOLTS

A hook bolt is a long bolt (figure 5, item 1) having the head end shaped so that the bolt can be hooked to the plating (figure 5, item 2) of the outer hull. The common types are the T (figure 5, item 3), the L (figure 5, item 4), and the J (figure 5, item 5). They are so named because they resemble those letters. Aboard the LT, these items must be fashioned using whatever long bolts can be found. Metal clamps can be used in this fashion as well. The head end of the bolt is inserted through a hole, and the bolt is rotated or adjusted until it cannot be pulled back through the hole as seen in figure 5. A mattress or pillow is used as a gasket (figure 5, item 6). Deck plating or grating (figure 5, item 7) is then slid over the bolt, and the patch is secured in place by taking up the nuts. It is necessary to use these bolts in a minimum of pairs. Hook bolts can be used in combination with many of the patches previously mentioned.

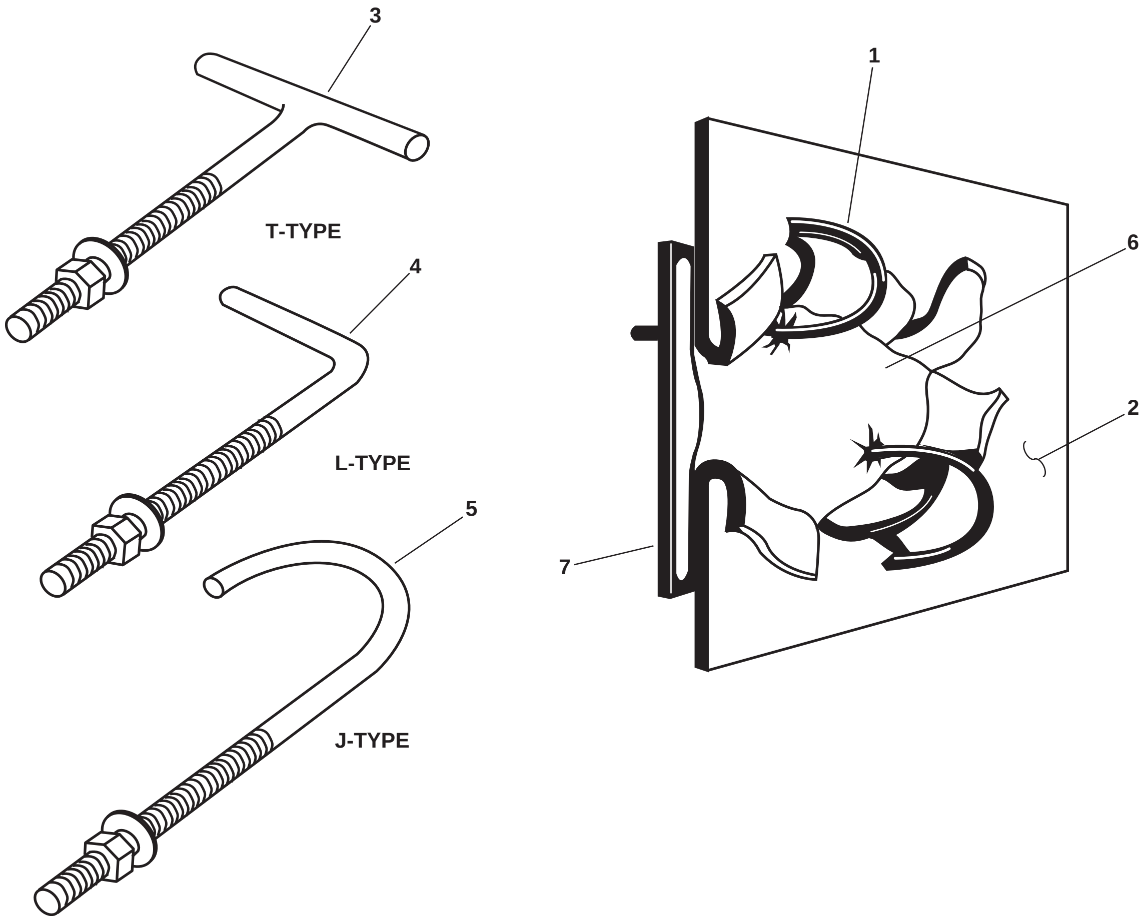


Figure 5. Using Hook Bolts

FOLDING T

A variation of the hook bolt is the folding T (figure 6, item 1). It resembles the T-bolt, but it has a hinge (figure 6, item 2) where the shank joins the crosspiece so it is much like a toggle bolt. This bolt may be folded and inserted through a small hole as seen in figure 7. When pulled back, the crosspiece (figure 7, item 1) catches on the hull plating (figure 7, item 2). By using this bolt, a crewmember standing inside the vessel can put a patch either inside or outside the hull. By means of a retaining line (figure 7, item 3) on the bolt, a strongback (figure 7, item 4) and a pillow (figure 7, item 5) can be threaded over the line and the entire patch folded and tossed out through the hole. When the line is hauled in, the patch takes up against the vessel where it can be readjusted to give a tighter fit. Nuts and washers (figure 7, item 6) can be used to hold and tighten the patch.

