2. Wind heel is often the major factor in determining the requirements for minimum stability.

3. Ice and snow present a problem in direct proportion to the weight added and its location.

a. Due to difficulty in determining weights and levers of ice on board, the effect cannot be readily evaluated.

b. Any slowing in period of roll under icing conditions should be investigated and action taken to reduce the ice and snow loading.

4. Waves influence stability by:

a. Changing the shape of the underwater portion of the ship which changes the location of the center of buoyancy causing roll, pitch, and yawing.

b. Adding weight on deck.

(1) Major danger is the impact of waves, which may rupture watertight hatches and deckhouses and thus cause flooding.

(2) If watertightness is maintained, boarding seas will be drained off the decks by the ship's motion.

NOTE TO INSTRUCTOR: The above is a summary of material presented in detail in the references listed under IIB. These should be referred to for more detail in this presentation.

V. SUMMARY.

A. The problem of balancing the ship's weights and buoyancy may seem to have become complicated by curves of form, required compartmentation and floodable lengths, wind heel, free surface, and the effect of waves. It is emphasized that all these are tools used to measure the effects of ship weights and wind and water forces and to build characteristics into the ship which will assist in simplifying the stability problem under conditions of danger. In the use of these tools, the ship's officer must become a skilled craftsman. This can only be achieved by the old fashioned method of practice and continued exercise in solving the various problems which may be encountered. Napoleon took Paris with a minimum of apparent effort because he practiced a seige of the city when he was in the military school. In a smillar manner a ship's officer will be able to better cope with more difficult problems of stability if he studies assumed damage conditions beforehand and knows his ship's stability situation at all times, particularly in approaching coastal waters.

VI. TEST AND APPLICATION.

A. Test. Use these and additional questions as a review.

1. Q. Define the location of the metacenter at a small angle of heel.

A. The location of the metacenter is at the point at which the vertical line drawn through the center of buoyancy intersects the vertical centerline longitudinal plan of the ship.

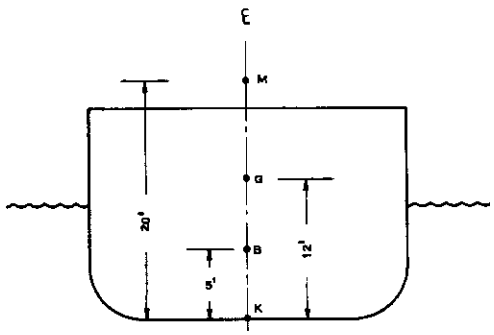
2. Q. What are the curves of form or hydrostatic curves?

A. They are curves showing the variation of the geometric characteristics of the ship corresponding to various drafts, such as volume of displacement, location of center of buoyancy, metacentric height, etc.

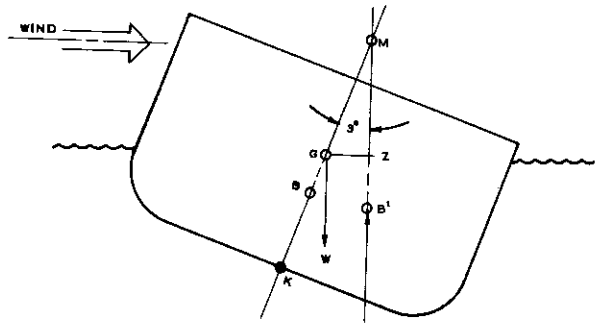
3. Q. What is meant by KM?

A. KM represents the distance of the metacenter, M, from the reference point, K (moulded baseline at centerline).

4. Q. Draw a diagram of transverse stability representing a ship with a KM of 20 feet, a center of gravity of 12 feet above moulded base line (K), a vertical center of buoyance 5 feet above K. Displacement is 5000 tons.



PROBLEM 4



PROBLEM 5

5. Q. In the above problem draw the diagram indicating the ship under the effect of a wind resulting in a heel to starboard of 3°. Assume no free liquids. (In the diagram exaggerate the heel.)

6. Q. What limits the heel to 3°?

A. The counter moment of the ship's weight times the horizontal distance between center of gravity and vertical line through the new center of buoyancy.

7. Q. What happened to the ship's center of gravity?

A. Nothing, no weight was added and since it was assumed no liquids could shift to the low side, no shifts in weight were made. In actual practice, liquids will shift in a proportionate shift in the ship's center of gravity.

8. Q. In the above problem, what is the horizontal shift of the center of buoyancy (sin 3° equals .05)?

A. Shift of B equals (KM - KB x sine θ
equals 20 - 5 x .05
equals 15 x .05 equals .75 ft.

9. Q. What is the righting arm?

A. GZ equals (KM - KG) x Sin θ
equals (20 - 12) x .05 equals 8 x .05 equals .4 ft.

10. Q. What is the righting moment?

A. M equals Weight of ship x righting arm equals 5000 x .4 equals 2000 ft. tons.

B. Application. Ship's officers should discuss the practical application of these principles in the ship's regular operations, solving similar practical problems.

CHAPTER 4

ADVANCED DAMAGE CONTROL - For Deck and Engine Personnel (Lesson Plans)

SECTION 4.3

THE TRIM AND STABILITY BOOKLET

I	Objectives	IV	Presentation
II	Material	V	Summary
III	Introduction	VI	Test & Application

I. OBJECTIVES.

A. To train personnel in the use of the Trim and Stability Booklet.

B. To assure that the ship has adequate stability for the desired compartmentation.

II. MATERIAL. Trim and Stability Booklets for the type ship, as: USNS GREENVILLE VICTORY (T-AK 237), USNS BARRETT (T-AP 196), or USNS AKL 17 (T-AKL 17).

III. INTRODUCTION.

A. Introduce self and subject (The Trim and Stability Booklet).

B. Establish scope of session and state objectives.

C. Arouse interest.

1. Coast Guard requirements (CG-256 and CG-257) state that:

a. Passenger vessels. "The master of the vessel shall be supplied with the data necessary to maintain sufficient intact stability under service conditions, to provide satisfactory operating stability, and also to enable the vessel to meet the damaged stability requirements."

b. Cargo vessels. "Information shall be furnished to the master which sets forth the stability data necessary to permit efficient handling of the vessel. In general, this information shall be such that the master can readily determine the metacentric height and determine the freeboard for any condition of loading."

2. MSTS requirements.

a. For cargo ships - a one-compartment standard.

b. For passenger ships - a two-compartment standard.

3. Master's responsibility. In accordance with the Coast Guard stability letter, "It shall be the master's responsibility to maintain proper stability at all times."

IV. PRESENTATION.

A. Types of Booklets. There are three basic types of trim and stability booklets. They cover the operation of passenger ships, cargo ships, and ships having virtually no restriction on the method of loading cargo, fuel, and water. The three types of trim and stability booklets thus are:

1. Passenger

2. Cargo

3. Unrestricted

B. Contents of Booklets. The trim and stability booklets are designed to inform the ship's officers with respect to how much stability is required and how the required stability may be obtained. All booklets contain the following basic information:

1. Information contained in all booklets.

a. Principal characteristics.

b. Hydrostatic properties.

c. Tank capacities, free surface corrections, and centers of gravity.

d. Cargo hold volumes and centers of gravity.

2. Special information in individual booklets.

a. Passenger ships. A loading table and loading diagram are given in the back of the booklet. In this table and diagram are entered the principal items of load according to height above the base line. These items are double bottom tankage, cargo and deep tankage, and passengers and stores. In general, additional double bottom tankage increases stability most per ton added. Cargo and deep tankage helps somewhat less. Addition of passengers and stores may decrease stability.

b. Cargo ships. A loading table and loading diagram are given in the back of the booklet. The principal items of load are double bottom tankage, cargo in holds, cargo in lower 'tween decks, cargo in upper 'tween decks, and deck cargo. Double bottom tankage and lower hold cargo increase stability. Lower 'tween deck cargo makes little difference. Upper 'tween deck and deck cargo decrease stability.

c. Unrestricted ships. Here the principal difference from passenger and cargo ship trim and stability booklets is that the ship has adequate stability for almost any condition of loading. As a result, the booklet indicates the stability, draft, and trim for widely different loadings, and omits examples or blank sheets for determining stability, draft, or trim.

3. Individual requirements. Since all passenger ships, or all cargo ships, are not the same, there are differences in the stability required after damage or the stability required in bad weather. The booklet provides that this amount of stability is available at all times so that the ship is always ready to sustain damage or heavy weather. One of the principal dangers when damaged is excessive listing due to water entering on one side only. This is commonly known as unsymmetrical flooding, and all possible means should be taken to reduct the list, by flooding to the other side (counterflooding) after a compartment to one side is damaged.

a. See general note #2 in operating instructions for the BARRETT-- "When the No. 1 and No. 2 fresh water tanks in No. 3 hold are in use, the flooding equalizing valves, which are operated from 2nd deck, shall be kept closed and the blank flanges kept off. In case of damage involving one of these tanks, these valves shall be opened to equalize flooding. When these tanks are empty, the valves shall be open and the blank flanges off."

b. See general note #4 in operating instructions for GREENVILLE VICTORY-- "Ship shall be operated at no less than 14'-0" draft."

c. Refer to operating instructions for your ship to see if any particular condition such as the above has to be maintained. Note, in the case of the BARRETT, that cross-flooding is achieved by opening a valve in the interconnecting pipeline between port and starboard tanks, while in the GREENVILLE VICTORY the minimum required draft assures that cross-flooding will occur over the shaft alley if the ship is damaged in No. 4 or 5 holds. The danger of unsymmetrical damage water is demonstrated in the case of the ANDREA DORIA, under lessons from casualties.

C. Using the Booklet. No amount of reading and studying will instruct a ship's officer in the stability characteristics of his particular ship as well as will practical experience. Therefore, the ship's trim and stability booklet should be referred to. Its contents should be noted, the various sheets studied and sample loadings should be worked out. A good starting example would be to check the condition of the ship as she is at the moment. Refer to the instructions in the front of the booklet for developing the example, also check procedures against the example. Knowledge of the ship's stability can only be obtained by using the trim and stability booklet regularly:

1. Upon departure, to assure adequate stability for that condition.

2. For projected arrival condition.

3. For intermediate condition at which salt water ballasting will be required if the stability in the projected arrival condition is not adequate.

V. SUMMARY.

A. Coast Guard requirements.

B. MSTS requirements.

C. Types of Stability Booklets.

D. Information for passenger ships.

E. Information for cargo ships.

F. Discuss examples of departure and arrival conditions.

VI. TEST AND APPLICATION.

A. Test. Use these and additional questions as an oral quiz.

1. Q. What is meant by a "one-compartment ship?"

A two compartment ship?

A. A one-compartment ship is one that will remain afloat when flooded or open to the sea between any two main watertight bulkheads. A two-compartment ship will withstand the flooding of any two adjacent compartments.

2. Q. What is the required GM curve?

A. The required GM curve indicates, at various drafts, the minimum GM required before damage, in order to keep the ship afloat after damage.

3. Q. Explain the term and condition of a light ship.

A. Light ship is the ship complete in every respect, with water in the boilers at steaming level and liquids in machinery and piping, but with all fuel oil and fresh water tanks empty and no passengers, crew, cargo or consumable stores on board.

4. Q. What is the procedure when the GM available is less than the GM required?

A. This condition must be corrected by ballasting sufficient tanks so as to provide a positive margin of stability in the event of damage.

5. Q. Why does GM increase when tanks are ballasted?

A. Ballasting tanks adds weight low in the ship, thereby lowering the ship's center of gravity, "G", and moving it further away from "M."

6. Q. When both are available, is it more efficient to ballast double bottom tanks or deep tanks and why?

A. It is more efficient to ballast double bottom tanks since they have a lower center of gravity and will thereby have a greater effect in increasing the GM.

7. Q. What effect does free surface have on GM?

A. Free surface decreases the GM of a ship by raising the ship's center of gravity, "G," thereby moving it closer to "M."

8. Q. What is the trim table?

A. A trim table is a table of the change in inches to draft forward and aft for each 100 tons (or other fixed load) loaded or unloaded at any distance from amidship.

B. Application. Use the ship's trim and stability booklet to determine the ship's condition of stability for various loadings. Also, assuming various conditions of damage, determine the ship's stability, and the indicated action to improve it.

CHAPTER 4

OFFICERS' DAMAGE CONTROL - For Licensed Officers (Lesson Plan)

SECTION 4.4

PLASTIC PATCHING

I.	Objectives	IV.	Presentation
II.	Material	V.	Summary
III.	Introduction	VI.	Test and Application
		VII.	Handout

I. OBJECTIVES.

A. To familiarize personnel with the purpose of the plastic pipe patch and the method of application.

B. To familiarize personnel with the characteristics and adaptability of the plastic patch and the precautions to be followed in determining the amounts of material to use.

