

NAVAL SHIPS' TECHNICAL MANUAL

CHAPTER 079

VOLUME 2 - DAMAGE CONTROL PRACTICAL DAMAGE CONTROL

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CHAPTER 079

DAMAGE CONTROL VOLUME 2 PRACTICAL DAMAGE CONTROL

SECTION 20.

GENERAL

079-20.1 BASIC DAMAGE CONTROL CONSIDERATIONS

079-20.1.1 HOW TO USE THIS BOOK. The information in this volume is used in conjunction with directives and other publications that concern types, classes or individual ships. It supplements *NWP 3-20.31, Surface Ship Survivability*. The information in this volume is intended to support but not to supersede, render obsolete, or invalidate any directive or publication issued by competent authority pertaining to any particular ship or group of ships.

079-20.1.1.1 Damage control represents the measures necessary aboard ship to contain, preserve and reestablish watertight integrity, stability, maneuverability and combat systems. Just as combat systems dominate the battle space outside the ship, the goal of damage control is to dominate the casualty inside the ship.

079-20.1.1.2 The most important part of damage control takes place before damage occurs. Only through prior training, exercises (drills), tests and inspections can personnel achieve the necessary knowledge, skills and teamwork to take effective damage control action. It is too late to start an intensive damage control program when the ship is sinking or burning. Training needs to start with the establishment of the ship's precommissioning detail and continue until the ship is decommissioned or stricken from the Navy list.

079-20.1.1.3 Training drills need to be repetitive, realistic and include all personnel who may become involved during an actual emergency. These exercises should cover all possible damage situations, including fires, flooding, battle damage that involves structural damage and Chemical, Biological or Radiological (CBR) attack, among others.

079-20.1.1.4 Three basic objectives of shipboard damage control are time phased as taking place roughly before, during or after the ship sustains damage. Briefly stated, these objectives are as follows:

- a. To take preliminary action before damage occurs. This includes maintenance of watertight and airtight integrity, preservation of reserve buoyancy and stability, removal of fire and missile hazards, preventive maintenance and test of emergency equipment and damage control fittings.
- b. To minimize, contain and localize casualty damage by controlling flooding, dewatering, firefighting and care to injured and wounded personnel.
- c. To accomplish emergency repairs and recover as soon as possible after damage occurs, by segregation, reconfiguration, establishing casualty power, regaining a safe margin of stability and buoyancy, reinforcing and shoring damaged structures and manning essential equipment.

079-20.1.1.5 Damage control is offensive as well as defensive and requires rapid, continuous response to sense, assess and engage casualties. The ship's ability to inflict punishment on or destroy an enemy, or to perform any

other assigned mission may depend on the success of damage control procedures. It is essential that all hands in the ship's company understand the importance of their responsibilities.

079-20.1.2 SCOPE. Damage control concerns not only battle damage but also nonbattle damage such as that caused by fire, collision, grounding or explosion. Damage control may be necessary in port as well as at sea and may involve the use of personnel and facilities of an undamaged ship or a shore command.

079-20.2 NECESSARY KNOWLEDGE

079-20.2.1 KNOW THE SHIP. Damage control requires a detailed knowledge of ship construction, characteristics, compartmentation and stability and of the tools and equipment aboard ship to prevent and control damage. Personnel can easily determine the proper corrective action to be taken when they have a thorough knowledge of their ship, its systems and its repair equipment. The control of damage depends on the ability and initiative of personnel to take immediate action, using the available materials and equipment.

079-20.2.2 DAMAGE CONTROL REFERENCES. This volume (a responsibility of the Naval Sea Systems Command (NAVSEA)) is of general application. Additional or more specific information is incorporated by referencing other Naval Ship's Technical Manual (NSTM) chapters, bulletins, individual ship's damage control books and equipment instruction pamphlets. The Chief of Naval Operations (CNO), the Chief of Naval Personnel and afloat commanders distribute policy and instructions on organization and training. NWP 3-20.31 lists publications that contain information and instructions on damage control. Also, see [Table 079-20-1](#).

079-20.2.3 OTHER SURVIVABILITY REFERENCES. The ship building industry has moved into performance requirements, replacing the Navy's military standards and specifications and detailed ship specifications as guidance for designing and building new ships. This paradigm shift has created a greater need to define and provide detailed reference materials which address all aspects of ship survivability and recoverability. One valuable reference source is *OPNAV P-86-4-99, U.S. Navy Survivability Design Handbook for Surface Ships*.

079-20.2.4 SHIP'S SELECTED RECORDS. Ship's Selected Records (SSR) are those parts of a ship's technical documentation designated by the CNO to be maintained current throughout the life of the ship. The SSR program is described in *NAVSEA SL720-AA-MAN-010, Fleet Modernization Program Management and Operations Manual*. SSR comprises three categories: Selected Record Drawings, Selected Record Data and Allowance Lists. Selected record data, which includes Damage Control Books and Diagrams, constitute important sources of basic technical information on shipboard arrangements, equipment and systems applicable to a given ship. Under the cognizance of NAVSEA, they are selected for their value (for operational, maintenance, training and consulting purposes) to an individual ship's force, fleet commands, planning yards, overhaul yards, training commands and other Naval activities.

079-20.3 GENERAL RESPONSIBILITIES

079-20.3.1 SHIP'S COMMANDING OFFICER (CO). Besides other responsibilities in damage control, the CO is responsible for maintaining a file of the ship's configuration changes, regardless of who effected them (whether ship's force or anyone else) and regardless of whether or not the changes represent additions or removals. The CO is also responsible for maintaining a complete configuration change file, including records of action taken during the operational period. This file shall be reviewed by the Naval supervising activity at the pre-arrival conference or during ship checks.

079-20.3.2 THE PLANNING YARD. Unless otherwise directed by NAVSEA, the planning yard for each ship class is the engineering design agent for selected record drawings. The planning yard is responsible for the development, maintenance and update of the selected record drawings. During assigned availabilities the planning yard temporarily transfers maintenance responsibility to the installing activity, but retains custodial responsibility the entire time. The planning yard remains responsible for reviewing damage control diagrams submitted by the overhauling yard, giving final approval to them and distributing approved copies.

079-20.3.3 NAVSEA SHIP LOGISTICS MANAGER (SLM). NAVSEA SLMs are responsible for task configuration and COSAL maintenance efforts performed by the Naval supervising activity prior to and during overhauls. SLMs provide the current listings of alterations programmed for accomplishment during the availability, including updates to the list as changes are identified.