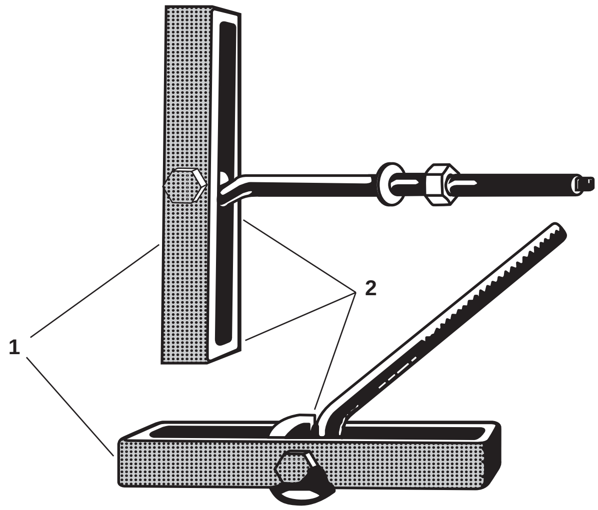


Figure 6. Folding T Patch

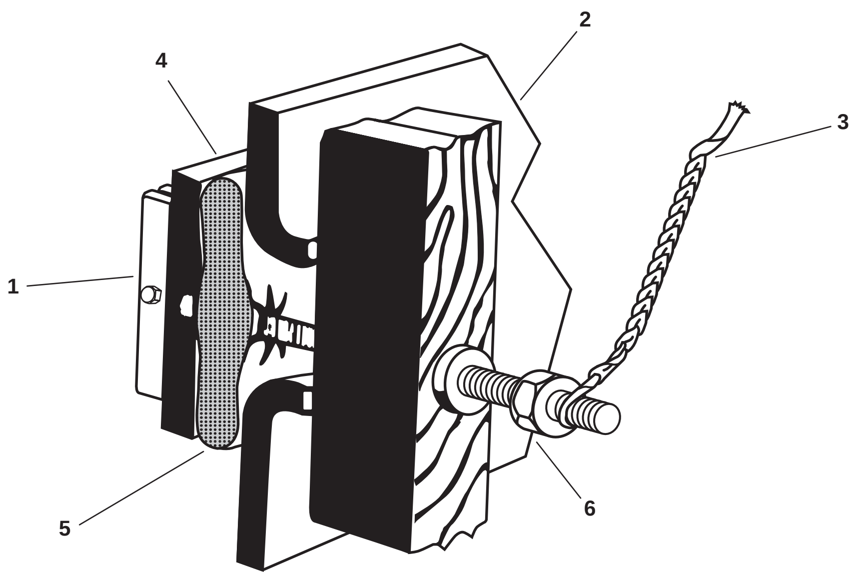


Figure 7. Using a Folding T Patch

STRENGTHENING BEAMS AND FRAMES

Beams, frames, and decks, and some bulkheads are strength members of the hull structure, and if they break or become weakened, the hull may collapse, and the vessel will break in two and sink. A small vessel may not have the equipment needed to weld heavy rails or angle irons to give additional support, but some help can be obtained by shifting weights to reduce the strain, and by shoring. Beams and frames can be patched or strengthened by bolting or welding doubling plates or bars along the webs as shown in figure 8.

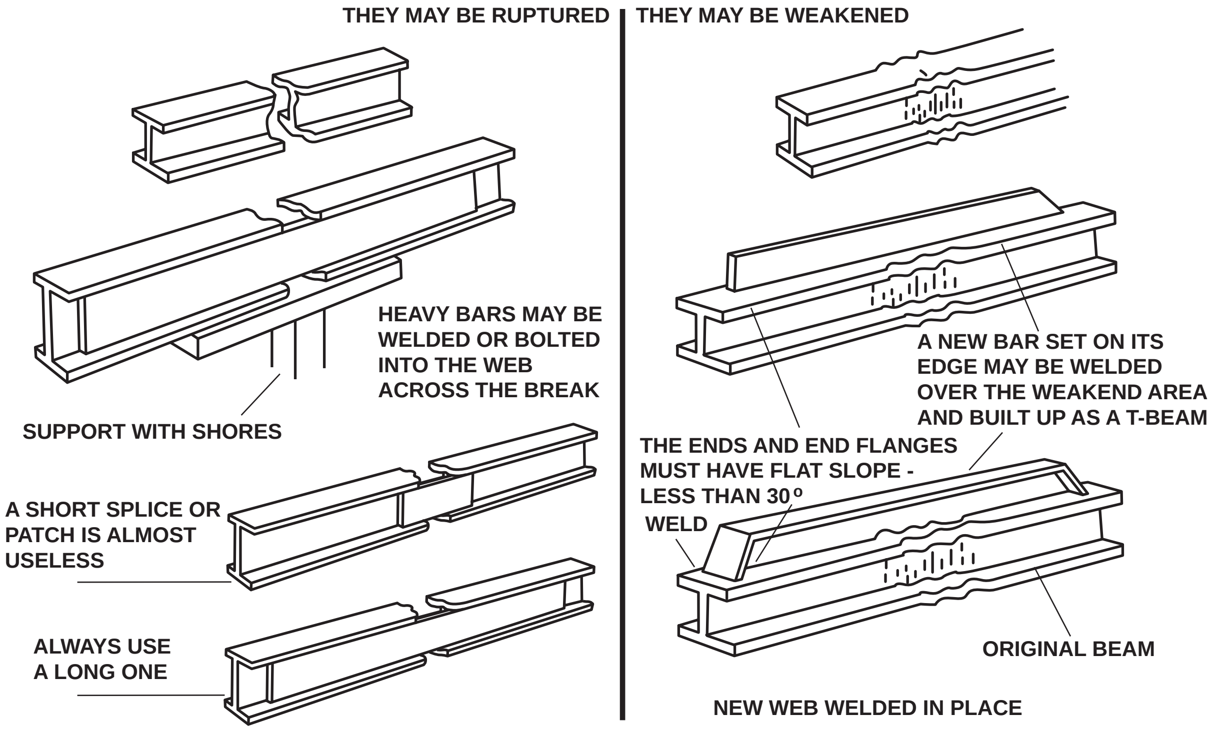


Figure 8. Examples of Structural Repairs

QUICK-SEALING LEAKS AND CRACKS

A fairly common type of leak is caused by a crack in a steel plate. When the leak is in a flat surface away from frames and other interferences, generally it can be stopped by scraping the surface smooth and applying a patch of sheet packing backed by a shore, which can be held in place with metal shoring. Upon inspecting a crack, it may be found that it has increased in length. The plating is being torn like paper. To prevent further cracking, drill quarter-inch holes at the extreme ends of the crack (figure 9), and plug the holes. If there is time, weld a plate over the crack. Generally, it is not advisable to drive wedges into cracks in thin plating, especially hardwood wedges, as the wedges tend to open the cracks. Marline, oakum, and rags often can be used as effective caulking materials.

Supports for heavy equipment may be pushed back into place with screw jacks and shoring. The LT is fitted with steel shores that may be welded in place if needed. Chainfalls and heavy wires fitted with turnbuckles may be useful in pulling plating and equipment back to their original positions. Supports under dislocated machinery often must be carried down several decks because a single deck may not have the strength to support all the weight. It may be necessary to make successive supports down to the bottom frames. In shoring heavy weights, the butt of the shore needs to be placed on a solid frame. When damaged, structural members can become cracked. The stresses of repair or reloading may cause further cracking and weakening of the member. Holes drilled at the end(s) of the crack will stop the run. The overall strength of the member is reduced. Spreading the load between three frames by the use of shores and reducing stress fatigue by halting the cracks generally makes for a safer structural repair.