C. To acquaint personnel with the need for strict observance of safety precautions at all times.

II. MATERIAL.

A. Training Aids.

1. Ship's plastic pipe patching repair kit.

2. Split section of pipe patch.

3. Section of pipe with hole for demonstration.

4. Film, MN-9537C, Damage Control-Plastic Repairs, 20 minutes.

B. References.

1. Training Manual for Emergency Damage Control Metallic Pipe Patch, NAVPERS 91845 (1953).

2. MSTSPACAREA Emergency Pipe Repair Pamphlet, Volume No.1, Plastic Patching.

3. Training Manual for Damage Control Metallic Pipe and General Purpose Repair Kit, NAVSHIPS 250-638-2 (1959).

4. Manufacturers' Instruction Manual.

C. Handouts.

1. Types and Treatment of Ruptures.

2. Pre-cutting Patch Materials.

3. Preparing a Patch (D. C. Metallic Pipe Patch Kit).

4. Applying Patch (D. C. Metallic Pipe Patch Kit).

III. INTRODUCTION.

A. Introduce self and subject, Plastic Patching.

B. State the objectives of this session.

C. Outline the scope of this discussion as follows:

a. To cite specific advantages of plastic pipe patching.

b. To describe materials used in patching.

c. To acquaint class with the phenomena of chemical reaction.

d. To familiarize class with proper sequence for applying patch.

e. To stress safety precautions to be followed before, during and after the patch is applied.

D. Arouse General Interest. One crew of an MSTS (civil-service-manned) ship is credited with saving a Navy seaplane by sealing its damaged pontoons with plastic patches so that it could be recovered. In another instance, an MSTS (civil-service-manned) ship was to be held up until an expensive unit of a water-cooling system could be flown overseas from the United States. Fortunately, one of the ship's engineers was able to repair the worn-out unit with plastic materials, thus saving $7,000. This incident happened more than eight years ago and the patch is still intact.

E. Develop Personal Interest. Upon your shoulders rests the responsibility for keeping the many piping systems aboard ship operating. Because such systems do not break down at convenient times or during shipyard availability periods, your individual skills, your ingenuity and your willingness to do the best job possible must be combined to resolve the multitude of problems that some pipe ruptures present. Through what you learn here, you may someday be able to:

1. Save your ship from a disaster that could only be contained by activation of a damaged piping system.

2. Preserve the life of a shipmate whose survival may depend on the promptness and efficiency of your repairs.

3. Bring about long-range economies of operation that will ensure continued employment of your ship because of lower maintenance costs.

IV. PRESENTATION.

A. Advantages of the Plastic Patch.

1. Versatility.

a. The plastic pipe patch is most adaptable as an emergency repair on all sizes of salt and fresh water piping and their fittings to repair holes, cracks, and ruptures. It requires no special sizes or shapes to be made up in advance.

b. It possesses excellent adhesiveness to steel, cast or malleable iron, copper, nickel, brass, bronze, galvanized metal and, at times, even aluminum.

c. Ruptures to pipe lines and fittings can be repaired and service restored to the systems with minimum loss of time.

2. Simplicity. The preparation and application of patching materials are similar to first-aid methods of applying a dressing and bandage to an injured human limb.

3. Effectiveness. When properly applied and cured, the plastic patch:

a. Possesses a high strength-weight ratio.

b. Possess excellent adhesiveness and vibration-resistance in service.

c. Will repair not only holes and cracks, but also complete breaks by joining the broken ends.

d. Leaks seldom occur. Should they occur, an additional patch can be applied over the first, extended about two inches beoynd its end.

4. Ease of application.

a. Minimum time required for training personnel.

b. Techniques of application will vary little on individual jobs.

5. Durability.

a. The maximum life of this patch is unknown. Some test patches have held, under normal service conditions, for more than a year without failure.

b. The patch will last until permanent repairs can be made.

c. It is not intended as a permanent repair, but it can be relied upon for extended periods.

B. Materials and Use. The basic materials used in making patches differ according to their intended uses.

1. Standard resin and activator is used for general patches. The more recent paste and putty resins and hardeners are used for special patches. The standard resin and activator and its use will be described first.

a. The standard resin comes in a partially-filled container which allows room for adding and mixing the activator.

b. The standard activator comes in its own small container.

c. Mixing the activator into the resin initiates a chemical reaction which produces a hard, tough, thermo-setting resin compound of high adhesive character.

d. Reinforcing materials (glass, cloth, mat, fibers, and tape) are provided to give mass and strength to the patch and to hold the fluid plastic compound while the chemical reaction is completed through the cooling and setting stages. These additional materials for a standard plastic pipe patch are:

(1) Void cover. A plastic-impregnated, stiff glass fiber cloth which is used to keep the patch from sinking into the hole or break.

(2) Fibrous glass mat or woven roving cloth.

(3) Glass tape. 1½" or 2" tape in 36 ft. long rolls. It is used to bind the other materials together into a tight, solid mass by wrapping with half-width lapover on each turn, similar to the wrapping of a first-aid bandage.

(4) Retaining cover. Kraft paper wrapped over the completed patch to prevent loss of the fluid activated resin by dripping. If kraft paper is not available, newspaper or other paper in a sheet large enough to cover the entire patch may be used. In new type patch kits, the retainer cover may be a thin transparent polyvinyl chloride plastic film, called "PVC" film.

(5) Chalk-line (string) is used to secure the void cover over the opening, to lace the paper retaining cover over the outside of the patch and to secure the ends of the retaining cover to prevent loss of the liquid activated resin during the curing period.

e. The combination of activated resin and reinforcing material produces a solid, tough, hard patch capable of withstanding up to 300 p.s.i. of pressure and a temperature of 200 degrees F.

2. Strong-Back Sealer is used for sealing cracks and small leaks.

a. The Sealer Resin comes in a partially-filled container to allow for adding and mixing the activator.

b. The Sealer Activator comes in a small container.

c. A bag of short inert reinforcing fibers is provided to give mass and strength to the seal and to provide a body for holding the liquid activated resin through the chemical reaction and cooling and hardening stages.

d. The combination of Sealer Resin, when activated, and reinforcing material (glass fibers) provides a plastic mass which can be molded and pressed into cracks, small holes, and leaking points to form a seal. If desired, or if required by the size and nature of the crack or leak, a standard patch may be applied over this sealer on piping.

3. Paste or putty is used for plugging small holes and for pressing into cracks and small leaks to seal them.

a. The Paste Resin comes in a partially-filled container to allow space for adding and mixing the activator.

b. The Paste Activator comes in a small container.

c. A bag of Putty Powder is provided.

d. The combination of activated special Putty Resin and Putty Powder, when mixed and kneaded into a smooth homogeneous mass, similar to glazier's putty, can be pressed into cracks and other small leaks or holes to plug and seal them before application of the standard patch. In some cases it will be effective without such reinforcement.

4. Strong-Back Fairing Compound is used to fill in breaks or depressions before applying a standard patch.

a. It consists of a Standard Resin in a partially-filled container to allow for adding and mixing the activator.

b. The Standard Activator is in a small container.

c. A bag of long, chopped-glass fibers is provided to add mass and body to the fairing and to thicken and hold the liquid activated resin through the chemical reaction, cooling and hardening stages.

d. The combination of the activated resin and reinforcing fibers, when mixed in the bag and thoroughly kneaded into a homogeneous mass, produces a material which is used for fairing over breaks in flanged joints and depressions in fittings, such as valves that may have cracked. A standard patch is then applied over-all. The combination of fairing compound with a standard patch over it is called a complex patch.

5. BUSHIPS has developed a new, more compact and more versatile damage control metallic pipe and general purpose repair kit (plastic) to replace current repair kits. The new materials are assembled in a kit (Stock No. GM 4730-289-4533) and a refill kit (Stock No. GM 4730-289-4532). These new repair kits have been authorized in MSTS allowances as replacements for existing kits. Present kits will be used for general repairs and for training purposes.

a. The new materials consist of two assemblies containing a synthetic thermosetting resin in paste and liquid forms, with hardening agents and glass reinforcement.

(1) Assembly #1 - liquid resin for repair of metallic pipes.

(2) Assembly #2 - paste resin to patch holes in decks, bulkheads, flat surfaces or cracks.

b. The two assemblies may be used in combination to patch large holes.

c. Training Manual for Damage Control Metallic Pipe and General Purpose Repair Kit, NAVSHIPS 250-638-2, describes the procedures for use of these new materials.

C. Chemical Reactions.

1. Stowage. As long as the resins and activators are kept in their individual closed containers, they may be stored for an indefinite period with no noticeable deterioration and without any reaction taking place.

2. Stirring. Stir the resin as you would stir paint before using.

3. Mixing. When the activator is added to the resin (it should be mixed throughly for about two minutes) and the two are stirred together, a chemical reaction takes place which generates heat. This heat generation occurs gradually at first, until the "kick-over" point is reached. At this point the temperature rises rapidly to its peak and then gradually cools down. During the cooling period, the mass sets up and hardens into the finished patch or repair.

4. Temperature. The peak temperature generated at "kick-over" is:

a. For the Cordobond Standard Materials - 250 to 300 degrees.

b. For Emergency Damage Control Metallic Pipe Repair Kit (Navy Kit) - 350 degrees F.

5. Time required. The time required for completion of the chemical reaction cycle is governed by the temperature of the materials when mixing, the temperature of the surface to which applied, and the free air temperature. However, resin temperature is the most important. At 73 degrees F., mixing time to "kick-over" time will be twelve to fifteen minutes. Higher temperatures shorten the time and lower temperatures lengthen the time required to apply a patch. Therefore, all materials must be cut, prepared and laid out ready for use in sequence before mixing the resin and activator.

6. Curing time. When the patch has been completed and "kick-over" has occurred, the time required for curing will depend largely on the mass of the patch.

a. A thin patch of glass fiber tape and activated resin will take from two to four hours to cure and harden ready for normal service.

b. A patch of one-half inch or thicker will generate more heat quickly and cure much faster - in from 20 minutes to 3/4 hour.

7. Setting. During the stage immediately following "kick-over", the activated resin emits noxious fumes. It is in a state somewhat similar to boiling liquid and flows freely. The mass of resin and impregnated reinforcing material is soft but, as cooling takes place, it sets as a result of the generated heat (thermosetting) and hardens into a solid homogeneous mass, impervious to water, oils, gasoline, and even dilute acids and many chemicals.

D. Pipe Preparation and Application of Plastic Patch.

1. Preparation of ruptured piping or fitting.

a. Remove lagging.

b. Clean and roughen surfaces removing all paint, grease, oil, scale, dirt, or other foreign matter.

c. Remove irregular projections. Use a hammer and chisel or coarse file to form a smooth contour over the break.

d. The type and size of patch will depend on the size of pipe or where it is to be applied, and on the size of the rupture or leak.

(1) On a flat surface, a flat patch will consist of fairing compound molded over the rupture, covered by a sheet of glass cloth extending at least two inches beyond the fairing material all around, and the whole well-brushed with activated resin. The patch may be backed up with a back-up-plate or wood, sheet metal or any rigid flat surfaced material, held in place with suitable bracing.

(2) Liquid or paste resins may be used for flat patches or a combination of both used.

(3) On a pipe, the patch will include void cover, glass fiber mat, glass tape, activated resin and retaining cover. Woven roving material may be used in place of glass fiber mat and tape.

e. If the new woven roving cloth is used, it may be impregnated with activated resin and wrapped 3 or 4 times around the pipe. This will eliminate the use of the fibrous glass mat and glass tape.

f. The amount of material required can be estimated readily by observation of the size of the break. One unit of resin and activator is sufficient for the average rupture in pipes up to three inches in diameter. All material should be pre-cut to speed application.

2. Application of materials to form patch.

a. After brushing a coat of activated resin on the area surrounding the break, apply a pre-cut piece of void cover which is at least one inch larger than the rupture all around and lash it securely in place with chalk-line.

b. Pour and spread or brush activated resin on the inner layer of the glass mat, pre-cut one inch longer at each end than the void cover and long enough to go completely around pipe with a small overlap on the ends. Apply the impregnated mat over the void cover and smooth it in place.

c. Wrap the glass tape from one end to the other of the inner mat, beginning and ending one or two inches clear of the ends of the mat, lapping the tape over one-half its width on each turn and pulling it tight as each turn is completed. Brush on a coat of activated resin over the layer of tape. A tape-coating machine is included with the kit to coat the tape with activated resin before wrapping. This machine merely allows the tape to be run off one reel, through the activated resin and onto another reel, which is then used to wrap the impregnated tape. About four layers of tape are required for adequate strength.

d. Apply the outer layer of glass mat pre-cut to extend at least one inch beyond each end of the previous tape wrapping and impregnated with activated plastic in the same manner as the inner mat layer.

e. Again wrap on another layer of glass tape and brush with activated resin. This additional wrapping is not essential but will add strength and bind the complete patch.

(1) If the new woven roving cloth is used, it may be impregnated with activated resin and wrapped 3 or 4 times around the pipe. This will eliminate the use of the fibrous glass mat and glass tape.

f. Apply a wrapping of kraft or (PVC film) to extend several inches beyond both ends of the completed patch and going around pipe and patch twice to retain the liquid activated resin in the patch and to prevent its loss by dripping.

g. Finally, take two turns with string around one end of the retaining cover and then wind string diagonally around the patch to the opposite end. Take two turns tightly around the end and wind the string diagonally back to the beginning and tie it off. The patch is now complete except for "kick-over" and curing.

E. Safety Precautions. Personnel handling plastic pipe patching materials must protect themselves from its fumes and from the harmful effects of these materials on the skin. The following precautions must be observed:

1. Apply petroleum jelly to the exposed skin of hands and wrists before mixing the resin and the activator.

2. Wear goggles to protect the eyes from fumes.

3. Wear neoprene rubber gloves furnished in the kit when handling glass fiber materials and activated resin.

4. Personal cleanliness is a primary factor. On completion of the patch, thoroughly wash gloves and tools in warm soapy water.