079-20.3.4 OVERHAUL YARDS. Overhaul yards are required to update only those data that are directly affected by the overhaul, including data identified by ship's force as requiring updating when submitted in the pre-overhaul package or during the overhaul and to incorporate all changes as needed to mesh with other update actions.

Table 079-20-1 DAMAGE CONTROL REFERENCE PUBLICATIONS

TITLE	SOURCE OF SUPPLY
Tactical Doctrine Publications (NWP, FXP, and ATP)	Reg. Pub. Iss. Office, or Symbol I (FPSO) Stock Point
Damage Control Book with diagrams lithographed in color	NTS 9090-820
Damage Control Book with black and white diagrams	NTS 9090-820
Liquid Loading Instructions (incl. ballasting letter)	Type Commander and NAVSEA
Various Fleet and Type Directives on Damage Control	Appropriate Fleet and Type Commander
Booklet of General Drawings	Planning Yard
Ship Information Book	Planning Yard
Schedule of Watertight Integrity Tests and Inspections	Planning Yard
Damage Control Sections of COSAL	NAVICP, Mechanicsburg, PA 17055
Engineering Casualty Control Book	Ship
Damage Control Bills	Ship
Compartment Check-off Lists	Ship or Type Commander
Booklet of Plans of Machinery	NAVSEA
Copies of Hull Drawings	Planning Yard
Naval Ships' Technical Manuals	NAVSEA
First Aid Bulletins	BUMED
War Damage Reports	NAVSEA

079-20.4 DAMAGE CONTROL BOOKS - SURFACE SHIPS

079-20.4.1 ISSUANCE. NAVSEA issues damage control books and diagrams to all aircraft carriers, surface combatants, amphibious ships, mine warfare ships, fleet support ships and large floating drydocks. As a rule, NAVSEA does not issue damage control books and diagrams for small vessels less than 200 feet in length, such as small patrol craft, landing craft, small fleet support vessels and yard craft. The crews for such vessels may independently develop their own damage control books and diagrams. Damage control books are issued to ships in both the active fleet and Naval reserve force. Recipients of damage control books are held responsible for them to the same extent as for ship's selected records and technical manuals. Custodians of the books, upon their detachment or relief, shall account for all books and turn them over to their successors.

079-20.4.2 DAMAGE CONTROL BOOKS AND DIAGRAMS - CONTENT AND STRUCTURE.

079-20.4.2.1 Ships' damage control books and diagrams are developed under stringent requirements established by NAVSEA Technical Specification (NTS) 9090-820. This specification establishes the requirements for the preparation and revision of damage control books and diagrams for all U.S. Navy surface ships for which damage control diagrams and books are prepared.

079-20.4.2.2 Damage control books and diagrams contain information pertaining to the damage control features of the ship's compartmentation, piping, ventilation and wiring systems. Damage control books relay the information in the form of tests, tables and illustrations.

079-20.4.2.3 Most of the damage control diagrams are three dimensional isometric diagrams, and for most surface ships, are printed in color. Some older ships have damage control diagrams printed in the black-and-white halftone format. As funding permits, such ships' halftone diagrams will be converted to color.

079-20.4.2.4 On all diagrams, each compartment, tank, void or other space is designated by number, letter or both. Various shipboard systems, such as piping or communications, are shown as much like the actual installations as possible and are designated by colors, letters, numbers and symbols.

079-20.4.2.5 Each deck or platform is shown as a separate level. Compartments not intersected by an overhead deck or platform are drawn as part of the deck from which they extend upward. Some of the drawing conventions used on the diagrams are listed below.

- a. Heavy lines show watertight or oil-tight boundaries.
- b. Lighter lines show airtight, fumetight or nontight boundaries.
- c. Dotted lines show hidden boundaries, piping and valves.
- d. Visible piping is shown by solid lines.
- e. Piping that goes through a bulkhead has a circle showing the point of penetration.
- f. There is no circling at the point of deck penetration.

079-20.4.2.6 [Figure 079-20-1](#) shows a sampling of symbols used in damage control diagrams. [Figure 079-20-2](#) (pages 20-6 and 20-7) illustrates a typical damage control diagram and the use of diagram symbols.

079-20.4.3 DISTRIBUTION OF DAMAGE CONTROL BOOKS AND DIAGRAMS. Following new ship construction and overhauls of active ships, damage control books and diagrams are issued to the subject ship. Copies of the books and diagrams are distributed to other commands and activities in accordance with *SL720-AA-MAN-010, Fleet Modernization Program Management and Operations Manual (FMP), Volume 2, Appendix E*.

079-20.4.3.1 Ships are issued sets of laminated diagrams which are mounted in hinged leaf units within Damage Control Central and each repair station. Additional sets of laminated and non-laminated diagrams are provided for potential use elsewhere on the ship. The number of laminated and non-laminated diagrams provided to each ship is specified in the FMP manual.

079-20.4.3.2 Requests for additional or replacement damage control books and diagrams shall be made to the ship's assigned planning yard. The FMP manual contains a list of ship classes and their assigned planning yards. The name of the ship's planning yard is also printed on the inside title page of damage control books and in the lower title block area of each damage control diagram.

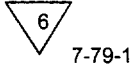
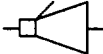
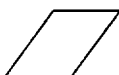
SYMBOL	SYMBOL KEY	SYMBOL	SYMBOL KEY
	FOG FOAM PROPORTIONER PUMP AND CONTROL		QUICK ACTING WATERTIGHT DOOR
	HOSE STOP OR FIRE PLUG		DECK DRAIN VALVE
	REMOTE CONTROL STATION (FIGURES INDICATE VALVE NUMBER)		DECK DRAIN
	VENTILATION CLOSURE (APEX INDICATES DIRECTION OF FLOW)		EDUCTOR (JET PUMP) FLOW IS IN DIRECTION OF FLARE
	VALVE MANIFOLD		OVERBOARD CONNECTION FOR SUBMERSIBLE PUMP
	BLOWER IN VENTILATION SYSTEM		STOP CHECK VALVE
	REMOTELY OPERATED CLOSURE FITTING		STOP-LIFT CHECK VALVE
	BILGE SUCTION		RELIEF VALVE OR SPRING LOADED CHECK VALVE
	SEA CHEST		HATCH
	BULKHEAD PENETRATION		MANHOLE
	WATERTIGHT DOOR		QUICK ACTING SCUTTLE
			REMOTE CONTROL VALVE