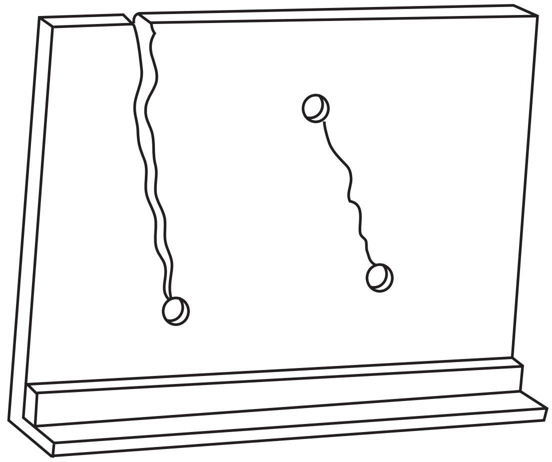


Figure 9. Halting Stress Cracks

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) PIPING RELATED FLOODING

PATCHING

There are several types of patches that can be used for repairing pipes. They include fiberglass plastics, wooden plugs, soft patches, and items that must be made with whatever material can be found. Always keep in mind that there is no perfect emergency patch. There is only the best that you can do for a given situation. The goal of damage control is to stop the flooding to save the vessel. However, it may be impossible to completely halt all leaks. So, the next best thing is to slow all flooding and leaks to the point that the onboard pumps can keep ahead of the incoming water. Various methods for accomplishing this are described in this work package.

TYPES OF RUPTURES

There are various types of ruptures that can occur in piping systems (figure 1). Some examples are as follows:

1. Simple - a rupture with no protruding edges, located on a straight section of pipe.
2. Elbow - a rupture with no protruding edges, located on a curved section of pipe.
3. Severed - a section of pipe that has been completely separated from another section of pipe.
4. Compound - any rupture that has protruding edges. This includes the three listed above, ruptures in fittings and flanges, mangled pipes, and similar piping damage.

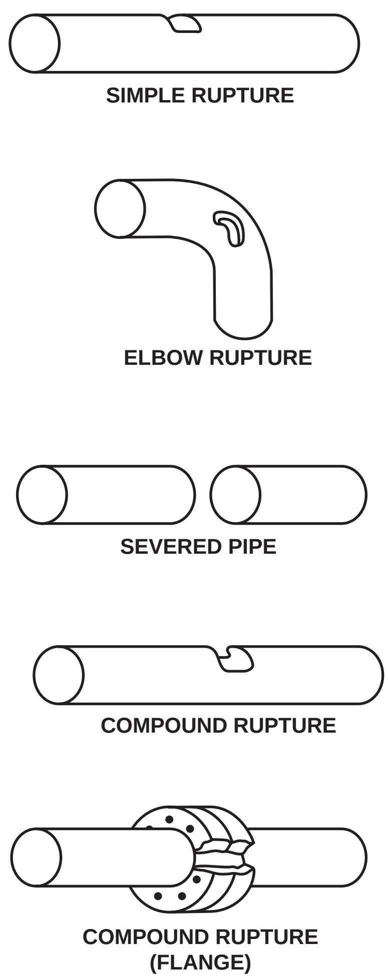


Figure 1. Types of Piping Ruptures

BASIC MATERIALS USED IN PATCHING PIPES

Materials used for patching pipes are some of the simplest on board the LT. Plugs and wedges that can be driven into cracks and holes are provided. These simple tools have been used for hundreds of years, and they still have a place in modern damage control. Chemically activated materials are also used aboard the LT. Descriptions of their uses are listed in the following paragraphs.

RESINS AND HARDENERS

The damage control pipe repair kit on board the LT utilizes liquid and paste resins of the two part epoxy type. The liquid and paste provided in the kits are chemical compounds used to harden resins. These ingredients are packaged in prescribed amounts. When the hardeners and resins are mixed, a chemical reaction occurs that causes the mixture to harden. The liquid mixture sets in approximately 12 minutes, and the paste mixture sets in approximately 17 minutes. These mixtures are used in the following manner:

1. Woven Roving Cloth is made of a short staple, glass fiber woven into a thick fluffy cloth. During the application of a plastic patch, the cloth is coated with the resin hardener mixture, and then it is wrapped around or placed over the damaged section. The cloth provides the principal strength of the patch and the resin provides the adhesion and ensures that the patch will conform to the damaged area.

2. Film (PVC) is a thin, transparent, polyvinyl chloride material used as a separating film for a flat patch to prevent the patch from adhering to the backup plate or supports. In pipe patching, it is used to cover the entire patch and retain the activated resin around the patch. In this application, it is described as a retaining cover. Plastic wrapping paper or Mylar can be substituted as retaining covers.

DAMAGE CONTROL METALLIC PIPE AND GENERAL REPAIR KIT (PLASTIC)

All water, fuel, and gas lines can be repaired by use of the piping repair kits. The complete kit is basically a fiberglass repair kit, and is versatile because it can be used to repair piping systems, fittings, bulkheads, and decks. The plastic can be used as a filler for cracks and small holes where the pressures are under 300 lb/in² (20.7 bar) and the temperature does not exceed 200 °F (93.3 °C). The patching material has excellent adhesive qualities when applied to ferrous and cuprous metals and can be employed for emergency repairs to a variety of damaged structures having smooth or jagged protruding edges.

Plastic patches can be applied to systems that require permanent repair but must be delayed due to mission requirements. The preparation and application of the plastic patch can be accomplished with basic knowledge and training. The application of the pipe or surface patch is comparable to that of a battle dressing in first aid, and the use of the paste is as simple as applying putty. When properly applied, plastic patches are completely effective. When defects do occur, the leakage is usually found at the extremities of the patch, between the patch and the metal surface. These leaks generally are less than one percent, and do not become greater.

The defects are generally attributed to faulty preparation or application. The speed of application of a plastic patch is basically determined by the size and type of rupture, and the local working conditions. A simple type patch can be applied to a 4-inch (10.2 cm) pipe in less than 10 minutes. Various types of damage may require varying preparation times. But once the patch is properly in place, the type and size of the rupture or the size and shape of the structure have little effect on the time involved. The maximum patch life has not been determined, but all indications are that a properly applied patch will last until such time as a permanent repair or replacement can be made.

The patch is relatively inert, and is adversely affected only by temperatures above 200 °F (93.3 °C). and concentrated acids. The success of a properly applied patch is dependent upon only two factors. The overall strength of the patch, and the adhesion of the patch. If these two factors are present, the patch will be completely effective. While curing, the patch will have the tendency to adhere to metal and to other surfaces. The process of applying the plastic patch actually reinforces the activated resin with fibrous glass material. The reinforcement of the resin greatly increases the overall strength of the patch when it is cured. If you run out of fibrous glass materials, reinforcing can be accomplished by the use of cloth such as a blanket or some other material that will absorb the resin. In most cases, reinforcing with other materials will not provide the equivalent strength, but substitute materials are highly effective when nothing else is available.