5. When using plastic pipe patching materials in enclosed areas, rig a forced supply and exhaust ventilation to remove noxious fumes.

6. Avoid breathing noxious fumes given off during the curing period.

7. Avoid spilling plastic materials. Keep kraft paper under the patch to catch any spilled or dripping materials.

F. Custody and Stowage-Repair Kit. The plastic pipe repair kit is an item of damage control equipment but, due to its designed purpose, is assigned to custody of the Chief Engineer for use in emergency repair and training.

1. Stowage will normally be in Repair 2 locker or, in cargo ships, in the custody of the Chief Engineer.

2. Stowage should, if possible, be in a cool place in consideration of the effect of temperature on working time from mix to "kick-over". If kept cool, more time will be available for making an emergency patch before its "kick-over".

V. SUMMARY.

A. Advantages. Review briefly the five advantages of plastic patching.

1. Versatility.
2. Simplicity.
3. Effectiveness.
4. Ease of application.
5. Durability.

B. Materials. Outline the basic materials required for plastic patching.

1. Fibrous glass materials.
2. Resins and activator or hardener.
3. Retaining cover.

C. Patching. Review patching skills and their application.

1. Application of patches.

a. Variety of methods depends on type of patch.

b. Procedures for each type of patch.

2. Safety precautions.

a. Material handling precautions.

b. Personnel safety measures.

D. Ship's Allowances. Custody and stowage of repair kit.

1. In custody of Chief Engineer.

2. Generally stowed in Repair 2 locker.

3. May be stowed in machine shop or in engineer's storeroom.

VI. TEST AND APPLICATION.

A. Test. Use these and additional questions as an oral quiz.

1. Q. In applying a simple rupture patch, what is the first material applied

A. Void cover.

2. Q. Plastic patch temperature cycle "kick-over" time is approximately how long, if the temperature of the resin, air and pipe is about 73 degrees F.?

A. 12 to 15 minutes.

3. Q. What type of patch is applied to a surface having projections such as a flange or jagged edge?

A. A complex patch consisting of fairing compound with a standard patch over it.

4. Q. What is the primary factor of personal protection?

A. Cleanliness of self and protective clothing.

5. Q. What is the greatest hazard to personnel in plastic pipe patching?

A. The heat generated at "kick-over."

6. Q. Is the plastic patch a permanent type of repair?

A. No, it is intended for emergency use only, although it does make a very effective, semi-permanent repair.

7. Q. What personnel protective equipment is provided in the pipe repair kit?

A. Rubber gloves, goggles , and ointment.

8. Q. Which factor has the greatest effect on the "kick-over" time?

A. The temperature of the resin.

9. Q. Can holes in flat surfaces or leaking tanks seams be repaired with plastics?

A. Yes, by combining and by varying the application of putty and/or fairing compound with the standard patch, as appropriate.

10. Q. How may plastic patches be removed aboard ship?

A. By sawing the patch, or with hammer and cold chisel.

B. Application. Demonstrate the use of all types of plastic patching - the standard resin and activator, liquid resin and hardener, and paste resin and activator. Give the group an opportunity to put a plastic patch on a pipe which may require repair. Point out the materials and amounts used, see that all safety precautions are observed, and discuss each phase of the operation as it proceeds.

VII. HANDOUTS. These summaries and information sheets are on the following pages.

A. Types and Treatment of Ruptures.

B. Pre-cutting Patch Materials.

C. Preparing a Patch (D. C. Metallic Pipe Patch Kit).

D. Applying a Patch (D. C. Metallic Pipe Patch Kit).

E. MSTS Magazine Reprint, August 1958.

F. BUSHIPS Journal Reprint, November 1959.

TYPES AND TREATMENTS OF RUPTURES
VII A

FIG. 1

Figure 1. SIMPLE RUPTURES are on straight sections of pipe and have no protruding edges.

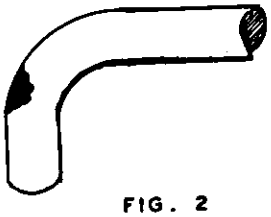


FIG. 2

Figure 2. ELBOW RUPTURES are on curved sections of pipe and have no protruding edges.

FIG. 3

Figure 3. SEVERED RUPTURES are ones in which the pipe is completely separated.

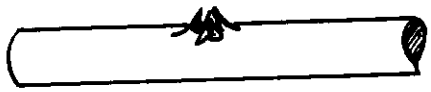


FIG. 4

Figure 4. COMPOUND RUPTURES have protruding edges and include ruptures in flanges, fittings and mangled pipe.

After cleaning the patch area surface thoroughly, the step-by-step procedure may be followed to apply a patch to a SIMPLE RUPTURE.

To patch an ELBOW RUPTURE the edges of the void cover must be slit and the mats cut to conform to the contour of the pipe.

When patching a SEVERED pipe, if the severed area is 5" or less in length, use the regular procedure. Where severance is greater than 5", use asbestos sheeting or light sheet metal for a substitute void cover. Because a long void increases stress, substitute void covers should extend 5" on each end of severed pipe, with 2" overlap on the round turn.

Patching a COMPOUND RUPTURE.

1. Where practical, cut away or file down protruding edges.
2. Where removal of protruding edges is not considered practical for short ruptures, cut away the damaged area to make a severed pipe.
3. If patch must be applied over protruding edges, patch materials must be cut to conform with existing barbs and protrusions.

PRE-CUTTING PATCHING MATERIALS
VII B

Due to the limited time in which to apply a patch, it is important that all materials be pre-cut. The table below will assist in selecting measurements accurate enough for most applications.

TABLE

PIPE DIAMETER	1/2"	3/4"	1"	1.5"	2"	2.5"	3"	3.5"	4"	5"	6"	8"	10"	12"
CIRCUMFERENCE	3"	3.5"	4"	6"	7.5"	9"	11"	12.5"	14"	17.5"	21"	27"	34"	40"
PATCH LENGTH	LENGTH OF RUPTURE + 8"													
PATCH AREA	CIRCUMFERENCE X PATCH LENGTH													
RESIN (GRAMS)	PATCH AREA X 10													
TAPE (YARDS)	PATCH AREA ÷ 9													
R.C. LENGTH	6.5"	7.5"	8"	11"	13.5"	15.5"	18.5"	21"	23"	28.5"	33.5"	43"	53"	62"
R.C. WIDTH	PATCH LENGTH + 4													
O.M. LENGTH	12"	14"	16"	24"	29"	36"	44"	50"	66"	70"	84"	108"	136"	160"
O.M. WIDTH	LENGTH OF RUPTURE + 8"													
I.M. LENGTH	5"	5.5"	6"	8"	9.5"	11"	13"	14.5"	16"	19.5"	23"	29"	36"	42"
I.M. WIDTH	LENGTH OF RUPTURE + 4													
V.C. LENGTH	LENGTH OF RUPTURE + 2													
V.C. WIDTH	LENGTH OF RUPTURE + 2													

HOW TO USE THE TABLE

EXAMPLE: A $2\frac{1}{2}$" cooling water line loses pressure because of a rupture which extends 3" along its length and about 2" across the width of pipe. Basic information for measuring patch material for pre-cutting may be selected from the table above.

Circumference: From table, diameter $2\frac{1}{2}$" =9" circumference
Patch Length: Length of rupture + 8", or 3" + 8" = 11"
Patch Area: Circumference x Patch length, or 9 x 11 = 99 sq. inches
Resin (grams): Patch Area x 10, or 99 x 10 = 990 grams
Tape (yards): Patch Area divided by 9, or 99 ÷ 9 = 11 yards
Retainer cover length: From table, $15\frac{1}{2}$"
Retainer cover width: Patch length + 4", or 11 + 4 = 15"
Outer mat length: From table, 36"
Outer mat width: Length of rupture + 8", or 3 + 8 = 11"
Inner mat length: From table, 11"
Inner mat width: Length of rupture + 4", or 3 + 4 = 7"
Void cover length: Length of rupture + 2", or 3 + 2 = 5"
Void cover width: Length of rupture + 2", or 2 + 2 = 4"

PREPARING A PATCH
VII C

Before attempting to apply a patch, certain preparations must be made.

1 Remove lagging several inches from rupture, clean off all rust, oil, grease, water and other foreign matter. Wirebrush around patch area to ensure solid metal surface.

2 If the rupture is compound, remove irregular projections to make a simple rupture, if possible, or cut out section to make a severed rupture.

3 Stack or arrange, pre-cut Patch Materials in the same order in which they are to be used:

a. Void cover
b. Inner mat
c. Outer mat
d. Retainer cover

4 Thread tape to tape coating machine, if one is being used.
(Tape may be coated with resin by brushing on after each layer is wrapped onto pipe).

5 Have tools and supplies in a convenient place:

a. Spatulas (stir sticks)
b. Brush (or "dobber")
c. Scissors
d. Chalk line

6 If ruptured pipe is still leaking after isolating the damaged area, prevent further leakage by securing gasket material over hole with Fiberous Glass Tape #890. To ensure required promptness in completing the final patch, two men generally work together.

APPLYING A PATCH
VII D

EIGHT BASIC STEPS FOR APPLYING A PATCH

1 Pour activator into resin. Mix thoroughly and stir for 1½ to 2 minutes.

2 Coat void cover and pipe with activated resin, either by brushing or dipping void cover.

3 Tie void cover over rupture tightly with chalk-line to prevent slipping.

4 Wrap resin-saturated inner mat tightly around void cover.

5 Wind glass tape through the activated resin onto empty reel, if tape coating machine is being used.

6 Wrap the resin-coated tape around inner mat; allow overlap of ½ width of tape each turn. If tape coating machine is not being used, brush on the activated resin after each layer of tape, until 4 layers have been applied.

7 Saturate outer mat with activated resin and wrap mat 4 times tightly around the pipe. Secure snugly with chalk-line.

8 To prevent drip from patch materials, wrap retainer cover (brown wrapping paper) around entire patch with 2" overlap and secure with chalk-line.

COMSTSINST 3541.5A
27 April 1960

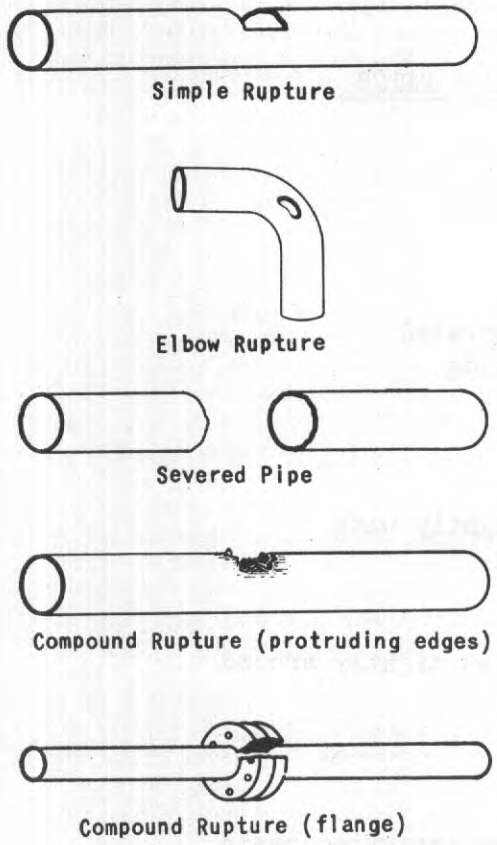
Reprinted from MSTS Magazine August 1958

VII E

Pipe Patches

The Repair Party's 'Ace in the Hole'

TYPES OF PIPE RUPTURES

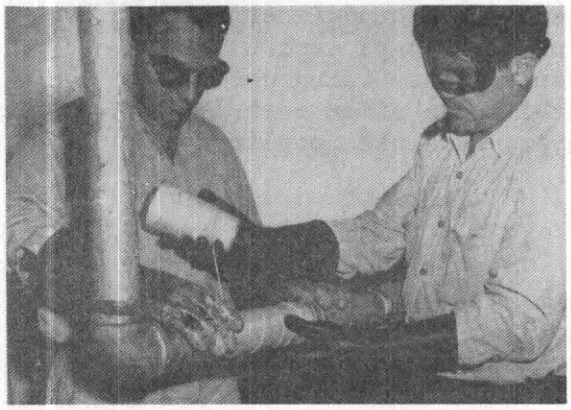


PIPE RUPTURES can be grouped into 5 basic types. Properly used, the plastic patch can seal nearly any size and type leak.

A 4-man repair party from WestPac's USNS *LST 664* recently saved the Navy an estimated $150,000. Using pipe patching materials from the ship's damage control locker, they salvaged a Navy amphibian patrol plane thought to be beyond repair.

The plane, UF 909, had encountered severe hull damage while trying to take off at sea during a squall. Unable to get the crippled amphibian aloft, the pilot taxied toward a nearby atoll in the Marshall Islands. The sea gushed through ⅜-inch cracks in the hull as UF 909 wallowed in heavy swells. Water had reached the level of the cockpit seats just before the amphibian beached.

LST 664 received orders to divert to the Marshall Islands and assist in removing *whatever parts could be salvaged.* When the *LST* arrived at the atoll, the master, Capt. Noel Peterson, came ashore, accompanied by the ship's carpenter and 2 ABs. After a careful examination of the damage, Capt. Peterson ordered his men to break out the ship's pipe patch kit.