Figure 079-20-1. Sampling of Damage Control Diagram Symbols

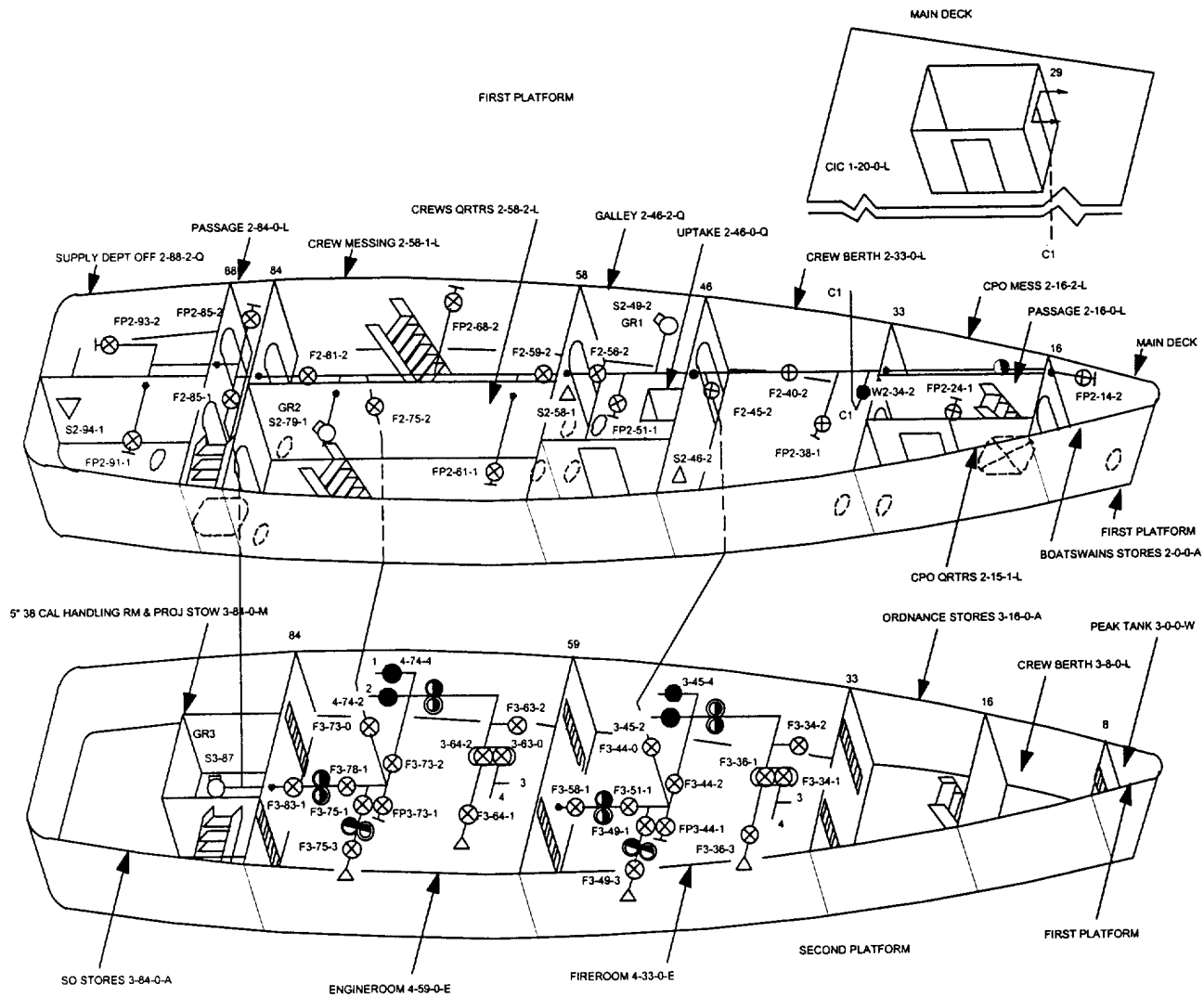


Figure 079-20-2. Illustrative Damage Control Diagram (1 of 2)

FIREMAIN, SPRINKLER AND WASHDOWN SYSTEMS

KEY

F	FIREMAIN
S	SPRINKLER SEE NOTE
W	WASHDOWN
	VALVE AND CHANGE OF SYSTEM
	VALVE (SEE TEXT FOR SIZE AND TYPE)
	VALVE - REMOTELY OPERATED
	CHECK VALVE - SHADED PORTION IS OUTLET
	HOSE VALVE, FIRE PLUG OR JUMPER CONN
	VALVE MANIFOLD
	REMOTE CONTROL STATION. NUMERALS IDENTIFY VALVE OPERATED. SEE TEXT FOR TYPE OF OPERATION
	WASHDOWN SPRAY NOZZLE - FLOW IS IN DIRECTION OF APEX
	PUMP - SHADED PORTION IS OUTLET. SEE TEXT FOR TYPE AND FUNCTION.
	SEA CHEST
	BULKHEAD PENETRATION
1-	OVERBOARD DISCHARGE
2-	TANK BALLASTING
3-	FUEL OR DRAIN
4-	DRAINAGE SUCTION

NOTES

DOTTED LINES AND CROSS-HATCHING INDICATE BOUNDARIES, PIPING AND FITTINGS HIDDEN FROM VIEW.

DOT-DASH LINE INDICATES INTERSECTION OF HORIZONTAL LEVEL WITH VERTICAL BULKHEAD.

MEDIUM HEAVY LINE INDICATES WATERTIGHT OR OILTIGHT BOUNDARIES.

MEDIUM THIN LINE INDICATES AIRTIGHT, FLAMETIGHT OR NONTIGHT BOUNDARIES.

THE LETTER PRECEDING A VALVE OR FITTING NUMBER REFERS TO THE SYSTEM AND IS NOT ACTUALLY PART OF THE VALVE OR FITTING NUMBER EXCEPT FOR FIREPLUG.

Figure 079-20-2. Illustrative Damage Control Diagram (2 of 2)

079-20.4.4 USE OF DAMAGE CONTROL DIAGRAMS. Damage control diagrams are used in damage control central, the bridge and repair stations during casualties to plot and display the current status of fire and flooding boundaries, the progress of firefighting, dewatering and other damage control activities. The damage control diagrams are also used during casualties to direct the operation of vital ships' systems. During a major casualty, it is usually necessary to muster some personnel and possible rescue and assistance teams from other ships to areas located away from usual damage control stations. The ship's extra sets of laminated and non-laminated diagrams should be carried to these mustering points to assist in orienting and coordinated personnel.