TYPES OF PATCHES AND THEIR USES

PIPE PATCH

The components in the repair kit used for repairing piping systems are the liquid resin and the liquid hardener mixture together with the woven roving cloth fibrous glass material. This mixture is authorized for use in patching fresh water, salt water, lube oil, fuel oil, and refrigeration piping systems.

PASTE PATCH

The paste patch can be used as a metallic or as a nonmetallic surface repair patch. The paste mixture was developed primarily for repairing small holes and cracks less than one inch in diameter. In many respects, the paste mixture has the same general characteristics as the liquid mixture. However, the paste is much thicker, and it has the necessary reinforcement already built into the mixture. The paste mixture is approved for patching sea chests, valve bodies, pump casings, cooling water jackets, condenser heads, flanges, and threaded joints. It can also be used as caulking for leaking seams. Basically, it can be used as a patch on whatever shape it will conform and adhere to.

FLAT PATCH

The simple flat patch is approved for making plastic repairs to ruptures in metallic and nonmetallic surfaces. Ruptures up to 12 inches in diameter can be repaired by using procedures similar to those employed in making pipe repairs. For ruptures more than 6 inches in diameter, the patch overlap should increase by about one inch for each inch of increased diameter. The greater the overlap, the larger the area to which the patch will adhere. This increases the overall strength of the patch.

VOID COVER

A void cover is a resin treated glass cloth that can be cut and formed to cover and support the patching materials over a damaged area. The void cover can be used for some structural repairs too.

RENEWING PIPING

If the pipe has been badly holed or ruptured, patching may not suffice, and it may be necessary to renew a section. It is advisable to carry spare sections of the smaller sizes of important pipe. In an emergency, it may be possible to remove a section from an unimportant system to use where the need is more urgent. If the original pipe was fitted with screw flanges, remove the entire damaged section, cut screw threads on the new piece, screw the flanges onto the new piece, and install it. The flanges are bolted together. To renew only the damaged part of a small pipe, cut out the damaged area with hacksaws, and cut a piece of pipe almost the same length as the gap. Cut screw threads on all exposed ends of pipe and make up the joints by using pipe unions and couplings. Cut the filler piece short enough to permit inserting the pipefittings. White lead may be used on screw threads to seal the joint. Unions, similar to the soft patches previously described, may be improvised. If the joints are not held together, they may be pushed apart by pressure reaction. It is advisable to force the joints together by means of lines, shores, or wedges.

GASOLINE OR OTHER FLAMMABLE FLUID LINES

Soft patches are not recommended for gasoline or other flammable fluid lines because the slightest leak in a pressurized system causes misting and vapors. This would create a tremendous fire hazard. It is far safer to renew the damaged section. If absolutely necessary, a plastic patch can be used as an emergency repair for flammable fluid lines.

SOFT PATCHES

Small holes or cracks in low pressure piping can be repaired by what are known as soft patches. The first step is to reduce the area of the hole by driving in softwood wedges. Ensure that the wedges are not driven in too far, or they will retard the flow of fluids. In some cases, the wedges can be cut before they are driven into the pipe. The wedges are then trimmed flush with the outside of the pipe and covered with a strip of sheet rubber packing. If possible, the packing should extend 2 inches on either side of the hole. Finally, marline or wire is used to bind the soft patch into place. Examples of soft patches can be seen in WP 0007 00.

The soft patch can be modified or improved to suit immediate conditions. If available, use a curved plate of lightweight sheet metal between the packing and binding layers. Also, marline has been used successfully as a caulking material in cracks. In many cases, such as in sharp curves, it is not possible to use sheet packing. Combinations of wedges, marline, and various plastics will often make effective patches. Wooden plugs covered with cloth have stopped or slowed many leaks in piping. Sometimes a combination of both plugs and wedges is needed. The goal is to slow the flooding and leaks so that the pumps can keep up. If necessary, set the plugs with a hammer and secure them in place with clamps. Even if the leak is not completely halted, significant progress will be made in slowing the leak. If you slow the leaks enough, the pumps will do the rest.

WOODEN PLUGS

Wooden plugs covered with cloth have stopped many jagged holes in piping. Sometimes, combinations of plugs may be used. Install the plugs with a hammer and try to secure them in place with clamps or wires. Unsecured plugs may work out under pressure. If the hole is not too large, it may be drilled and tapped for inserting a screw plug.

THUMB CLAMPS AND C CLAMPS

C clamps and thumb clamps may be used to hold plugs or patches in place. For example, a block of soft wood may be rough-shaped to fit over a damaged area in a pipe, and the pad may be held in place tightly with two thumb clamps. Care must be taken to monitor patches held in place by clamps as they have a tendency to work loose under shock and vibration.

CAULKING WITH HAMMER AND CHISEL

Light caulking with a hammer and chisel has sometimes been used to close small crack leaks, especially adjacent to flanges. There is always a danger of opening the crack even wider.

WELDING AND BRAZING

Welding, brazing, and silver soldering can be used to repair leaks, especially at the joint between pipe and flanges. These methods are slow and unreliable in the hands of unskilled personnel and may lead to fires and explosions.

METAL CLAMPING TOOL

A metal clamping tool, usually referred to as the band-it, has many uses in the repair of piping. It is simple to operate, and it produces a very effective repair when properly applied. The crew must practice its use during flooding drills. This device can be used to patch pipes of any diameter on the vessel. The steel bands can also be used to hold plugs, wedges, and strongbacks in place in pressurized piping. Use of the metal clamping tool is demonstrated in WP 0007 00.

BLANKING LINES

Ruptured pipelines often are a menace because they cannot be readily isolated and continue to perform a vital function within the piping system. In the case of the fire main, the choice may lie between flooding a compartment or extinguishing a fire. Frequently, in the case of oil lines, important and undamaged machinery must be secured. Such problems have been solved by blanking off part of the pipeline. Low pressure pipelines often can be blanked by driving wooden plugs covered with cloth into the pipe. Unsupported, these plugs have a tendency to back out. Adequate support generally can be provided by using metal shores or jacks. Sometimes drilling a hole through the pipe and pinning the plug in place is effective. For frayed ends of pipe cut by fragments, combinations of plugs may be desirable. When the damaged pipe is joined by screw fittings, it is a simple matter to unscrew the damaged part and to stop the flow of fluid by means of a pipe cap or a plug.

THE JUBILEE PIPE PATCH

The jubilee pipe patch is homemade, and is an extreme modification of a hose clamp. This patch consists of a piece of sheet metal (figure 2, item 1) that is rolled into a cylinder. The cylinder forms a gap that can be used as flanges (figure 2, item 2). These flanges can be reinforced by welding on strips of scrap iron (figure 2, item 3), after which the two flanges are drilled to take from three to five bolts (figure 2, item 4). Small braces (figure 2, item 5) can be welded to keep the flange faces more parallel under pressure.