VOID COVER may be made from cardboard or any pliable material sturdy enough to form a firm base for the rest of the patch. Before cover is applied, the pipe is cleaned and coated with plastic resin

PLASTIC TAPE coated with resin is wrapped around the void cover like a bandage. High pressure pipe lines often require a thicker patch reinforced with several layers of tape and glass fiber mats.

The plastic patching kit used in MSTS ships includes tools and materials used to make prompt, effective repairs to ruptured pipes. The patch consists of a plastic compound applied in liquid state to various layers of spun glass. The saturated fibrous glass material then is wrapped around the ruptured pipe like a bandage. The result is a hard, watertight seal.

Damage to the plane's hull extended over an area 6 feet long. There were 3 hull fractures, each 6 to 12 inches long, plus numerous open seams and torn rivets. Oakum dipped in white lead was forced into the seams with a calking knife. The fractures and calked seams were coated with plastic patching compound and covered with spun glass.

When repairs were completed, the ship's LCVP pulled UF 909 off the beach. The amphibian was towed out to the *LST* and lifted aboard by one of the ship's two 30-ton booms. *LST 664* carried the plane to Kwajalein where it was transferred to a barge. Navy salvage experts at Kwajalein estimated the saving to be $150,000.

The salvage of UF 909 is especially noteworthy because of the fact that the plane is made of aluminum—one of the few materials not considered suitable for patching with the pipe repair kit. Nevertheless, the patches held.

Although several MSTS commands have successfully tested pipe patches on a variety of surfaces, the pipe repair kit is designed primarily for patching pipes of all sizes in systems with pressures up to 300 p. s. i. Pipe repair kits have been used in MSTS ships since 1953.

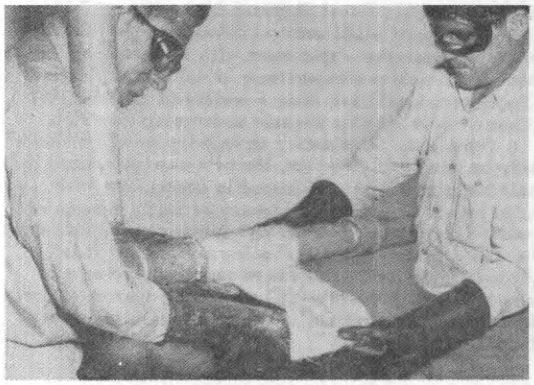
The speed and ease with which the pipe patch can be applied is due to the synthetic plastic resin used. The resin is a compound of two different plastics. Combined, they form a hard, watertight seal, yet allow for expansion and contraction of the pipe.

Plastic patches are easy to use once the basic techniques have been learned. First, the pipe surface is cleaned. Then the liquid plastic resin is mixed with a chemical activator. The temperature of the activated resin rises until it reaches approximately 350 degrees.

The heated resin is applied both to the pipe and to four layers of spun glass material. The first layer is the void cover, a rigid cloth that can be cut and formed to cover the hole. The void cover and each succeeding layer is secured with cord.

The inner mat, a layer of glass fibers bonded together with plastic resin, is applied like a bandage. Then the mat is covered with glass tape dipped in resin. Another layer of plastic-saturated glass fiber forms the outer mat. A retaining cover or wrapping paper completes the patch.

As the plastic cools, it hardens to form a solid, durable seal. Although a properly applied pipe patch will last indefinitely, plastic patches are only intended to be a temporary repair. The patch should be sawed off, and permanent repairs made as soon as possible.



GLASS FIBER MAT is placed over the plastic tape. The mat is saturated with chemically heated plastic resin compound. As the resin cools, the various layers harden into a firm, watertight patch.

RETAINING COVER goes over the glass fiber mat. Ordinary brown wrapping paper provides sufficient outer protection. Plastic patches can be used on shipboard pipelines with pressures up to 300 p. s. i.

VII F.

Kits Contain Paste Plastic Resin

Reprinted from BUSHIPS JOURNAL November 1959

By LCdr. M. V. Martini, USN
Naval Damage Control Training Center, Philadelphia

Paste resin and paste hardener are included in the new damage control repair kits (plastic) now being evaluated onboard selected ships. The pastes work in the same way as liquid resin and hardener, but they are easier to use for many repair jobs.

The new kit contains the liquid resin-hardener mixture, used in the old kit, for flat patch repairs to metal or wooden surfaces. The liquid-impregnated cloth may be applied to tank, void, bulkhead, or other flat surface ruptures not exceeding 12 inches in diameter. Previously, this type of patch was limited to wrap-around repairs for piping systems.

One new feature of the kit is the paste mixture. Removed from the 4 to 1 ratio containers, the paste resin and hardener may be mixed on any flat surface; then troweled, squeezed, or molded in place for a variety of plastic repairs.

The paste mixture may also be used in combination with the liquid mixture for both flat surface and piping system repairs. For example: To repair a flat surface, the paste mixture may be used to fill the ruptured area, and the liquid-impregnated cloth then applied to either side of the surface.

Combination patches can be used when too little of either liquid or paste remains in the kit. Better results may also be obtained under some conditions when the two types of patch are used to supplement each other.

The paste mixture alone may be useful for small ruptures. The uncured mixture has a tendency to sag, fall through, or pull away from larger ruptures. The paste has been used satisfactorily for small bulkhead holes resulting from removal of small electric cables, and for small fuel oil tank leaks, small piping system ruptures, and the cracked water end casing of a reciprocating bilge pump.

Staff personnel at the Damage Control Training Center have assisted in making emergency plastic repairs to Fleet units operating in the Philadelphia area. One incident involved a PCER scheduled to get underway. The lighting-off watch had discovered a 2-inch-diameter hole in the wet-type exhaust muffler of the main diesel engine.

The leaking exhaust muffler on a plane beneath the ship's waterline could not readily be isolated. The paste mixture, externally preheated to speed up kick-over (heat-generating chemical reaction incidental to hardening), was pressed firmly into the hole. It served as a stop-gap measure to stop leaking. Within minutes, because of the cooling water effect in the system, the paste patch had cured. For added tightness, liquid-impregnated cloth was wrapped around the muffler to form a combination patch.

The application was repeated in another PCER, but under less trying circumstances. Each plastic repair cost $15 in materials as opposed to an estimate of $800 for emergency repairs. Both repairs prevented requests for temporary shipyard availabilities and made it possible for the vessels to continue in operation. Each repair was completed in 45 minutes, including time spent in testing out the exhaust system.

A third incident involved a U.S. Coast Guard picket boat. Impact from grounding had driven the rudder blade completely through the steel hull, leaving a 10-by 2-inch rupture below the waterline. The 40-foot craft also had considerable propeller damage. It was beached and, as the tide ran out, left high and dry.

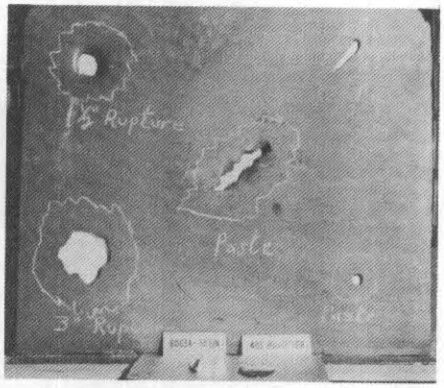
When Damage Control Training Center personnel arrived, approximately 60 minutes remained before high tide. Both paste and liquid-impregnated cloth were used to form a combination patch. Because repairmen were literally racing against the tide, with the outside temperature a low 45° F., heat had to be applied to accelerate hardening of the patch. The only source of heat available, a gasoline-soaked torch on a broom handle, was used in this emergency situation, despite the flammability hazard.

A fourth incident is included in a USS *Sturdevant* report. A leak in one of the fuel tanks was repaired with epoxy resin costing 20 cents; shipyard repair costs were estimated at $500.

Naval Damage Control Training Center personnel have close liaison with the value engineering branch of the Philadelphia Naval Shipyard for exchange of ideas involving epoxy resin uses on naval vessels. Because of their operational experience with shipboard equipment and classroom experience in the use of plastics, Center personnel have done a variety of experimental plastic repair jobs for vessels undergoing overhaul.

Other uses for plastics in ship repair will undoubtedly be devised. However, the new damage control repair kit is now being evaluated in comparison with other means of making emergency or battle damage repairs. The damage control kits (plastic) will ultimately become a part of the ships' allowance lists. It is planned that previously issued metallic pipe repair kits S.N.S. #G4730-289-4533 may be brought up to date by separate procurement of the paste resin and paste hardener.

Figure 1. Test plate with ruptures for paste and liquid impregnated cloth patch. Maximum span of rupture in one direction must not exceed 2 inches in diameter; length of rupture does not matter.



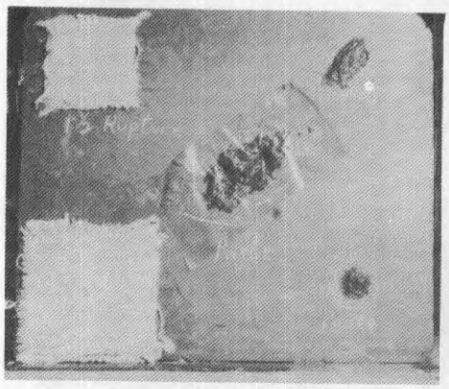


Figure 2. Liquid impregnated cloth patches and paste patches. All patches to be tested at 300 p.s.i.

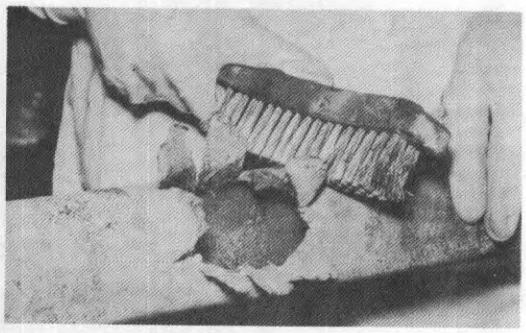


Figure 3. Compound rupture being cleaned before application of plastic.

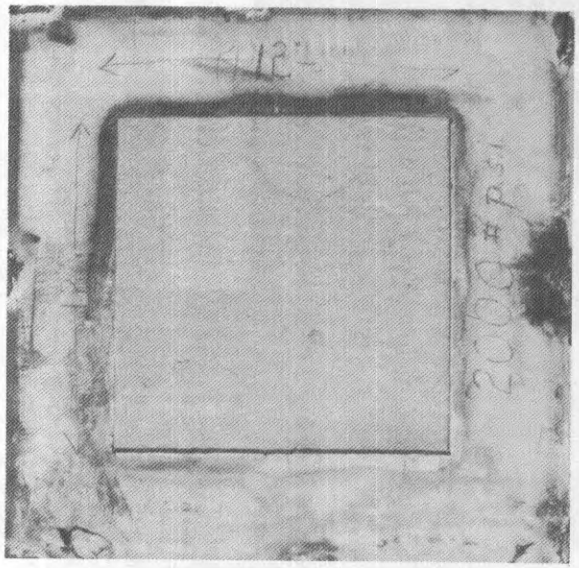


Figure 5. Twelve-inch flat surface liquid-impregnated cloth patch. Test pressure of 2,000 p.s.i. is required to separate patch from test plate. Circular imprint shows position of ram used for applying hydrostatic pressure. Authorized working pressure for all patches is 300 p.s.i. (maximum).

Figure 4. Liquid impregnated cloth compounded pipe rupture. Mound shows buildup over flared edges.

PLASTIC PIPE PATCHING

CHAPTER 4

OFFICERS' DAMAGE CONTROL - For Licensed Officers (Lesson Plans)

SECTION 4.5

UNWATERING

I. Objectives	IV. Presentation
II. Material	V. Summary
III. Introduction	VI. Test and Application

I. OBJECTIVES.

A. To impress officers with the importance of drainage systems.

B. To explain built-in drainage systems, their designed purposes and their practical application to unwatering.

C. To familiarize officers with the capacities and limitations of equipment.

II. MATERIAL.

A. Training Film. MN 6774, Methods of Unwatering Flooded Compartments, 18 minutes, B & W, sound.

B. References.

1. BUSHIPS Manual, Chapter 88.
2. Damage Controlman 1 & C, NAVPERS 10572.
3. Damage Controlman 2 & 3, NAVPERS 10571.
4. Ship's Allowance List Group S47 - Pumps.
5. Ship's Allowance List Group S88 - Damage Control.
6. Ship's Allowance List Group S93 - Firefighting.

III. INTRODUCTION.

A. Introduce self and subject (Unwatering).

B. Compartments may become flooded as a result of direct damage or from excess water used to fight fire through ruptured piping, etc. This water must be removed to restore normal stability as well as to restore the compartment to its normal use. Such emergencies may arise either in port or at sea. They involve the emergency employment of personnel as well as of unwatering equipment.

C. MSTS ships have occasionally had to use portable pumping equipment to unwater chain lockers, holds, or compartments which became flooded. Compartments which are connected to the main drainage system have at times had their strainers plugged, preventing use of the drainage system. Portable unwatering equipment has proven very useful in such emergencies.

D. All ships officers and men should have a working knowledge of the ship's drainage system and portable unwatering equipment, their uses and limitations, and the proper methods of rigging and operating unwatering equipment.