079-20.4.5 REVISION OF DAMAGE CONTROL BOOKS AND DIAGRAMS. One set of the ship's damage control books and one set of diagrams shall be designated as the master copy book and diagrams. The master copy shall be kept updated to reflect changes made to the ship by ship's force and other activities between regular overhauls and availabilities. Applicable ship and ship system alterations shall be entered into the master copy book and diagrams as soon as they are completed. Revisions to the master shall be clearly marked in red ink so other copies can be revised to duplicate the master copy book and diagrams.

079-20.4.6 MARK-UP PROCEDURES. Damage control book and diagrams shall be marked up as follows:

- a. **DELETE** information by crossing out old information with red ink. No erasures are to be made and no notes are necessary to explain that the information has been deleted.
- b. **ADD** information to the diagrams using the colors of the established color coding systems in use on the diagrams. Make additions at the correct position on the diagrams, circling each change in red ink.
- c. **CHANGE** information (names of compartments or in notes) by marking the change in the margin of the book and diagrams, using black ink. Minor changes (i.e., a change from a non-tight to a watertight duct, change in the type of valve) can be indicated by a note in the margin to show the extent of the correction.

079-20.4.6.1 At the time of each ship overhaul, the commanding officer shall deliver a duplicate copy of the master damage control book and diagrams to the overhaul activity at the arrival conference. Changes in the ship's configuration or systems which were marked in the master and the duplicate books and diagrams shall also be recorded in the current ship's maintenance project (CSMP). The CSMP shall state whether ship's force requires help from the overhauling activity in checking the damage control diagrams for accuracy against actual ship installations. The master damage control book and diagrams developed prior to the overhaul shall be retained on board the ship during the overhaul until revised damage control books and diagrams are received from the planning yard at the end of the overhaul.

079-20.4.6.2 Following the overhaul, the commanding officer shall verify the following:

- a. That the revised diagrams provided by the planning yard have been updated to incorporate revisions from the duplicate of the master damage control book and diagrams provided by the ship at the start of the overhaul, and
- b. That the revised book and diagrams accurately represent the ship at the time of the ship's departure from the overhauling activity.

The outdated damage control books and diagrams shall be destroyed as prescribed in *DOD Regulation 5200.1, Information Security Program Regulation, Chapter IX*.

079-20.4.7 PLANNING YARD REVISION RESPONSIBILITY. The planning yard or overhauling activity as designated by the planning yard is responsible for the following:

- a. Incorporating ship's force changes from the duplicate copy of the ship's master damage control book and set of damage control diagrams received from the ship prior to the start of the overhaul
- b. Incorporating changes made by the overhauling activity
- c. Printing and distributing the revised damage control books and diagrams to the ship prior to the ship's sea trials at the end of the ship's overhaul or availability
- d. Following ship overhaul or availability, issuing revised damage control books and diagrams to the subject ship, with copies of the books and diagrams distributed to other commands and activities in accordance with the FMP manual

079-20.4.8 PRELIMINARY DAMAGE CONTROL DIAGRAMS. If preliminary diagrams are given to the ship, such diagrams shall be accompanied by a cover letter stating that the diagrams are for interim use only. Preliminary diagrams shall be identified by a preliminary label as required by *NAVSEA Technical Specification (NTS) 9090-820, [Appendix B](#)*.

079-20.4.9 FINAL DAMAGE CONTROL DIAGRAMS. The final copies of the damage control diagrams will omit the preliminary label but will include the planning yard logo adjacent to the NAVSEA logo in the lower title block area of the diagram as required by *NAVSEA Technical Specification 9090-820, [Appendix B](#)*.

079-20.4.10 DAMAGE CONTROL BOOKS AND DIAGRAMS STATUS REPORTS. Surface ship planning yards are required to submit a quarterly status report to NAVSEA, listing the status of the production damage control books and diagrams for new ships (under construction) which will be under the cognizance of the planning yard. The status report should also list the status of damage control books and diagrams revisions for active ships currently in overhaul which are under the cognizance of the planning yard.

079-20.4.11 DECK STOWAGE DIAGRAMS. Diagrams will be prepared for well decks, upper and lower vehicle stowage areas, mezzanine and helicopter platforms/decks. All these diagrams are outsized and will be prepared/laid out so presentation of decks for one ship will be on one sheet of paper, with upper decks above lower. These diagrams will be scaled, plan views of the decks and shall reflect the location of bulkheads, frames, stanchions, elevators, hatches, conveyors, escape scuttles, ramps, overhead/deck/bulkhead obstructions, firefighting stations, firelanes (if required), monorail/overhead crane tracks, monorail stowage locations, material handling equipment (MHE) and ship's vehicle(s) preferred stow locations and any other items which could affect the planning for stowage therein. Cloverleaves/padeyes will not be shown unless specifically required for clarity. Explanatory notes shall be printed on the page (sheet) adjacent to the appropriate diagram, but will not be placed within the planned stowage areas. The following information will appear for each diagram:

- a. Ship's name, type and hull number
- b. Scale: 1/8" = 1'
- c. Length of area (U.S. and Metric)
- d. Width of area (U.S. and Metric)
- e. Available square feet
- f. Restrictions:
 - 1. Minimum clearance(s): (List those which are appropriate for the area)
 - 2. Maximum weight allowed per square foot in pounds
- g. Pertinent dimensions shown but not placed within the planned stowage area(s)
- h. Frame numbers shown at key reference points.

079-20.5 DAMAGE CONTROL BOOKS - SUBMARINES

079-20.5.1 STANDARD SUBMARINE DAMAGE CONTROL BOOKS (SSDCB). The SSDCB is issued to all attack (SSN) and all ballistic missile (SSBN) type submarines built prior to the SSN 688 and SSBN 726 classes. The SSDCB is a two-volume document containing text, tables and diagrams which are bound within the books. The SSDCB is developed under the stringent requirements of *Military Standard (MIL-STD) 797, Damage Control Books for Submarines, Preparation and Revision Of*. Volume 1 of the SSDCB contains general damage control information peculiar to the class of submarines. Volume 2 of the SSDCB is issued to each submarine in the class and contains damage control information applicable to the specific submarine. One copy of the SSDCB shall be marked, "Ship's Master Copy" and shall be kept current as required for surface ships.