The sheet metal in the body of the patch must be as heavy and strong as possible, but it should be capable of being bent, so the gap will go over the pipe to be repaired. A sheet of packing (figure 2, item 6) is first put over the hole. Make sure the packing extends on either side of the hole. The jubilee clamp is then folded open and placed over the packing. When the bolts are tightened, this patch will easily hold 100 lb/in² (6.9 bar) of pressure. It is advisable to prefabricate several of these homemade patches in assorted sizes. In some cases, the patch can be prepositioned, waiting for use.

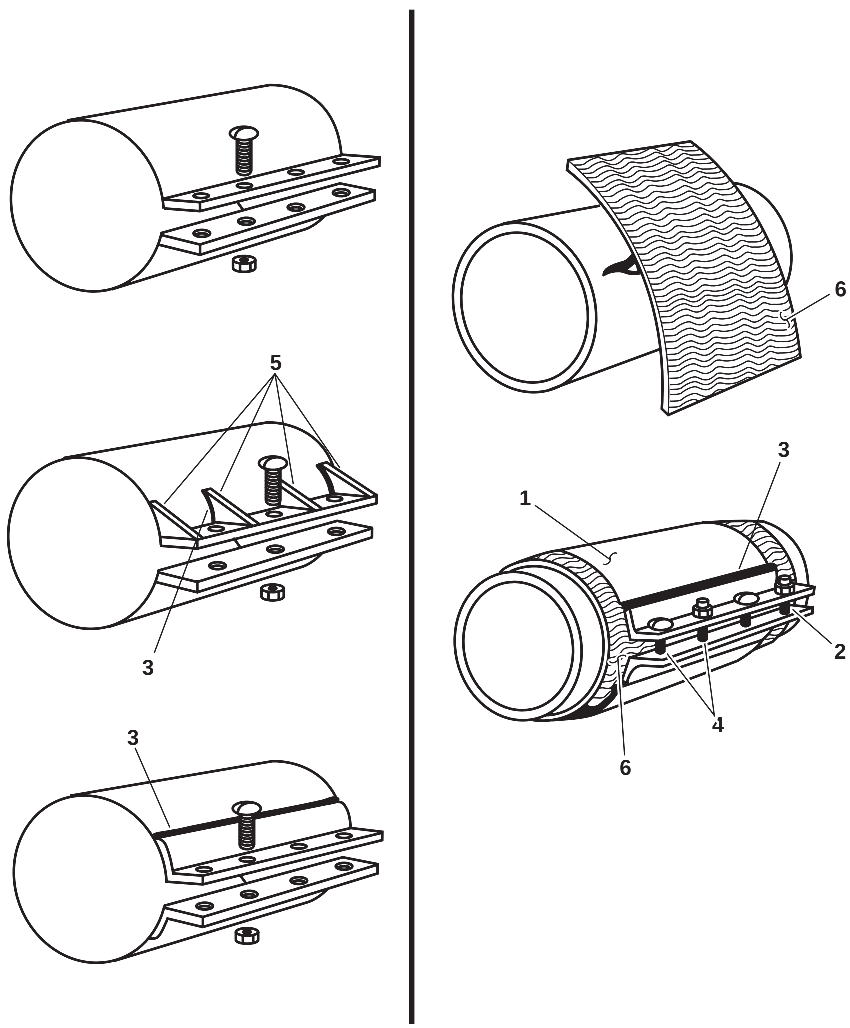


Figure 2. The Jubilee Pipe Patch

END OF WORK PACKAGE

Chapter 9

Electrical Power and Lighting
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) NORMAL ELECTRIC POWER

Electrical power is indispensable to the functional effectiveness of the LT. Electrical power produces light, runs vital equipment, and provides the power necessary to help turn the rudders. It also operates the radar, communications, ventilation, and a host of other equipment necessary on the LT.

Normal electrical power is supplied by two Caterpillar 3408 DITA-JW Marine Generator Sets. Each generator set is rated at 450 Vac, 275 kW. A single generator is capable of providing enough power to operate the equipment on the vessel. One generator can be operated by itself, or both generators may be run in parallel. The generators supply power to the main switchboard, which in turn supplies power to the various equipment, distribution panels, and to the emergency switchboard during normal power operation.

Power may also be taken from an off-hull source via a shore power connection, which feeds the main switchboard. An interlock prevents parallel operation of the generators and shore power. The shore power connection is located on the main deck centerline on the bulkhead of the deckhouse, and two 75-foot lengths of shore power cable are supplied with the vessel.

ELECTRICAL DAMAGE CONTROL

Wiring circuits may be severed by blasts, fragments, and structural damage. Wiring repair should only be accomplished when it is essential for returning to port. The method most commonly used for making these repairs is splicing. The splicing of wires should only be done whenever it is absolutely necessary. Repairing open circuits by splicing involves inserting a new “jumper” wire that bypasses the problem area. Improperly installed jumper wires often draw more current than the original wiring and may present overloading problems and/or fire hazards. If wire is not available in shipboard storage, it may be necessary to salvage wire from non-essential or inoperative systems.

POWER DISTRIBUTION

The distribution feeders originate at the main switchboard and supply power to distribution panels or directly to individual auxiliaries. The distribution panels distribute power to the individual auxiliaries. Figure 1 shows normal power distribution. During flooded conditions, it may be necessary to remove power from the affected area. In most cases, power will be removed automatically when the floodwaters cause breakers to trip. However, when entering a flooded space, do not assume that power is removed for all equipment. Electrical powered equipment must be treated as energized until it is proven electrically safe. Power should not be restored to flooded equipment until the water has been removed, circuits cleaned, properly dried, and an inspection made to ensure that the electrical conditions are safe.