E. Flooding dangers exist in gravity drain piping. Such piping usually pierces the ship's side and passes through watertight decks. As a damaged ship lists to one side, or settles more deeply, unless some positive closure is provided, water will flow back through drainage piping and flood the ship.

IV. PRESENTATION.

A. Drainage Systems.

1. Definition. Each ship has some means provided for removing water from within its hull. Systems of piping with or without pumping facilities installed for this purpose are termed drainage systems.

2. Component parts of drainage system. A drainage system fundamentally consists of:

a. A length of suction piping (drainage main).

b. Branches leading from the main line into spaces to be drained, normally near the lowest point in each space.

c. One or more pumps, or eductors, to take suction from the drainage main.

d. Discharge piping from the pumps, leading overboard.

e. Necessary valves, manifolds, and strainers.

3. Kinds of systems. The drainage systems installed in most ships are, the:

a. Main drainage system.

b. Secondary drainage systems.

c. Plumbing and deck drains.

d. Weatherdeck drains.

e. Feed drains in machinery spaces.

4. Main drainage system.

a. The main drainage system runs throughout the main machinery compartments. However, in some ships, it may extend forward and aft of the machinery compartments.

b. In smaller ships, the drainage main consists of a single pipe running fore and aft, usually along the centerline.

c. In larger ships, it is a loop system extending along both sides of the engineering compartments and joined at the ends.

d. Main drainage systems may be used in many modern ships to empty fuel oil tanks which have been ballasted with sea water.

e. Main drainage piping is normally of about 5" galvanized pipe or copper-nickel tubing. The branch suction lines leading to valves or manifolds from various bilge wells, tanks, or other compartments are of smaller size on down to about 2".

5. Secondary drainage systems.

a. Secondary drainage systems serve to drain spaces forward and aft of the main machinery compartments. The piping is smaller in size than that used in main drainage systems.

b. Secondary drainage systems are independent systems, each with its own pump or eductors.

6. Plumbing and deck drains.

a. These are provided for draining fixtures and compartments within the ship by gravity. Gravity drainage piping is installed most extensively in compartments above the waterline.

b. In large ships, some compartments near or below the waterline may be drained to compartments lower in the ship from which the water can be pumped overboard. These lower compartments may be bilges and bilge wells, shaft alley sumps, drain tanks, or sanitary drain tanks.

c. Flooding danger exists in gravity drain piping unless some positive closure is provided.

(1) Each separate overboard discharge led through the ship's side from spaces below the freeboard deck must have an automatic non-return valve fitted with a positive means of closing it from above the freeboard deck. In passenger ships where the bulkhead deck is higher than the freeboard deck, the positive means of closing is from the bulkhead deck.

(2) An alternate way of fitting such overboard discharge closures is through two automatic non-return valves without positive means of closing, provided the upper valve is so located above the deepest loadline as to be accessible for examination under service conditions, and is of a type which is normally closed.

7. Weatherdeck drains. Weatherdeck drains are provided to drain exposed levels and main decks. These drain entirely by gravity, overboard above the waterline.

8. Feed drains in machinery spaces.

a. Gravity drains should not be confused with feed drains from machinery. These, too, drain water by gravity, but in this case the water is steam condensate, potential boiler feed water. Therefore it is carried to tanks lower in the ship and is retained.

b. Since such piping pierces decks and bulkheads, there is a potential danger of breeching watertight integrity. Some cases of machinery compartments flooding through open drain piping have occurred.

B. Types of Pumps and Eductors.

1. Types of pumps installed in the main drainage systems are:

   a. Steam-driven reciprocating pumps (in older type ships).

   b. Turbine or motor-driven centrifugal pumps.

   c. Jet pumps (eductors).

2. Types of pumps used in the secondary drainage systems are:

   a. Electric motor-driven centrifugal pumps.

   b. Jet pumps (eductors).

   c. Portable electric submersible pumps.

3. Fixed pumping equipment provided aboard ship include:

a. Steam-driven double-acting reciprocating pumps. These are usually for ballast and general services and are cross-connected into the bilge manifold. Their capacity is about 400 GPM.

b. Electrically-driven centrifugal pumps (bilge, ballast, and general service). These are cross connected into the bilge manifold. Their usual capacity is about 400 GPM although they may be larger.

c. Fixed electric submersible pump for the main bilge system, capacity up to 600 GPM.

d. Main circulating pump.

(1) With the sea chest valve closed and the bilge suction valve open, this pump will rapidly unwater engine room bilges, discharging through the main condenser and overboard.

(2) It cannot be connected to any other compartment.

C. Portable Pumping Equipment. This includes:

1. Portable electric submersible pumps.

2. Eductors (conventional type or peri-jet).

3. P-500 pumps (furnished to ships on special missions).

D. Capacities of Portable Pumping Equipment.

1. Portable electric submersible pump.

a. 140 GPM at a 70 foot head.

b. 180 GPM at a 50 foot head.

c. 200 GPM with no head pressure.

2. Eductors (conventional and peri-jet type).

a. 151 GPM at a 40 foot head. Approximately 182 GPM is required to operate the eductor.

b. The rule of maintaining a minimum ratio of 3 to 1 between operating and discharge pressures is of particular importance when fire main pressure is used to actuate an eductor.

3. P-500 pump.

a. 675 GPM at static discharge heads of 55 feet or less.

b. 1,043 GPM at a static discharge head of 20 feet in combination with two eductors.

c. 500 GPM at a discharge pressure of 100 PSI with a 16 foot suction lift.

E. Use of Unwatering Equipment for Firefighting.

1. Do not use the electric submersible pump as a firefighting pump. It is not designed for positive displacement of water. Its discharge hose can be led to the scene of fire; however, do not use an applicator or all-purpose nozzle with it.

2. The model P-500 pump was originally and primarily developed for firefighting. Straight suction up to a maximum of 16 feet may be taken either from overboard or from a flooded compartment. For suction lifts of over 16 feet, an eductor activated by one of the two pressure lines from the P-500 pump can be used to boost suction water into the pump inlet.

F. Types of Valves Installed in the Drainage Systems.

1. Stop or cutout valves (gate, angle, or globe).

2. Stop check valves.

3. Check valves (swing check or spring loaded).

4. Gagged scupper valves and plug cock valves. Gagged scupper valves have a flap which is kept closed (gagged) by a screw-down stem or other device. Plug cock valves have a simple rotating plug closure.

G. Operation of Valves.

1. In smaller ships, only the main cutout valves can be remotely operated. In larger ships the main cutout valves, together with many of the important stop check valves, may be operated from distant control stations.

2. Valves in smaller ships are controlled mechanically; larger ships have hydraulic or pneumatic control.

H. Bucket Brigade. Should all other methods fail, an efficiently organized bucket brigade should be available to control flooding. This should be kept in mind and adequate provision made for handling flooding in this way. All ship's personnel should understand that this may be expected of them in such an emergency.

V. SUMMARY. Review key points and stress the following:

A. Function of Drainage Systems. The function of drainage systems is to remove flood water from the ship. Their importance requires that they be maintained in efficient operating condition ready for use at all times. A group of trained and skilled men, who are able to use the drainage facilities to their maximum efficiency, will go far to keep the ship afloat when damage occurs.

B. Control Flooding. No matter how small a leak may be, the water it allows to enter must be removed or it will eventually flood not only one but possibly many compartments. Such flooding must be controlled. Drainage by fixed system or portable pumps is ineffective in handling flooding due to damage until the rate of flooding has been controlled.

C. Test Pumping. A compartment containing drain lines leading to pumps can often be tested for flooding by putting a suction on the compartment, without having to enter the compartment. If water is present, it will show in the pump discharge; if the compartment is dry, the check valve will rattle. Such test pumping may also indicate the amount of flooding and the size of the holes causing it. Thus if a single fire and bilge pump were put on a flooded compartment and the pump lost suction within a half hour, the flooding would be controllable and the hole relatively small.

D. Use of Other Pumps. It should be understood that any pump can be used as a drainage pump if there is power to operate it and if its suction side can be tightly connected through suitable hose or piping to the area to be drained. The vertical distance between the suction side of the pump and the water cannot exceed approximately 15 feet unless some means, such as with an eductor or electric submersible pump, can be used to raise the water part of the distance to the pump.

E. Isolation of Flooded Compartments. The entire pumping capacity of the drainage systems is sufficient to care for only minor damage where the leaks are small. A hole in the shell plating, with an area of only one square foot, fifteen feet below the surface, will admit water at the rate of 13,900 GPM. Since all pumping facilities cannot be brought to bear on any single flooded compartment, it is essential that compartments flooded by any considerable underwater damage must be isolated by watertight subdivision before unwatering efforts will meet with any degree of success.

VI. TEST AND APPLICATION.

A. Test. Use these and additional questions as an oral quiz:

1. Q. Give three sources of flooding in addition to flooding from direct damage to the ship's hull.

A. (1) Excess water used to fight fire (as in the case of the NORMANDIE).

(2) Rupture of any of various piping systems.

(3) Progressive flooding due to improperly secured or damaged watertight fittings.

2. Q. What is the capacity of the electric submersible pump?

A. (1) 140 GPM at a 70 foot head.

(2) 180 GPM at a 60 foot head.

(3) 200 GPM with no head pressure.

3. Q. List the five drainage systems found aboard ship.

A. (1) Main drainage system.

(2) Secondary drainage system.

(3) Plumbing and deck drains.

(4) Weatherdeck drains.

(5) Feed drains for machinery spaces.

4. Q. What type of drain piping is considered a flooding hazard?

A. Flooding danger exists in gravity drain piping.

5. Q. Fundamentally, what does a drainage system consist of?

A. (1) A length of suction piping.

(2) Branches from the main leading into the spaces to be drained, normally near the lowest point in each space.

(3) One or more pumps or eductors to take suction from the drainage main.

(4) Discharge piping from the pumps, leading overboard.

(5) Necessary valves, manifolds and strainers.

6. Q. What types of pumps are installed in main drainage systems?

A. (1) Steam-driven reciprocating pumps.

(2) Turbine or electric motor-driven centrifugal pumps.

(3) Jet pumps (eductors).

7. Q. What types of pumps are used in the secondary drainage system?

A. (1) Electric motor-driven centrifugal pumps.

(2) Jet pumps (eductors).

(3) Portable electric submersible pump (for emergency use).

8. Q. What types of valves are installed in the drainage systems?

A. (1) Stop or cutout valves (gate, angle or globe).

(2) Stop check valves.

(3) Check valves (swing check or spring loaded).

(4) Gagged scuppers or plug cocks.

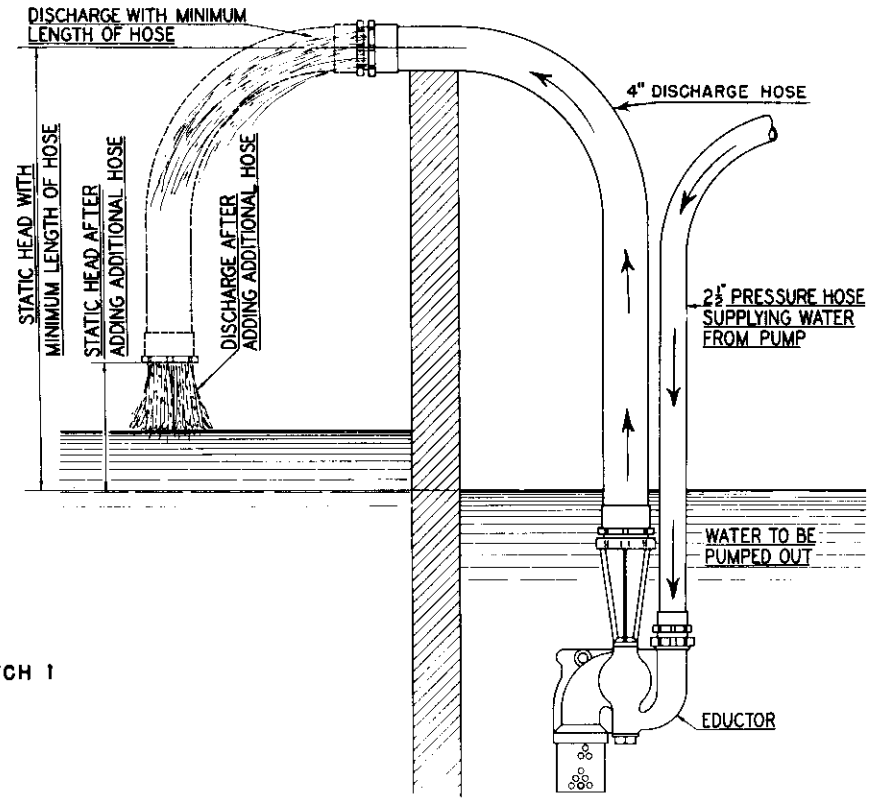
9. Q. What pump will rapidly unwater engine bilges, but cannot be connected to any other compartment?