079-20.5.2 REVISION OF STANDARD SUBMARINE DAMAGE CONTROL BOOKS. NAVSEA is solely responsible for revising Volume 1 of the SSDCB. All planning yards' or ship's force proposed revisions to Volume 1 shall be submitted via the submarine type commander to NAVSEA for review and approval prior to their incorporation into Volume 1. Proposed revisions to Volume 2 shall be submitted to the submarine planning yard (or overhauling activity as designated by the planning yard) at the time of overhaul. The planning yard shall revise Volume 2 of the SSDCB to reflect revisions made by ship's force and the overhauling activity during the overhaul. The revised SSDCB shall be distributed in accordance with *SL720-AA-MAN-010, Fleet Modernization Program Management and Operations Manual (FMP), Volume 2. Appendix E*.

079-20.5.3 SHIPS' SYSTEMS MANUAL (SSM). Submarine damage control information applicable to all SSN 688, SSBN 726 and future submarines classes is contained in various sections of the multi-volume SSM, currently issued to each SSN 688 and SSBN 726 class submarine. The SSM shall be revised in accordance with the procedures contained in the SSM.

079-20.6 DAMAGE CONTROL BOOKS AND DIAGRAMS FOR DECOMMISSIONED AND DISPOSED-OF SHIPS

079-20.6.1 DECOMMISSIONED SHIPS. When a ship is decommissioned and placed into inactive fleet storage, the ship's damage control books and diagrams remain in storage aboard the ship. The ship's planning yard places its copy of the ship's damage control books and diagrams in appropriate storage in case the ship is later reactivated.

079-20.6.2 DISPOSED-OF SHIPS. When a ship is decommissioned and slated for disposal, the ship's former planning yard shall ensure that one copy of the ship's latest damage control books and set of diagrams is retained and offered to NAVSEA or the Naval Historical Center for placement within the Naval archival records. The remaining damage control books shall be destroyed in accordance with *DOD Instruction 5200.1, Information Security Program Regulations, Chapter IX* and their disposition reported to NAVSEA.

SECTION 21.

DAMAGE CONTROL AND THE SHIP

079-21.1 DAMAGE CONTROL ORGANIZATION

079-21.1.1 EFFECTIVE DC POSTURE. For a ship to maintain an effective damage control posture, positive coordination and organization is required. Prerequisites to effective organization are the preparation of definitive damage control bills, accurate marking of closures and fittings and highly visible posting of compartment check-off lists.

079-21.1.1.1 The organization of ship personnel and their assignment to damage control functions are the responsibilities of each ship. Current directives issued by proper authority must be consulted when organizing or reorganizing ship damage control personnel. The damage control organization in a ship must conform with the recommendations contained in *NWP 3-20.31* and such other directives issued by proper authority.

079-21.1.1.2 When implementing current directives, the commanding officer, through the executive officer and the damage control organization, should impress upon all personnel the necessity for obtaining the highest degree of efficiency in the control of damage through understanding and application of damage control principles, knowledge of closures and fittings and familiarity with damage control equipment, materials and procedures.

079-21.1.2 RESPONSIBILITIES OF THE DAMAGE CONTROL OFFICER. Responsibilities of the damage control officer include effective organization of personnel assigned DC responsibilities, efficient functioning of the damage control organization, fire prevention, maintenance of material conditions of readiness and damage control equipment. The damage control officer must also ensure that all damage control personnel receive training in reading and properly interpreting the damage control book, diagrams, drawings and other material concerned with their duties.

079-21.1.3 RESPONSIBILITIES OF DAMAGE CONTROL PERSONNEL. All officers and enlisted personnel of the damage control organization must develop a working knowledge of the capabilities of the ship in order to control and survive the effects of damage. Personnel must study both the ship and its systems and the methods discussed in lessons learned from previous incidents.

079-21.1.3.1 Efficiency. The entire ship's company must be trained to understand the necessity for maintaining the highest degree of efficiency in damage control, both in port and at sea. Such expertise includes the following:

- a. Setting of material conditions of readiness
- b. Operating, using and maintaining (for damage control purposes) hull and engineering systems
- c. Using and maintaining damage control material and equipment, including interior communications
- d. Locating damage and making emergency repairs under adverse conditions
- e. Establishing and maintaining a rigid fire prevention program
- f. Giving first aid to injured personnel.

079-21.1.3.2 Overlapping Skills. Each member of a repair party must have the following attributes:

- a. Must be a jack-of-all-trades
- b. Must learn to do any job that may be required of any other member
- c. Must learn how to fight fires and to apply first aid
- d. Does not have to become an expert in every field, but must at least become a capable helper. In an emergency that added ability may be needed to save the ship.

WARNING

Some tasks, such as rigging casualty power, operating portable exothermic cutting units, and arc welding, are hazardous and should only be done by fully qualified personnel.

079-21.1.4 TRAINING. It is not sufficient that personnel merely read about how to make repairs, study pictures of equipment or discuss methods. Nor is it enough that they have all the tools authorized by the ship's allowance equipage list (AEL). All damage control personnel must understand and know how to apply basic principles. They must also know how to use equipment, systems and materials in the most effective way. Knowledge is gained through education and training. The capability to place this knowledge in service is gained through drills and actual practice.

079-21.1.4.1 General. Thorough knowledge of the ship is of prime importance. It is imperative that repair party personnel know their own area of responsibility as well as the areas of other repair parties.

079-21.1.4.2 Simulating Damage. [Section 45](#) of this book discusses the importance of training, using training aids and simulating damage to increase realism.

079-21.1.4.3 Reading Diagrams. It is essential for all personnel in the damage control organization to understand how to read and interpret DC diagrams.

079-21.2 INSPECTION SCHEDULES

079-21.2.1 REGULAR MAINTENANCE. Each ship must adhere to regular schedules of inspection, maintenance, repair and replacement to ensure proper operation and maintenance of all damage control systems, equipment, fittings and materials. A more detailed discussion of damage control inspections and tests is included in [Section 23](#).

079-21.3 COMPARTMENTATION

079-21.3.1 SHIP DIVISION DESCRIPTION. The ship is divided horizontally by both tight and nontight decks, platforms, flats, levels and bottoms. Deck gratings, false decks and similar flats are not considered as boundaries. Between these horizontal boundaries, the ship is vertically divided by tight and nontight bulkheads. Every area enclosed by horizontal and vertical boundaries (except for minor utility areas such as peacoat lockers, linen lockers, cleaning gear lockers and other similar areas), is considered a compartment and assigned a compartment name and number. Some compartments do not have access closures.