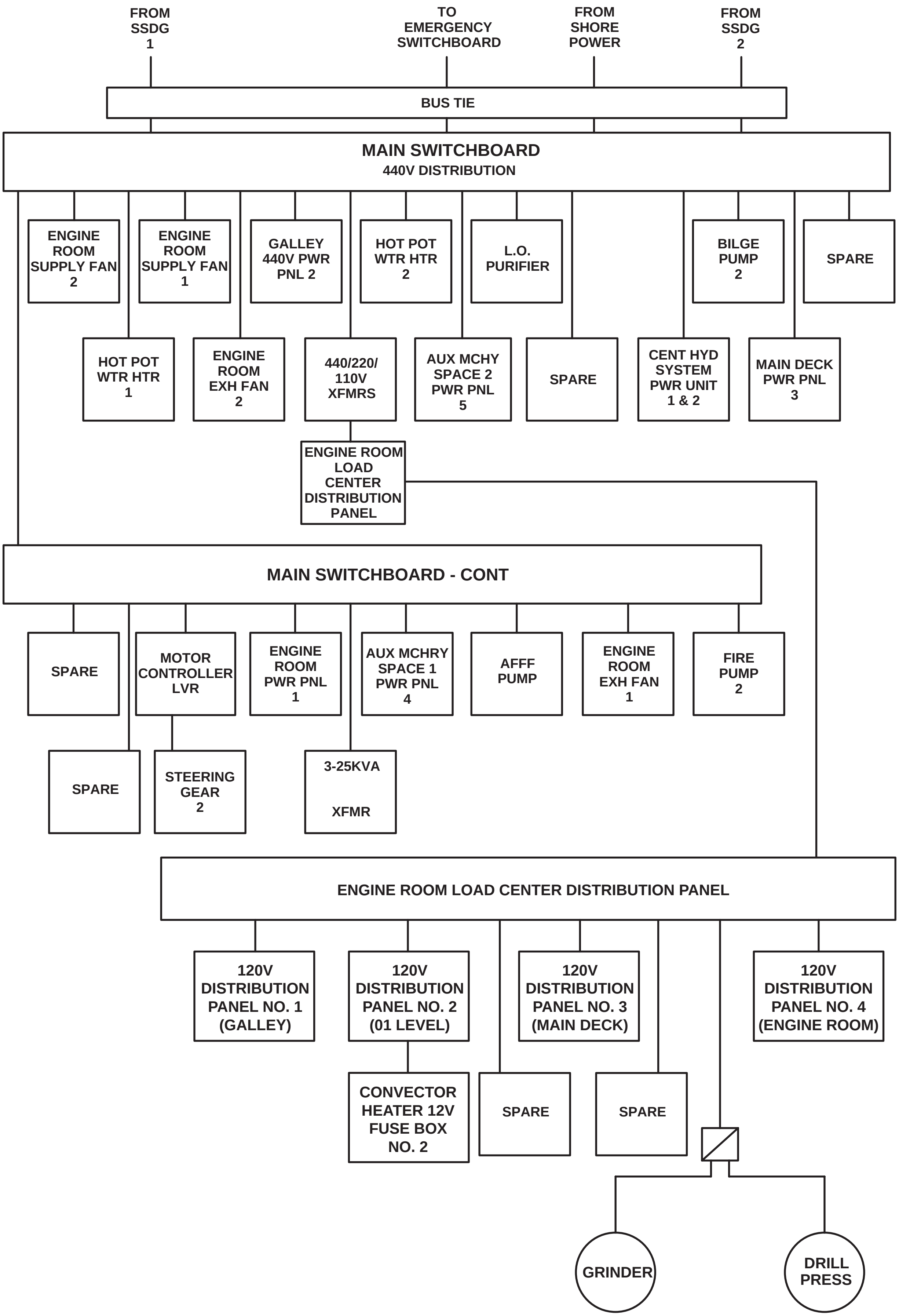


Figure 1. Normal Power Distribution

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) EMERGENCY ELECTRIC POWER

Emergency power (figure 1) is supplied by a Caterpillar Model 3304 NA Marine Generator Set. The emergency generator is rated at 450 Vac, 65 kW, and supplies the vital equipment. All loads fed by the emergency switchboard are considered vital. The emergency switchboard is normally powered by the main switchboard via the bus tie breakers. The emergency switchboard senses when normal power is lost, and automatically starts the emergency diesel generator within 45 seconds. In this condition, the emergency switchboard feeds the main switchboard and its vital equipment.

Seven independent 24 Vdc battery banks are provided. Battery chargers for each battery bank are provided. The chargers receive power from the emergency load centers. Damaged batteries can present toxic and flammable hazards. Locations of all batteries and their chargers should be known so that their condition may be checked in an emergency. Many of the batteries used are interchangeable. If a battery is damaged in a vital system, it can be replaced with one from a non-vital system. The systems containing batteries and chargers are as follows.

1. SSDG 1 Battery and Charger
2. EDG Starting Battery and Charger
3. General Alarm System Battery and Charger
4. Radio DC Electronics and Battery Charger
5. Machinery Plant Monitoring System Battery and Charger
6. Engine Order Telegraph Uninterruptible Power Supply Battery and Charger
7. Reverse Osmosis Water Purification Unit Battery and Charger

EMERGENCY POWER OPERATION

In the event of loss of normal power, the emergency generator will automatically start and energize the emergency switchboard within 45 seconds by use of Automatic Bus Transfer (ABT) equipment. The following equipment is powered directly from the emergency switchboard, and is immediately available when the EDG is online.

1. Fire and General Service Pump 1
2. Emergency DIESEL Generator Jacket Water Heater
3. Bilge and Ballast Pump 1
4. Fuel Oil Transfer Pump 1
5. Steering Gear 2
6. 120V Emergency Load Center Distribution Panel

EMERGENCY LIGHTING

Designated lights in vital spaces provide illumination during emergency conditions. There are 72 emergency lights throughout the vessel powered from the emergency switchboard in case of loss of normal lighting. Emergency lighting is provided in the EOS, the Bow Thruster Compartment, the Engine Room, AMS 1, AMS 2, the Steering Gear Room, and in the Pilothouse. Emergency floodlighting is provided for towing operations, life raft handling, anchor handling and operation of the deck crane.