A. The main circulating pump.

10. Q. What would be the last resort to control flooding should all other methods fail?

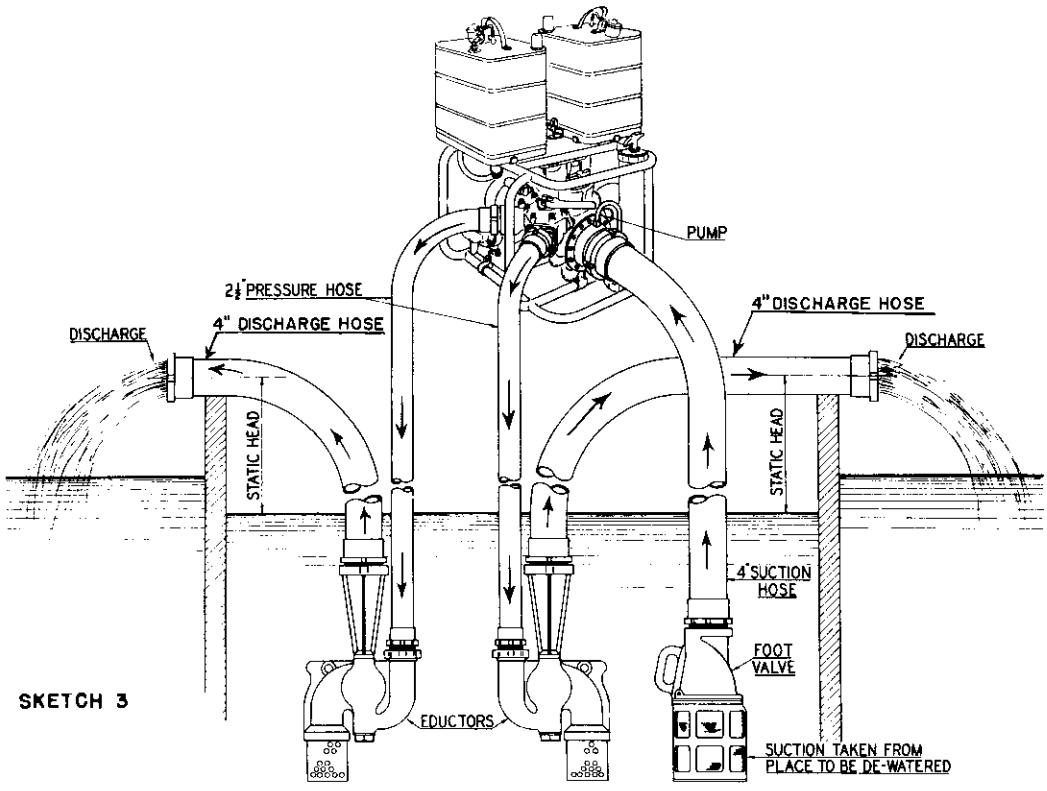
A. A bucket brigade.

B. Application. Tour the ship, pointing out the drainage systems, control valves and pumps. Demonstrate the operation of fixed pumps and the rigging and operation of portable pumps.



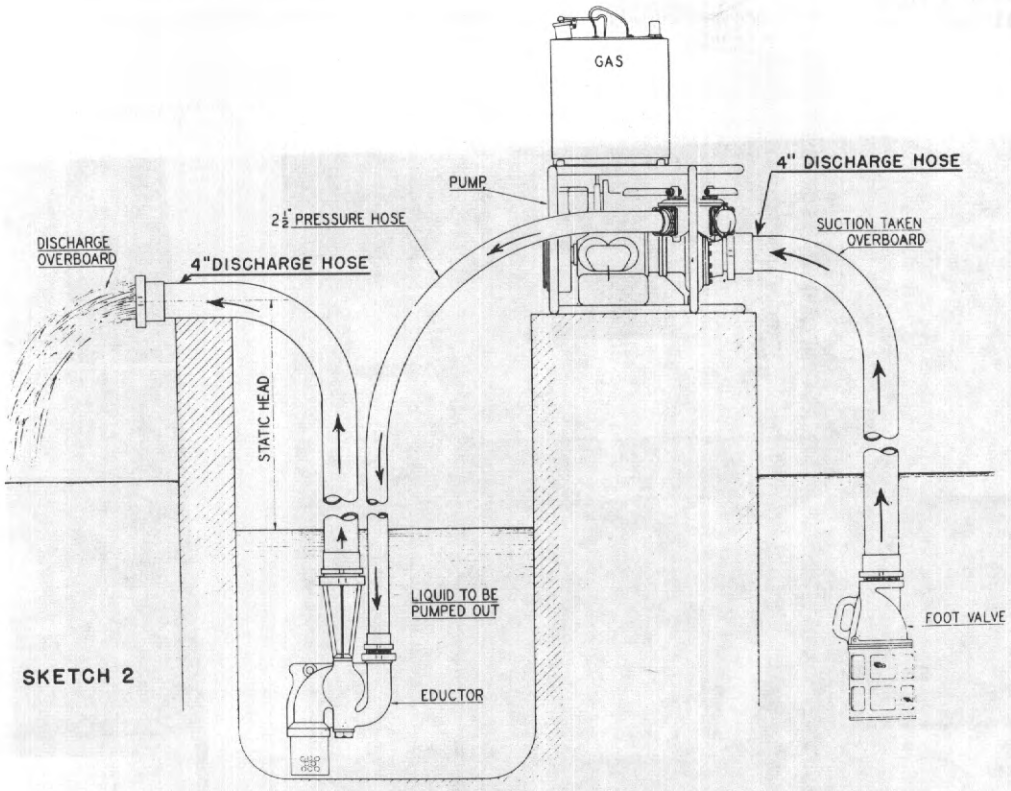
SKETCH 1

Reducing the Static Head While Using the Eductor as a Pump



SKETCH 3

Using Two Eductors as Pumps to Pump Large Quantities of Water at Low Static Head



Pumping Liquids Harmful to the Pump Using Eductor as a Pump

PORTABLE ALUMINUM EDUCTORS

Sketch No.1 - Eductor operated by fire main pressure in the 2½" hose.

Sketch No.2 - Eductor operated by P-500 pump taking suction from sea.

Sketch No.3 - Eductors operated by P-500 pump taking suction from compartment.

Note 1 4" discharge hose may be either canvas or hard rubber.

Note 2 If 4" suction hose is required 4" hard rubber hose is mandatory.

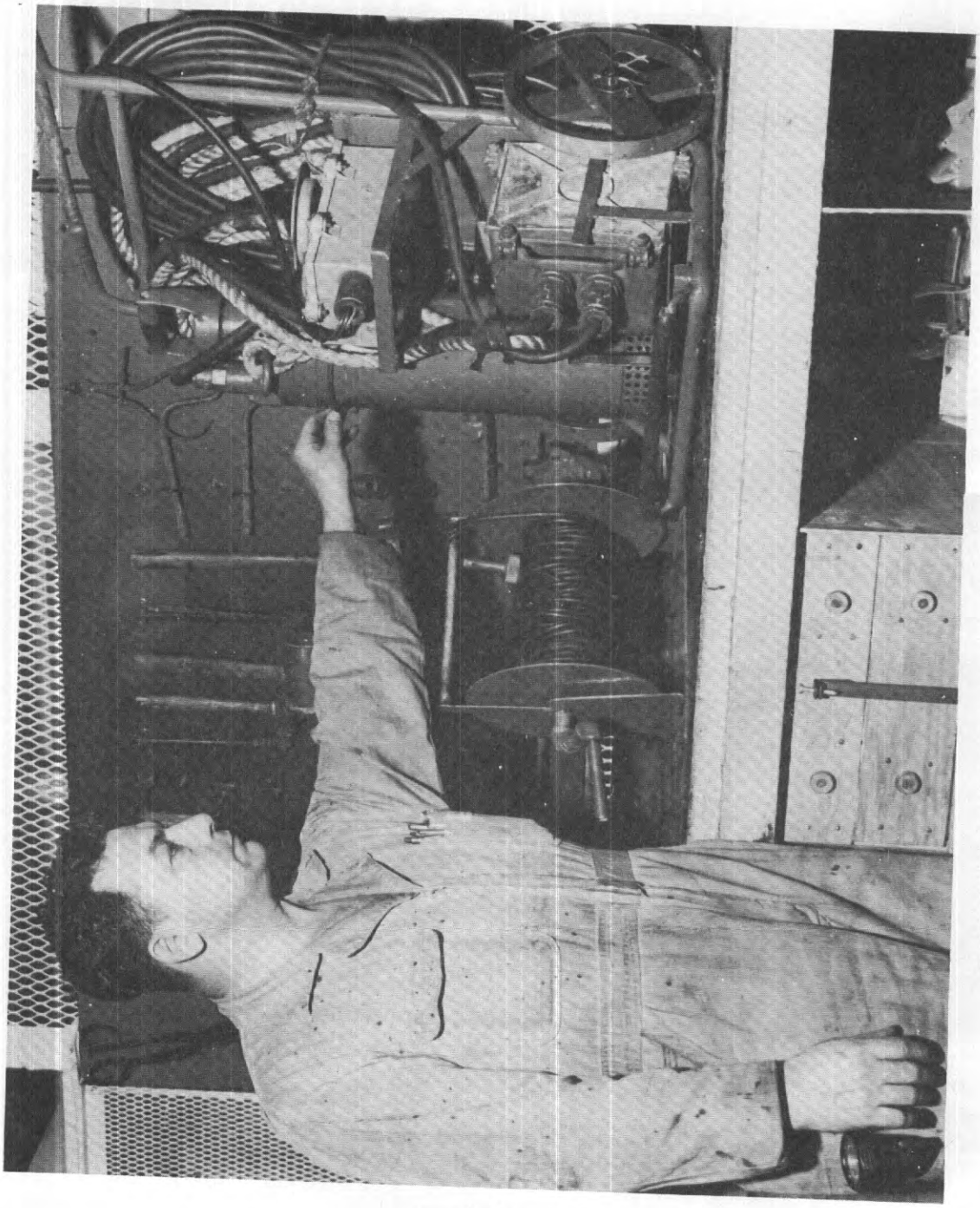
Note 3 Sketches indicate old type of eductor. New type called Peri-Jet permits the pumping of reasonably small particles of foreign matter.

Note 4 Eductors are safe to pump gasoline or oil where by an electric submersible pump would be in danger of burning out the motor.

Note 5 The 4" aluminum cutout valve is used with Peri-Jet eductor and is installed on end of first discharge hose. Cut out valve is operated for the purpose of back-flushing eductor.

Note 6 The lower the end of discharge hose - the lower the static head.

Prepared by Training Branch (IRD)
MSTSLANT



PORTABLE ELECTRIC SUBMERSIBLE PUMP

CHAPTER 4

OFFICERS' DAMAGE CONTROL - For Licensed Officers (Lesson Plans)

SECTION 4.6

STEERING SYSTEMS

I	Objectives	IV	Presentation
II	Material	V	Summary
III	Introduction	VI	Test & Application

I. OBJECTIVES.

A. To impress upon personnel the importance of a thorough knowledge of the main and auxiliary steering systems.

B. To acquaint personnel with the different types of steering systems provided aboard ship and their interchangeability in the event of casualty.

C. To familiarize shipboard personnel with steering system terminology.

II. MATERIAL.

A. BUSHIPS Manual - Chapter 22.

B. Drawing of ship's steering systems.

C. Manufacturer's instruction book.

D. Rules and Regulations - USCG 256.

E. COMSTS INSTRUCTION P3120.2B.

III. INTRODUCTION.

A. Introduce self and subject (Steering Systems).

B. Arouse interest.

1. When steam power for ship propulsion was introduced, it brought about many problems aboard vessels, the first and probably most important of which was to emphasize the inadequacy of hand-powered steering apparatus. The rapid increase in the size and speed of steamships resulted in a correspondingly greater turning effort required at rudder stocks. Therefore, it was only a natural sequence that led to the introduction of steam-powered steering gear.

2. Today all large commercial and naval vessels are equipped with power steering of either steam or electrohydraulic design. Most large vessels are also arranged with an auxiliary hand-operated steering apparatus, either built into the power-driven steering gear or furnished as an entirely separate unit.

3. The importance of understanding steering systems cannot be overemphasized. Steering is a primary requirement for ship control underway, including:

a. Maneuvering around docks and in restricted waters.

b. Traversing harbor and channel to sea.

c. Making good courses between ports in the open sea.

d. Emergency maneuvering as in heavy weather, man overboard.

4. A foreign flag vessel lost steering near the Azores and ran aground with considerable loss of life in 1958. Cite other examples of steering casualties drawn from the instructor's or from the group's experience.

IV. PRESENTATION.

A. Steering System Terminology. A knowledge of steering system terms is necessary in order to understand the system's operation and emergency action.

1. Rudder - The vertical flat piece or structure of wood or metal that is fitted at the after end of a vessel's immersed body as the means by which she is steered.

2. Rudder post. The vertical post abaft the propeller which supports the rudder - more frequently called the stern post.

3. Rudder stock. The forward part of a rudder to which the main part is attached; the part which passes through the rudder post into the ship where the helm or quadrant is attached.

4. Tiller. A bar of iron or wood connected with the rudder head and usually leading forward. By means of the tiller, the rudder is moved as desired. The quadrant is the most frequent form of a tiller in modern vessels.

5. Hydraulic plungers. These are operated in a cylinder by pressure of a liquid. In a hydro-electric steering system, one at each side of the tiller forces the ship's rudder into any position required by the steering control.

6. Hydraulic pumps or units. Units comprised of constant speed motors driving a rotary type pump, delivery from which is automatically controlled.

7. Steering wheel. Used to send impulses to the steering gear by mechanical, hydraulic or electrical means to indicate the direction and amount of rotation of the rudder.