079-21.3.2 COMPARTMENT NUMBERING. Compartments are numbered for identification to facilitate location. The identification number assigned locates each compartment specifically and generally indicates the function and use of the compartment. Compartment numbers consist of four parts, separated by hyphens, in the following sequence:

- a. Deck number
- b. Frame number
- c. Position in relation to centerline of ship
- d. Use of compartment.

079-21.3.2.1 Deck Numbering. The main deck is number 1. The first deck below the main deck is number 2; the second below is number 3, and the numbers continue consecutively for subsequent lower division boundaries. If a compartment extends down to the shell of the ship, the number assigned the bottom compartment is used. The first horizontal division above the main deck is number 01, the second above is number 02, and the numbers continue consecutively for subsequent upper division boundaries.

079-21.3.2.2 Frame Numbering. The frame number at the foremost bulkhead of the enclosing boundary of a compartment is the frame location number. If the forward boundary is located between frames, the number of the foremost frame within the compartment is used. Fractional numbers are not used except where frame spacing exceeds four feet.

079-21.3.2.3 Position in Relation to Centerline. Compartments located so that the centerline of the ship passes through them are assigned the number 0. Compartments located completely to starboard of the centerline are

given odd numbers those completely to port of centerline are given even numbers. The first compartment outboard of the centerline to starboard is 1, the second is 3 and so forth. Similarly, the first compartment outboard the centerline to port is 2, the second is 4 and so forth. There may be cases in which the centerline of the ship would pass through more than one compartment, all of which may have the same forward bulkhead number. Wherever this occurs, that compartment having the portion of the forward bulkhead through which the centerline of the ship passes is assigned the number 0 and the others carry numbers 01, 02, 03 and so forth.

079-21.3.2.4 Compartment Use. A capital letter is used to identify the assigned primary use of the compartment. Only one capital letter is assigned, except on dry and liquid cargo ships, where a double letter identification is used to designate compartments assigned to carry cargo. The letters are selected in accordance with the following:

- A Storage spaces such as:
 - Issue rooms
 - Refrigerated stores
 - Storerooms
 - Cargo holds
 - Cargo refrigerated compartments
- C Ship and fire control operating spaces which are normally manned, such as:
 - Combat information center (CIC)
 - Communications office
 - Electronic operating areas
 - Pilothouse
 - IC rooms
 - Plotting rooms
- E Machinery spaces which are normally manned, such as:
 - Auxiliary machinery rooms
 - Evaporator rooms
 - Main machinery areas
 - Pump rooms
 - Refrigerating machinery rooms
 - Emergency generator rooms
 - Steering gear rooms
- F Fuel and oil tanks such as DFM, NSFO and lubricating oil
- G Gasoline (MOGAS) tanks and cofferdams
 - Cargo gasoline (MOGAS) tanks and cofferdams
- J JP-5 tanks
 - Cargo JP-5 tanks
- K Stowage of chemicals and hazardous materials, except oil and gasoline (MOGAS)
- L Living quarters, medical and dental areas and passageways
- M Ammunition (stowage and handling)

- P Port (decoy launcher, chain locker, top of signal shelter or magazine)
- Q Areas not otherwise covered, such as engineering, electrical and electronic areas that are not normally manned, galley, laundry, offices, pantries, shops and wiring trunks
- S Starboard (decoy launcher, chain locker, top of signal shelter or magazine)
- T Vertical access trunks
- V Void compartments, such as cofferdams (other than gasoline tank cofferdams) and void or ballast wing tanks
- W Compartments storing water, including bilge, sump and peak tanks
- X Weather deck area

079-21.3.3 EXAMPLE OF NUMBERING. "2-152-3-L" is a compartment located on the second (2) deck with its forward boundary located at frame (152). It is the third (3) compartment to the starboard side of the ship's centerline at that frame. It is either a living quarters, a medical or dental space or a passageway (L).

079-21.4 SYSTEMS MARKINGS

079-21.4.1 ABBREVIATIONS. Systems markings frequently make use of abbreviations. A list of authorized abbreviations for damage control usage is provided in [Appendix A](#).

079-21.4.2 PIPING SYSTEMS. For ready identification, every pipe and tube in a surface ship piping system is marked by color, number, letter and symbol. These markings occur throughout each piping system at intervals to facilitate tracing the system from end-to-end. For more detailed information, see *NSTM Chapter 505, Piping Systems*.

079-21.4.3 DECK PLATE MARKINGS. The inscribing of deck plate covers, such as sounding tube caps, shall be in accordance with drawing NAVSHIPS No. 810-1385848. In addition, a label plate having the same inscription content as the deck plate cover shall be mounted on the nearest adjacent bulkhead, stanchion or other permanent structure at a distance not less than 12 inches or greater than 36 inches above the deck. The first line of the plate inscription shall be the deck plate basic location timber. The second line shall identify the system function and the third line shall indicate the number of the tank or void. For example:

First line	2-97-2
Second line	Sounding
Third line	2-98-2-V

079-21.4.4 ELECTRICAL AND ELECTRONIC SYSTEMS. Power, lighting, electronic, interior communications, weapons control, degaussing and other equipment and cables are identified so that their functions, locations, distribution and specific identification can readily be determined. Electrical and electronic systems are fully described in *NSTM Chapter 320, Electric Power Distribution Systems*. Interior communications and fire control systems are described in *NSTM Chapter 430, Interior Communications Installations*.

079-21.4.5 COMPARTMENT CHECKOFF LISTS. Compartment checkoff lists (CCOLs) are required for every compartment or weather deck area where damage control facilities are located. They are permanently posted in the compartment near each access opening or in the area concerned. They provide an itemized list and location of all damage control classified fittings and are for the ready use of personnel responsible for the setting of material conditions of readiness.

079-21.4.5.1 General. Compartment checkoff lists are prepared and supplied by the shipbuilder. Ship's force is required to keep them current. CCOLs are prepared on form *NAVSHIPS 9880/2 (REV 2-67)*. Computer generated facsimiles may be used. Pen and ink changes are not authorized on computerized CCOLs. The DCA will maintain a master CCOL hard copy and a backup disk when the CCOL is computerized. Authorized abbreviations for use on the CCOLs are contained within the computerized program.