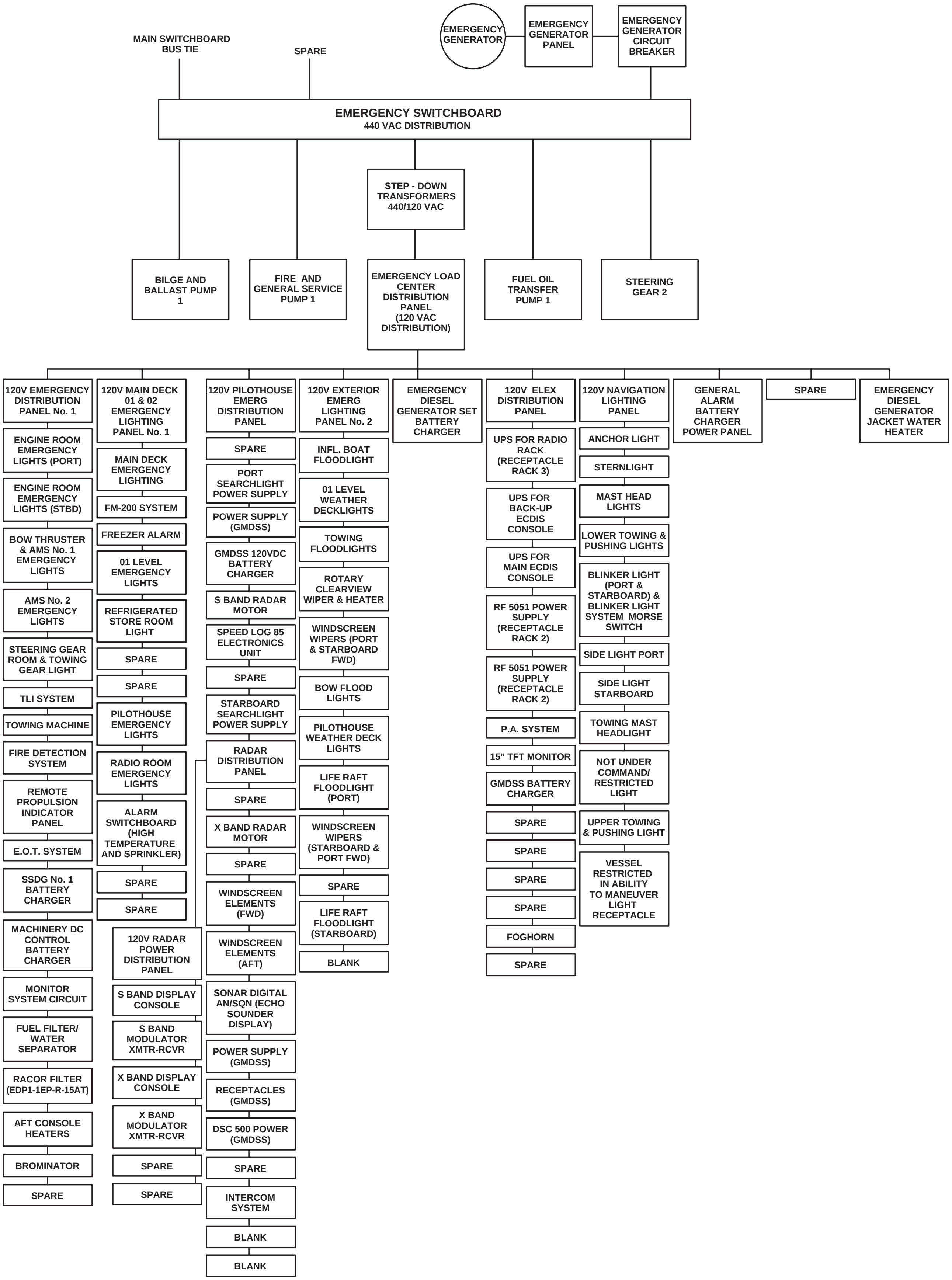


Figure 1. Emergency Power Distribution

Additionally, certain mission essential lighting and control circuits are considered vital, and they are powered from the emergency lighting panels. These include the following:

1. Pilothouse Emergency Lights
2. Main Deck Emergency Lighting
3. 01 Level Emergency Lights
4. Radio Room Emergency Lights
5. Alarm Switchboard (High Temperature & Sprinkler) for the Arms Room
6. Not Under Command/Restricted Manuvering Lights
7. Lower and Upper Pushing and Towing Lights
8. Anchor and Stern Lights
9. Masthead Lights

END OF WORK PACKAGE

Chapter 10

Supporting Information
for
Shipboard Damage Control

Inland and Coastal Large Tug (LT)

SHIPBOARD DAMAGE CONTROL FOR INLAND AND COASTAL LARGE TUG (LT) REFERENCES

This work package lists all field manuals, forms, technical manuals, and miscellaneous publications referenced in this manual.

ARMY REGULATIONS

AR 750-10	Army Modification Program

FIELD MANUALS

FM 4-25.11	First Aid
FM 55-501	Marine Crewman's Handbook
FM 55-502	Watercraft Safety

TECHNICAL MANUALS

TM 55-1925-273-10	Operator's Manual for Inland and Coastal Large Tug (LT)

FORMS AND PAMPHLETS

DA Form 2028	Recommended Changes to Equipment Technical Publications

OTHER PUBLICATIONS

No Publication Number	Stability and Load Data Booklet (prepared and supplied to the vessel by the design group)

END OF WORK PACKAGE

SHIPBOARD DAMAGE CONTROL MANUAL
INLAND AND COASTAL LARGE TUG (LT)
GLOSSARY

AFFF — A solution of 6% detergent and 94% water; used as an extinguishing agent on flammable liquid fires.

Buoyancy — The ability of an object to float on its own without outside intervention.

Casualty — Damage to the vessel or its crew.

Center of Gravity — The point at which all the weights of the unit or system are considered to be concentrated and have the same effect as that of all the component parts.

Clinometer — An instrument for measuring the angles of roll and pitch.

Damage Control — The assessment and repair of equipment failures that can occur under emergency conditions such as battle damage, fire, and flooding.

Damper — A flap, usually metal, that seals a ventilation opening to secure the flow of air through the opening.

Fire Monitor — Large water discharge nozzles provided primarily to fight fires on other ships when rendering aid.

FM-200 — A fire extinguising agent approved for use in occupied spaces onboard a vessel.

Freeboard — The distance from the waterline to the weather deck edge. For consistent use, freeboard is calculated at the amidships section.

General Alarm System — A multipurpose alarm that is used to alert the crew to general alarm conditions and casualties. In the event of an emergency such a fire, flooding, or collision, the general alarm is activated, and an announcement is made to inform the crew of the nature of the casualty.

List — A temporary inclining of the vessel to one side.

Logy — A term to describe heavy and sluggish movement of the ship.

Loll — The tendency of a ship to hang at the end of a roll instead of quickly righting itself.

PFD — Personal Flotation Device. A buoyant vest worn to keep personnel afloat.

PVC — A plastic material used in some electrical cable insulation.

Reserve Buoyancy — The volume of the watertight portion of the vessel above the waterline.

Shoring	Temporary bracing placed to prevent further structural degradation.
Smoke	A mixture of matter consisting of very fine solid particles and condensed vapor.
Sound Powered Telephone	An onboard communication system powered by the sound pressure of the speaker's voice rather than by an external electrical source.
Watertight Boundary	An enclosed area, impermeable to liquids. The watertight boundary is maintained to control flooding so that efforts to combat the casualty are better focused.
Watertight Integrity	A design condition composed of a system of closures or fittings that prevent the ingress of water to certain compartments.