8. Follow-up mechanisms. These maintain the movement of the rudder closely in step with the steering wheel. They consist of a differential gear and cam arrangement which controls the discharge of oil from the pumping units.

B. Evolution of Steering Systems. Steering systems were developed in the following order:

1. A simple paddle or sweep oar over the stern of a small boat.

2. A rudder and tiller as boats grew larger.

3. Hand lines and yoke on the rudder head.

4 A hand wheel attached to a yoke or quadrant on the rudder head by ropes, cables or chains.

5. Steam gear controlled by the wheel and transmitting its power to a quadrant or rudder head thru chain, cables, or shafting.

6. Telemotor equipment. Hydraulic connections between the wheel and the steering engine at the rudder post.

7. Electro-mechanical and electro-hydraulic systems for transmitting the steering action of the wheel to the steering engine and thus turning the rudder.

8. Automatic systems such as electric-gyro-pilot hydraulic pump and motor systems.

C. Types of Steering.

1. Steam. Reversible reciprocating engine with geared quadrant. Its disadvantages were vulnerability of piping, loss of heat, poor economy, and lack of flexibility.

2. Electro-mechanical steering. This is used on small craft and consists of a motor which operates a mechanical screw arrangement. It is bulky and heavy for large ships. In small ships, it serves as auxiliary steering gear. A hand lever controller may be used in some ships, such as submarines and tugs, instead of the wheel and follow-up gear. Electro-mechanical steering requires a large, powerful motor.

3. Other types of steering used in small craft are the worm wheel quadrant and the wire and drum type. These require frequent inspections.

4. Electro-hydraulic steering. This is the most widely used type of steering. It employs a telemotor system worked by the steering wheel and controlling the hydraulic pump on the steering gear. This electric-driven pump operates hydraulic rams which turn the rudder. Most installations include a hand pump for emergency steering in event of power failure. Many ships also have automatic gyro-pilot steering, which is an attachment to the electro-hydraulic gear.

5. Emergency steering in event of loss of power includes the following:

a. Hand pumps.

b. Wire rope and winch.

c. Chain falls, blocks, and other forms of relieving tackle.

d. Steering by propellers of twin screw ships.

e. Steering by various jury rigs or by towing drags over the side.

6. Remote control systems for steering units include:

a. Mechanical control of steering by means of shafting or wire rope from the steering station.

b. Hydraulic steering by means of a telemotor system.

c. Electric control by either a pilot motor and its controller or a synchronous transmission system.

7. A complete telemotor system is composed of:

a. Telemotors.

b. Interconnecting piping.

c. Valves.

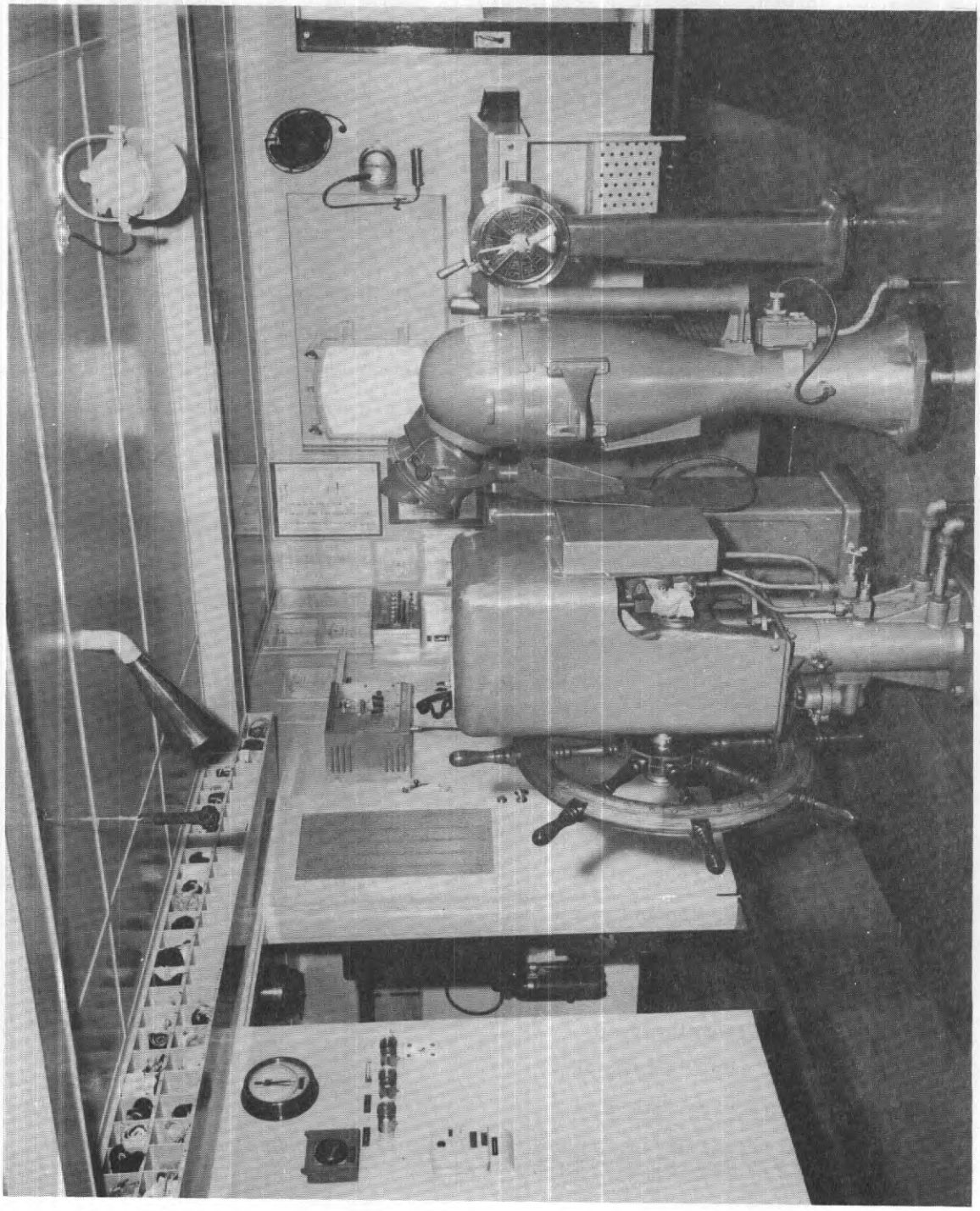
d. A charging tank with sufficient capacity to fill the systems.

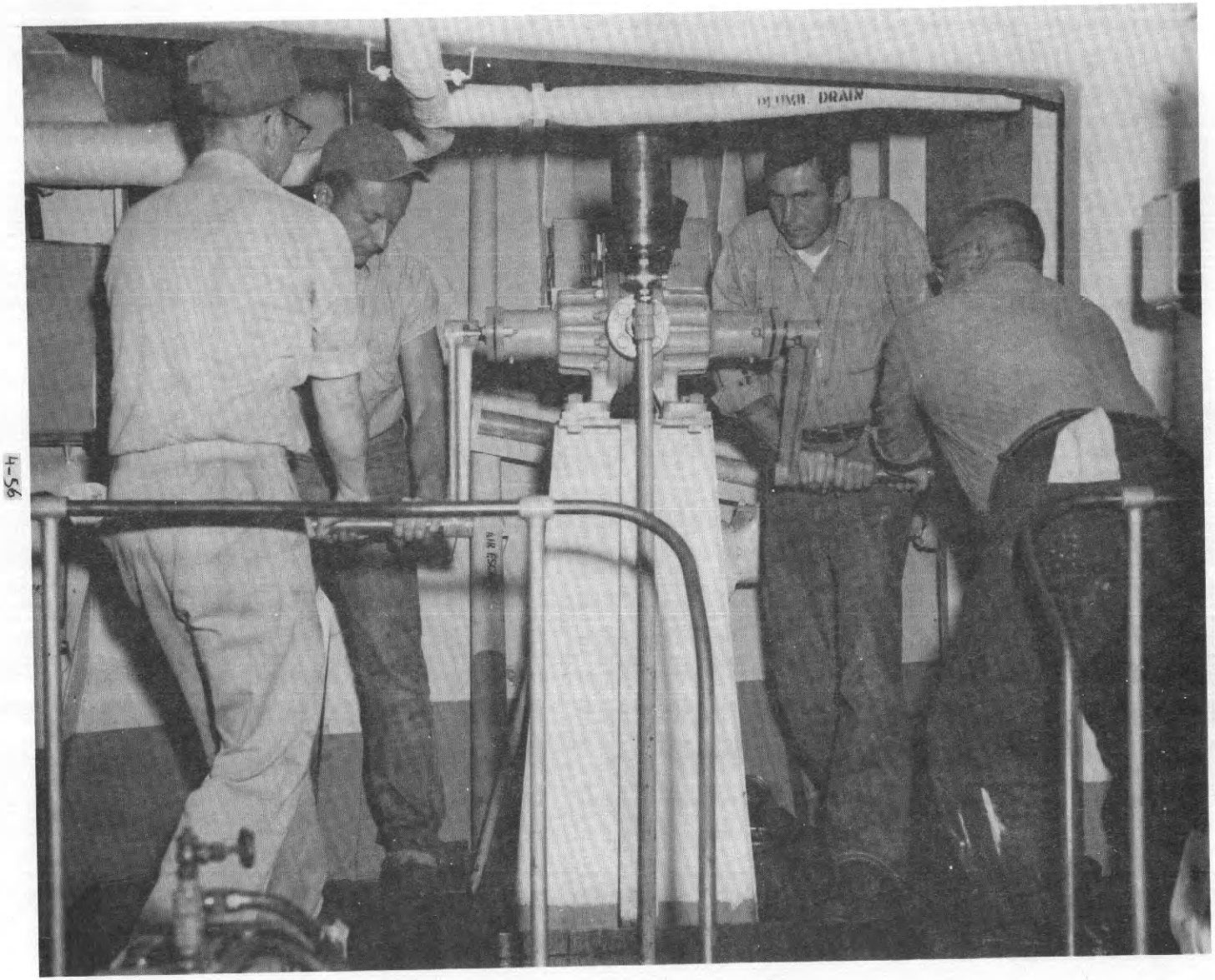
e. A charging pump.

f. A replenishing tank.

D. Steering Control Stations.

1. The bridge is the primary control station, essentially a remote control station. It generally includes:





95-4

a. A hand-operated telemotor.

b. A hand-operated electric control.

c. Automatic electric gyro-pilot.

2. The steering engine room station provides for:

a. Hand-operation of the electro-hydraulic system by means of a trick wheel.

b. Operation of the steering system by means of an erergency hand pump directly connected to the hydraulic rams for emergency use when power is out on the hydraulic pump motors.

c. Chain hoists for moving the rudder stock when power is out on the pump motors and there is no hand pump.

3. The after steering station permits hand operation of the electro-hydraulic system by means of a shaft connection to the trick wheel.

a. Changeover is accomplished by securing the hydraulic lines from the power pumps and opening the hydraulic lines from the after docking station unit to both sides of the ram. Changeover instructions are posted and all valves and fittings are marked. It is important to make sure that these markings and instructions are simple and clear, and that they are understood and maintained.

b. Emergency steering aft can be rigged by removing the access deck plate on the fantail and inserting an extension stock containing a quadrant bar into the rudder stock. Lines or cables can then be attached to shackles on the quadrant bar and run to capstans for steering with power. Instead of capstans, handy-billies can be attached to the shackles and to fixed points for hand steering.

E. Emergency Repairs and Restoration of Steering Control. When a casualty occurs involving loss of steering control, the primary consideration must be to restore control in the shortest possible time. The main steering system usually has two power units, one operating and one on standby.

1. If one power unit has failed, do the following:

a. Secure all switches to the affected unit.

b. Shift to the standby unit, following instructions posted in the steering engine room.

c. Line up the steering gear and rudder.

d. Return steering control to the bridge.

2. If both power units have failed, shift over to emergency steering, following posted instructions. Then locate the cause of the trouble and correct it.

F. Emergency Procedures during Steering Casualties.

1. Call the Master and hoist the "not under command" signal.

2. Execute the steering casualty bill.

3. Symptoms of steering casualties are:

a. On the bridge - steering control will be lost.

b. In the engine room - alarm sounds when power is lost in the steering engine room.

G. Demonstration of Changeover to each Method of Steering.

1. Study the changeover instructions posted in the steering engine room and learn the locations and markings of all the changeover valves and fittings.

2. Responsible personnel, assigned in the steering casualty bill, should actually make the changeover to all methods of steering available.

3. Some of the following methods of changeover to each type of steering may be found aboard your ship:

a. Shifting to standby unit.

b. Steering with trick wheel in steering engine room.

c. Steering from after steering station.

d. Shifting to hand pump steering. Generally seven turns equals a one degree change in course.

e. Wire rope and winch.

f. Chain falls, blocks, tackles.

g. Steering by propellers in twin screw ships.