079-21.4.5.1.1 The items to be entered on the CCOL are limited to those following:

- a. Access Watertight, airtight, oiltight and fire retardant doors, hatches, manholes and scuttles.
- b. Miscellaneous Closures Classifications include: passing scuttles, windows, air ports, ammunition hoist covers, ammunition and stores elevator doors, airtight fittings, voice and pneumatic tube outlets, root cutout valves for ship service steam and fresh water system, bolted equipment removal plates (BERPs), welded equipment removal plates (WERPs) and light covers.
- c. Drainage Main drainage system valves, secondary systems valves including semipermanently installed submersible pumps, valves at scuppers, plumbing drains, deck drains and miscellaneous gravity drains; caps for overboard discharge connections for portable pumps, air escapes, vents, sounding tubes with valves and sounding tube deck plates for water tanks; and voids and miscellaneous spaces.
- d. Damage Control and Ballasting Valves for ballasting and counterflooding.
- e. Tank Drain Valves in tank drain system.
- f. Firemain, Sprinkling, AFFF, Fresh Water Countermeasure and Washdown Firemain riser and cutout valves, root valves of flushing system, ammunition space sprinkling system valves, hangar and miscellaneous sprinkling systems, caps for fixed fog nozzles and valves for foam and washdown systems.
- g. Chemical Fire Systems Valves in CO₂ flooding and hose reel type systems, HALON systems, HFP, water mist and AFFF systems, if not included with firemain listing.
- h. Fuel Oil All damage control classified fuel oil filling, transfer and overflow valves, air escapes, vents and sounding tubes with valves, and sounding tube deck plates.
- i. JP-5 Fuel All damage control classified valves for filling, transfer overflow and auxiliary service, including aviation fueling and defueling stations, air escapes, vents and sounding tubes with valves, and sounding tube deck plates.
- j. Aviation and Automotive Gasoline (MOGAS) Valves for filling, transfer and overflow, including fuel and defueling stations and saltwater compensating valves.
- k. Ventilation Fans, valves and closures for mechanical and natural supply, exhaust and recirculating systems, closing devices for weather openings, mechanically operated fire dampers and classified valves in the chilled water system.
- l. Remote Operation Reach rods and flexible cable with deck plates or handwheels; hydraulic, pneumatic, or electrically operated remote control stations, including pushbuttons to start and stop fans and pumps.
- m. Compressed Air All damage control classified valves in high, medium, low and ship service systems, excluding reducing automatic cutout valves.
- n. Oxygen and Nitrogen All damage control classified valves and fittings.

079-21.4.5.1.2 The miscellaneous unclassified data fields category is deleted as a CCOL requirement since this data is also covered in DCAMS, EGLs and PMS. Information deleted includes: air escapes and vents not provided with closure fittings, dial- and sound-powered telephones listed in the directory, casualty communication

terminals, casualty power terminals, multipurpose outlets, casualty power panels, deck drains with no closure devices, fireplugs, foam generators, nontight door and accesses, loud-speaker transmitters and receivers listed in directory, relief, check, reducing and automatic cutout valves (with no closure devices) shown on damage control diagrams, ventilation ducts not fitted with closure devices, blank flanges for compartment air testing, casualty communication cables, casualty power supply cables, portable fire extinguishers, foam proportioners, hose for fireplugs, electric submersible pumps and oxygen breathing apparatus.

079-21.4.5.1.3 Any changes to the CCOLs will be as approved by the DCA.

079-21.4.5.1.4 Ensure that the division responsible or DC repair station is filled in on CCOL.

079-21.4.5.1.5 When using NAVSEA computerized software, the revision date and print date replace the signature requirement.

079-21.4.5.1.6 For compartments having dual responsibility (such as squadron work and living spaces on air-capable ships) both the "parent" division designator and the squadron alpha-numeric designator will be listed on the CCOL. (Example: 2ED/VA-196).

079-21.4.5.2 Duplicate Lists. A complete set of CCOLs will be posted at each entrance for compartments having more than one entrance. Each set will be marked DUPLICATE. Marking each set DUPLICATE will alert personnel to the fact that although more than one set of CCOLs is posted in that compartment, each set is complete in itself.

079-21.4.5.3 Partial Lists. In some cases, compartments have alcoves or areas included within them where facilities are located. It may be desirable to have partial CCOLs posted in these alcoves or areas, but these partial lists must be clearly labeled as PARTIAL. The item numbers on these lists must correspond with the numbers on the full posted list for that space. Having these lists labeled PARTIAL will alert personnel to the fact that they are incomplete for that space. CCOLs are to be kept within practical limits. It may be necessary to divide weather decks and some other decks into sections, i.e., main deck-frame 90-120 port side.

079-21.4.5.4 Card Holders. Card holders (drawing NAVSHIPS No. 804-1639213) will be used for posting CCOLs. CCOLs posted in the weather or in high humidity areas within the ship will be in moisture-proof holders (drawing NAVSHIPS No. 804-4563101). Ziplock type bags may be used when moisture-proof holders are not available.

079-21.4.5.5 Material Conditions of Readiness. Ships are designed to have three material conditions of readiness. These conditions provide three progressive stages of compartmentation of the ship and segmentation of the ship's systems. Ships maintain different material conditions of readiness according to whether contact with an enemy (or natural hazard such as wind or waves) is improbable, probable or potentially imminent. The basic material conditions of readiness through which all ships progress are XRAY, YOKE and ZEBRA. These three material conditions of readiness provide the following increasing degrees of protection:

- a. Against the spread of fire, flooding, smoke, dangerous fumes and gases, and chemical, biological and radiological (CBR) agents, and
- b. The total loss of an entire system.

In addition, there are six special classifications (Circle XRAY, Circle YOKE, Circle ZEBRA, Dog ZEBRA, WILLIAM, and Circle WILLIAM). These conditions are further defined and described in [Section 22](#). [Table 079-21-1](#) defines degrees of readiness and related condition watches.

Table 079-21-1 DEGREES OF READINESS AND CONDITION WATCHES

General Degree of Readiness		Condition Watch
1st	Complete readiness of immediate action	I
	Readiness to conduct amphibious assault operations	IA
	Readiness to conduct mine operations	IM
2nd	Temporary relaxation from 1st degree for rest and meals at battle stations	IE
3rd	Part of armament ready for immediate action; remainder on short notice	II
4th	Part of armament ready for immediate action; remainder at prolonged notice	III
5th	Peacetime cruising; no armament manned	IV
6th	In port; peacetime; no armament manned	V

079-21.4.5.6 Condition Watches. The relationship between condition watches of the various components of the ship's battle organization and degrees of readiness is described in *NWP 3-20.31* .