SHIPBOARD DAMAGE CONTROL MANUAL
INLAND AND COASTAL LARGE TUG (LT)
ALPHABETICAL INDEX

D

By Order of the Secretary of the Army:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

Official:

Sandra R. Riley

SANDRA R. RILEY
Administrative Assistant to the
Secretary of the Army

0529214

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These are the instructions for sending an electronic 2028.

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however, only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17 and 27.

From: "Whomever" whomever@avma27.army.mil
To: whomever@avma27.army.mil
To: TACOM-TECH-PUBS@ria.army.mil

Subject: DA Form 2028

1. ***From:*** Joe Smith
2. ***Unit:*** home
3. ***Address:*** 4300 Park
4. ***City:*** Hometown
5. ***St:*** MO
6. ***Zip:*** 77777
7. ***Date Sent:*** 19-OCT-93
8. ***Pub no:*** 55-1915-200-10
9. ***Pub Title:*** TM
10. ***Publication Date:*** 11-APR-88
11. ***Change Number:*** 12
12. ***Submitter Rank:*** MSG
13. ***Submitter Fname:*** Joe
14. ***Submitter Mname:*** T
15. ***Submitter Lname:*** Smith
16. ***Submitter Phone:*** 123-123-1234
17. ***Problem:*** 1
18. ***Page:*** 1
19. ***Paragraph:*** 3
20. ***Line:*** 4
21. ***NSN:*** 5
22. ***Reference:*** 6
23. ***Figure:*** 7
24. ***Table:*** 8
25. ***Item:*** 9
26. ***Total:*** 123
27. ***Text:***

This is the text for the problem below line 27.

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS

For use of this form, see AR 310-1; the proponent agency is the US Army Adjutant General Center.

Use Part II *(reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).

DATE: Date form is filled out.

TO: *(Forward to proponent of publication or form) (Include ZIP Code)*

Mailing address found on title block page.

FROM: *(Activity and location) (Include ZIP Code)*

Your mailing address.

PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER: TM X-XXXX-XXX-XXX

DATE: Date of the TM.

TITLE: Title of TM.

ITEM NO.	PAGE NO.	PARA-GRAPH	LINE NO.	FIGURE NO.	TABLE NO.	RECOMMENDED CHANGES AND REASON (Exact wording of recommended change must be given)
	0019 00 1	3	1	1		Step No. 2 says to secure doors open with locking bar or hooks from where to what? The bars or hooks are not identified.
	0019 00 4	4	1	1		Step No. 19 states to remove locking bars, pins or hooks from where to what? The bars, pins or hooks are not identified. Where are they stored?

SAMPLE

* Reference to line numbers within the paragraph or subparagraph.

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE
Doe, John, CPL	755-1313	*CPL John Doe*

TO: *(Forward to proponent of publication or form) (Include ZIP Code)*	FROM: *(Activity and location) (Include ZIP Code)*	DATE:

PART II- REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION/FORM NUMBER:	DATE:	TITLE:
TM X-XXXX-XXX-XXX	Date of the TM.	Title of TM.

PAGE NO.	COLM NO.	LINE NO.	FEDERAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

SAMPLE

PART III - REMARKS *(Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

* Reference to line numbers within the paragraph or subparagraph.

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE
Doe, John, CPL	755-1313	*CPL John Doe*

☆ U.S. GOVERNMENT PRINTING OFFICE 1981 341-646/8606

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25-30; the proponent agency is OAASA	Use Part II *(reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	DATE
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PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE
TM 55-1925-273-SDC		Shipboard Damage Control Manual for Inland and Coastal Large Tug (LT) NSN 1925-01-509-7013 (EIC XAG)

ITEM	PAGE	PARA-	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

DA FORM 2028, FEB 74 REPLACES DA FORM 2028, 1 DEC 68, WHICH WILL BE USED. APD V4.00

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PART II - REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	DATE	TITLE
TM 55-1925-273-SDC		Shipboard Damage Control Manual for Inland and Coastal Large Tug (LT) NSN 1925-01-509-7013 (EIC XAG)

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

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Metric Conversion Factors

Mc x F = Cf		
Measurement to be Converted (Mc)	Factor (F)	Converted Measurement (Cf)
Meters (m)	x 39.37	= Inches (in.)
Meters (m)	x 3.281	= Feet (ft)
Meters (m)	x 1.094	= Yards (yd)
Inches (in.)	x 25.40	= Millimeters (mm)
Inches (in.)	x 2.54	= Centimeters (cm)
Inches (in.)	x 0.0254	= Meters (m)
Inches (in.)	x 25400	= Micrometers (µm)
Feet (ft)	x 0.305	= Meters (m)
Square feet (ft^2)	x 0.093	= Square meters (m^2)
Foot-Pounds	x 1.35582	= Newton meters (N m)
Newton meters (N m)	x 0.73756	= Foot Pounds
Yards (yd)	x 0.914	= Meters (m)
Square yards (yd^2)	x 0.836	= Square meters (m^2)
Square Inches (in^2)	x 6.452	= Square Centimeters (cm^2)
Cubic Inches (in^3)	x 16.39	= Cubic Centimeters (cm^3)
Cubic Centimeters (cm^3)	x 0.061	= Cubic Inches (in^3)
Cubic Feet (ft^3)	x 0.028	= Cubic Meters (cm^3)
Gallons (gal)	x 3.785	= Liters (L)
Liters (L)	x 0.2642	= Gallons (gal)
Kilometers (km)	x 0.5397	= Nautical miles (nmi)
Meters (m)	x 0.0005397	= Nautical miles (nmi)
Nautical miles (nmi)	x 1.853	= Kilometers (km)
Fluid Ounces (oz)	x 29.574	= Milliliters (mL)
Pounds (lb)	x 0.4536	= Kilograms (kg)
Kilograms (kg)	x 2.2046	= Pounds (lb)
Kilopascals (kPa)	x 0.145	= Pounds (lb) per Square Inch (psi)
Pounds per Square Inch (psi)	x 6.895	= Kilopascals (kPa)
Degrees Centigrade (°C)	(°C x 1.8) + 32	= Degrees Fahrenheit (°F)
Degrees Fahrenheit (°F)	(°F-32) ÷ 1.8	= Degrees Centigrade (°C)
Bar	x 14.5	= Pounds per Square Inch (psi)
Pounds per Square Inch (psi)	x 0.06894	= Bar
Horsepower (hp)	x 0.746	= Kilowatt (kW)
Kilowatt (kW)	x 1.341	= Horsepower (hp)

PIN: 082854-000