V. SUMMARY.

A. All licensed personnel should know how to change over to each method of steering aboard your ship.

B. Listed below are must-know items:

1. Steering system terminology and its importance in steering control.

2. Various systems of accomplishing steering control.

3. Most frequently found types of systems.

4. Main components and method of operation.

5. Control stations provided, remote and local control.

6. Casualties and primary consideration.

7. Corrective procedure.

VI. TEST & APPLICATION

A. Test. Use these and additional questions as an oral quiz.

1. Q. What was the simplest hand steering used?

A. Paddle or sweep oar over the stern of a small boat.

2. Q. Where are the steering control stations located?

A. (1) Bridge or wheelhouse.
(2) Steering engine room.
(3) After steering station.

3. Q. What is the most commonly found steering system in use aboard ships today?

A. The electro-hydraulic steering system.

4. Q. What type of steering controls are most likely to be found in the wheelhouse?

A. (1) Hand-operated telemotor.
(2) Hand-operated electric.
(3) Automatic electric gyro-pilot.

5. Q. What type of steering controls are most likely to be found in the steering engine room?

A. (1) Trick wheel.
(2) Emergency hand pump.
(3) Chain hoists.

6. Q. What type of steering controls are most likely to be found at the after steering station?

A. (1) Steering wheel with shaft connection to the trick wheel in the steering engine room.
(2) Steering wheel operating positive displacement pump.
(3) Lines or cables attached and used in conjunction with capstans.
(4) Handy-billies attached to shackles and fixed points.

7. Q. In case of a steering casualty involving loss of steering control, what is the prime consideration?

A. To restore steering control in the shortest possible time.

8. Q. What is the procedure on the bridge in case of a steering casualty involving loss of steering control?

A. Call the Master and sound the steering casualty signal of one long and two short rings on the general alarm bells ("D"), announcement on the PA, and one long and two short rings on the alarm bells. When other ships are in the vicinity, hoist "not under command" signal or international code flag "D" and/or sound a long and two short blasts on the ship's whistle, as appropriate. Then execute the steering casualty bill.

9. Q. Where will you find the instructions covering changeover procedures for a steering casualty?

A. They are posted in the steering engine room.

10. Q. How can you identify steering gear changeover valves and couplings?

A. They are marked and labeled in accordance with the posted changeover instructions.

B. Application. Have the group indicate or demonstrate how they would change over to the various alternate steering methods.

CHAPTER 4

OFFICERS' DAMAGE CONTROL - For Licensed Officers (Lesson Plans)

SECTION 4.7

PLOTTING DAMAGE

I	Objectives	IV	Presentation
II	Material	V	Summary
III	Introduction	VI	Test And Application
		VII	Damage Control Reporting Slip

I. OBJECTIVES.

A. To impress officer personnel with the importance of making and maintaining an accurate plot of all damage control casualties.

B. To familiarize officer personnel with the ship's damage control display plans, their contents, purpose and use.

C. To indoctrinate officer personnel in standard methods of plotting casualties and the progress of corrective measures taken.

D. To explain the importance of establishing casualty boundaries and advancing them as progress is made to eliminate the casualty.

E. To explain the methods of completing the plot when the casualty has been eliminated.

II. MATERIALS.

A. Training Aids. Ship's damage control display plans.

B. References. BUSHIPS Manual, Chapter 88, Section II, Part 10, Investigating Damage; Section I, Part 18, Estimate of the Situation.

III. INTRODUCTION.

A. Introduce self and subject (Plotting Damage).

B. Arouse Interest.

1. Damage Control Display Plans have been furnished to all MSTS passenger ships and are being provided all other MSTS ships. These display plans are deck plans for the individual ship drawn on an isometric projection. They are set up in special frames in damage control central, under a plexiglass sheet, and used to plot the location, extent and progress of corrective action of each casualty occurring to the ship.

2. Communications between damage control central and repair parties and zone areas is of prime importance in furnishing damage control central with the necessary information to make the plot and maintain the record of progress so that a picture of the situation is kept current without relying on memory.

3. Standard symbols and colors are used throughout the MSTS fleet for plotting all casualty situations on damage control display plans.

4. As primary and secondary damage boundaries are set up and reported to damage control central, they are also plotted.

5. When the casualty has been eliminated, completion of the plot will so indicate. If there is more than one casualty existing, the progress and completion of each is graphically pictured as corrective operations proceed.

IV. PRESENTATION.

A. Plotting Procedures. The basis of damage control casualty plotting is the isometric projection of the ship's deck arrangement plans showing all compartments labelled and numbered according to the hull marking system (COMSTS INSTRUCTION 9280.3 or effective revision) and showing all damage control features by means of standard symbols.

1. These plans are generally mounted under plexiglass in special frames in damage control central.

2. Colored grease pencils are used to plot the different types of casualties. The plots are made directly on the plans' plexiglass covers and can be wiped off with a cloth when the drill is secured.

a. Red pencil is used for "Fires".

b. Green indicates "Flooding".

c. Black plotting shows "Hull Damage".

d. Yellow grease pencil is used for "ABC contamination".

3. Standard symbols are used throughout:

a. Fire. Fire is plotted by writing A, B, or C for the class of fire (as "C" for electrical fire) on the plexiglass over the compartment on the deck plan, using red grease pencil.

(1) When the repair party reports arrival on the scene, one side of a triangle to surround this symbol is drawn, also in red, as "C".

(2) Boundaries are drawn on the casualty plot as a wavy line surrounding the area and the repair party is instructed by sound-powered phone to set up boundaries and investigate accordingly.

(3) When the repair party reports the fire has been brought under control, the second side of the triangle is drawn in, as "/C".

(4) When the repair party reports the fire extinguished, the third side of the triangle is plotted, indicating that the fire is out and that cleaning up has been started, as "C".

(5) Fire main is indicated by the letters "F/M". Rupture of the fire main or other piping system in the fire area is indicated by the symbol "F/M" in red and, when repaired, is indicated thus "F/M".

(6) If required and if permission has been requested of and granted by damage control central, an open watertight door or fitting is indicated at its location on the plan by "WTD" in red. When secured, this symbol is boxed in "WTD".

b. Flooding. Flooding conditions are plotted in green grease pencil, using the letter "F" and a number to indicate the rate of flooding, as "F 300" for flooding at the rate of 300 GPM.

(1) When pumps have been rigged and unwatering started, the first side of the triangle surrounding this symbol is drawn in, as "F".

(2) When flooding is under control (no longer gaining), the second side of the triangle is drawn, as "F".

(3) When the repair party reports the compartment has been pumped dry, the third side of the triangle is plotted to complete it, as "F".

c. Hull Damage. Hull damage such as cracks or holes in shell plating are plotted in black grease pencil.

(1) Structural damage is indicated by the zig-zag symbol "".

(2) Damage repaired is a zig-zag boxed symbol enclosing the damaged area.

(3) A hole in plating is indicated by the symbol "" and a number indicating the size of the hole in feet or inches, as "3".

(4) When the hole has been patched, box in the symbol "3".

(5) Where shoring is erected, indicate this in the correct location and direction by symbol, "or".

d. ABC Contamination. Contamination resulting from ABC attack is plotted in yellow grease pencil

(1) Areas found to be contaminated after rough survey are circled and labeled with the appropriate symbol: "A" for atomic, "B" for biological, and "C" for chemical contamination.

(2) When the affected areas have been decontaminated, shade or cross-hatch the encircled area.

e. Use of Symbols. This standard system of plotting symbols and color code will permit maintenance of a current running picture of the casualty situation, progress of control measures, and corrective action on one or more casualties for the information of both the damage control officer and the master. Boundaries for containing damage are plotted in the color appropriate to the type of damage. Even after control and correction or repair of the damage, patrols such as fire and security watches are set to assure that control is maintained.

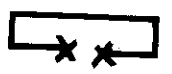
f. Resume of Casualty Plotting Symbols. These are the standard Navy symbols used in most ships for casualty plotting:

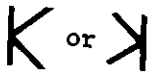
A B C	(in red).	Classes A, B, and C fires reported.
A B C	(in red).	Classes A, B, and C fires - under control.
A B C	(in red).	Classes A, B, and C fires - fire out.
A	(in red).	Class A fire - reflash watch set.
B	(in red).	Class B fire - compartment tested.
C	(in red).	Class C fire - fire overhauled.
F	(in green)	Flooding - reported
F300	(in green)	Flooding reported at the rate of 300 GPM.
F	(in green)	Flooding - pumps rigged.
F	(in green)	Flooding - being pumped out.
F	(in green)	Flooding - completely pumped out.
6" 4"	(in black)	Holes - indicating size.
4"	(in black)	Hole - patched.


Broken pipe or line (red for fire and black for other piping).


Broken pipe or line repaired (red for fire and black for other piping).

Broken pipe of line isolated (red for fire and black for other piping).


Break bypassed. (red for fire and black for other piping).


(in black) Shoring.

F/M (in red) Fire main

WTD (in black) Watertight door.

WTH (in black) Watertight hatch.

A/H (in black) Access hatch.

B. Communications. Communications, in any casualty situation, must be established quickly, must be accurate, and must be restricted to essential messages. In order to direct proper emergency action, the damage control officer must know exactly what the casualty is and all details regarding the location and extent of damage, distribution of equipment and personnel, and must receive regular reports of progress. Therefore:

1. Telephone talkers must be trained to transmit clearly, slowly and in standard phraseology.

2. Rigid control of circuit discipline must be maintained in order to insure that messages get through properly.

3. Repair parties must keep damage control central constantly informed of progress; regarding personnel casualties, if any; boundaries set up to contain the casualty; equipment used and steps taken to combat or eliminate the casualty; flare-up watch set on extinguishment of fire; security watch posted to check and tighten shoring when completed; progress of unwatering; repairs to piping or electrical circuits, etc.

4. If telephone cummunications are interrupted, the flow of information to damage control central must be maintained by utilizing messengers until telephone contact can be reestablished.

2. Q. What is the symbol and color used to plot flooding situations?

A. The letter "F", together with a number indicating the rate of flooding, enclosed by lines eventually forming a triangle, all plotted in green.

3. Q. What emergency situation does yellow indicate in the damage control plot?

A. ABC contamination.

4. Q. Why is it important to establish casualty boundaries?

A. Casualty boundaries are necessary in order to contain and prevent any further spread of fire or other damage. In passenger ships, these boundaries keep unnecesary personnel clear of the action area.

5. Q. What is the purpose of damage control display plans?

A. They permit a current running picture of any casualty situation and thus enable the damage control officer to efficiently direct corrective measures. They also make full information available to the master at all times to enable him to maneuver the ship to best advantage.

6. Q. Why are communications considered especially important in casualty situations?

A. Communications are important because plotting of damage cannot begin or be kept current without good communications to relay information from repair officers to damage control central and orders or instructions to be relayed back.

7. Q. What casualty information is plotted in black?

A. Structural damage, holes in shell plating and shoring.

8. Q. What do the sides of a red triangle plotted on the damage control display plans during a casualty represent?

A. A fire area: one side indicates the repair party is at the scene, the second side is plotted when the fire is reported under control, and the third side of the triangle is completed when the fire is extinguished.

9. Q. How is a ruptured fire main plotted?

A. It is plotted "—|—F/M" in red and "—⋈—F/M" when repaired.

10. Q. If repair one had to open a watertight door in the casualty area, what permission is required and how would it be shown on the casualty plot?

A. The damage control officer would have to authorize opening of a watertight door. He would plot it at its location, in red, as a "WTD". When secured, it would be shown boxed in.

B. Application. Have individuals demonstrate their ability to plot any of the following, using locations and data which can be assumed at the time.

1. Plotting a simulated fire and/or flooding.
2. Plotting a damaged structural area.
3. Plotting secondary boundary areas.
4. Plotting the access routes to damaged areas.
5. Plotting a simulated collision.

VII. DAMAGE CONTROL REPORTING SLIP.

DAMAGE CONTROL REPORTING SLIP | TIME

DIRECTIONS: *1. Repair Officer or Zone Area Commander should fill out slip and hand it to Telephone Talker or Messenger for transmittal to DCC. 2. At DCC, Telephone Talker records all information on an identical slip before forwarding to the D. C. Officer. He then hands it to the D. C. Officer. 3. Messages from DCC are handled as items 1 and 2 above. 4. After drills, the corresponding slips will be matched and reviewed for effectiveness and corrective action.*

REPORTING

REPAIR ZONE | LOCATION

EMERGENCY (BY TYPE)

CONDITION

REQUEST

REMARKS

CHAPTER 4

OFFICERS DAMAGE CONTROL - For Licensed Officers (Lesson Plans)

SECTION 4.8

LEADERSHIP IN DAMAGE CONTROL

I. Objectives
II. Material
III. Introduction
IV. Presentation
V. Summary
VI. Test

I. OBJECTIVES.

A. To impress officers-in-charge of repair parties, zone area commanders and lifeboat commanders with the importance of good leadership in meeting their responsibilities in the damage control organization.

B. To outline leadership procedures in specific damage control situations which reflect officers' leadership capabilities.

C. To accomplish a more efficient damage control operation with skilled men or at times with fewer trained men.

D. To emphasize the techniques of good instruction as they relate to damage control training.

E. To impress officers with the importance of establishing high standards of behavior and performance by personal example.

II. MATERIAL.

A. Training Aids. 1. Film - MN 5328B "Shipboard Training - Learning by Doing," 13 minutes. 2. Film, FN 8829, Effective Naval Leadership Series ch#8
3. Films KN-9698, Leadership Speaks series.

B. References.

1. Naval Leadership, U.S. Naval Institute.

2. Selected Readings in Leadership, U.S. Naval Institute.

3. COMSTS INSTRUCTION 5390.1 (Moral Leadership Program). ch#8

4. U.S. Navy Manual for Leadership Support, NAVPERS 15934A