079-21.5 DAMAGE CONTROL BILLS

079-21.5.1 PURPOSE OF BILLS. Damage control bills outline the procedures for operating a system, in conformity with the designated material conditions of readiness so the objectives of damage control will be met. Damage control bills are important in organizing the ship for damage control. Ships going into commission must complete all bills at the earliest possible date, since effective training is based on adequate organization. It is the responsibility of the commanding officer to have the required bills prepared and have them maintained current, by modifications, to agree with alterations to hull, armament, machinery and changes in complement.

079-21.5.2 PREPARATION. When preparing damage control bills, follow instructions contained in *NWP 3-20.31* and *OPNAVINST 3120.32 (series)* . Bills should be prepared so their meaning will be clear to ship's personnel. It is necessary that all personnel in the ship be familiar with the bills and that all members of repair parties have a thorough working knowledge of them. Copies of bills are to be widely distributed among officers, key petty officers and repair stations. Bills must also be placed in the repair party manual. Additional sources of information to assist with the preparation of damage control bills include the following:

- a. Ship's damage control book
- b. Ship's information book (for the particular ship)
- c. Diagrammatic arrangement plans of piping for the machinery and hull
- d. Principal engineering piping system drawings
- e. Manufacturers' pamphlets, manuals and instruction books
- f. Type commanders' damage control bills, instructions and repair party manuals
- g. Ship's finished hull and machinery plans
- h. Allowance equipment lists for damage control equipment
- i. Watch, quarter and station bill

j. Ship's manning document.

079-21.6 ALLOWANCE EQUIPAGE LISTS (AELs)

079-21.6.1 CHANGES TO AELs. The material and equipment authorized on a ship for damage control are listed on AELs. These lists and the equipment they authorize are frequently updated to reflect improved equipment, new technology and situational requirements. Changes to shipboard systems or changes in the ship's mission can also result in changes in the lists. All allowance change requests (ACRs) for DC AELs must have TYCOM concurrence and NAVSEA 05L approval in writing.

079-21.7 DAMAGE CONTROL MARKING SYSTEM

079-21.7.1 DESCRIPTION. The primary purpose of the damage control marking system is to provide rapid emergency egress information and to identify the locations of selected damage control systems and equipment. Photoluminescent and retro-reflective materials are used to enhance damage control and emergency awareness to personnel. Self-adhesive signs, labels, letters and tape are an authorized application means to replace painting applications that are no longer serviceable or effective. The highest priorities are given to egress markings, fixed DC systems, fire stations and portable damage control equipment. The photoluminescent marking system works as negative imagery designed to absorb energy from any nearby ambient light source, such as fluorescent or incandescent lighting. When the light source is removed, the material immediately emits a light of its own. Maximum luminance is up to one hour, but it remains visible up to eight hours to dark-adapted eyes. Photoluminescent material can be reactivated an unlimited number of times if properly applied. Retro-reflective material stands out when exposed to a shining light. Damage control markings may be retro-reflective, photoluminescent or a combination of both, depending on the marking's purpose. Photoluminescent material may be paint, tape or adhesive labels. Use of photoluminescent material for purposes other than those specified herein is not authorized. Photoluminescent and retro-reflective materials shall not be applied in areas exposed or opening to weather decks, such as the pilot house, gear lockers and light traps. Only NAVSEA-approved photoluminescent and retro-reflective materials are authorized for shipboard use.

079-21.7.2 DURABILITY. The damage control marking system must withstand normal shipboard environments including humidity, abrasions from cargo and equipment transfer, normal cleaning and maintenance actions. The markings must perform with no measurable chipping or significant decrease in luminance for a minimum of three years when applied according to the guidelines and requirements for surface preparation and application. Successful application requires detailed surface preparation procedures for proper adhesion and requires more attention than normal shipboard painting procedures. Base coat and thickness of application of photoluminescent paint is very important. Attention to detail on stencil paint application is of vital importance to avoid such things as bleeding and drips. For proper adhesion, it is extremely important to properly prepare the surface area.

079-21.7.3 GENERAL APPLICATION. Under no circumstances are photoluminescent markings to be applied on weather decks or areas where they may be visible from weather decks. Also, photoluminescent markings will not be used in areas that normally remain dark and unoccupied (i.e., fan rooms, closets, gear lockers and store-rooms). Red or blue light will not energize the materials; use in normally dark and unoccupied areas is optional. Areas where photoluminescent and retro-reflective materials are not allowed or desired will be marked using standard striping paints or non-reflective labels or placards. When using paint, whether photoluminescent or standard, the stencil provided is the size of the painted background area and may be used as a template.

079-21.7.3.1 Surface Preparation.

- a. Degrease surface with detergent such as general purpose detergent spray. Rinse and let dry.
- b. Lightly abrade with 120-grit sandpaper to roughen surface.
- c. Wipe off dust with a damp cloth.
- d. Dry the surface with a clean cloth.

079-21.7.3.2 Paint-Specific Application.

- a. Mix each paint th4oxy-based primer under white primer if painting on bare steel.

CAUTION**Do not paint CRES**

- c. Apply one coat of white primer. Let dry four (4) hours.
- d. If kit-supplied primer is expended, the following paint shall be used as a primer:

1 gallon	NSN 8010-00-045-3478
5 gallons	NSN 8010-00-463-7063

- e. Apply two (2) coats of photoluminescent paint, waiting 2.5 to 3 hours between coats. Remove masking tape after second coat of photoluminescent paint has been applied. (For best results, remove while paint is still wet and pull from center of sign outward).
- f. After second coat of photoluminescent paint has dried for 2.5 to 3 hours, apply one (1) coat of clear sealer, allowing the sealer to overlap the edges of the photoluminescent paint. Let dry completely.

CAUTION**Do not stencil before the clear sealer has been applied and thoroughly dried (8 hours).**

- g. Apply stencil coat where required. The stencil paint, which is standard shipboard striping paint, may be applied using spray cans (surface ships only) or a stencil brush (NSN 7520-00-223-8000). NSNs for spray paint colors are as follows:

Red	Color 11105, NSN 8010-00-721-9743
Black	Color 17038, NSN 8010-00-079-3752, or NSN 8010-00-290-6984
Green	Color 14062, NSN 8010-00-141-2951

079-21.7.4 MARKINGS APPLICABLE TO ALL SHIPS AND SUBMARINES. The following markings are applicable to all surface ships and submarines:

- a. Frame markings are to be applied to the frame or bulkhead at least once in each compartment less than 14 feet in fore-and-aft length as near the mid-distance as practical. For compartments greater than 14 feet in fore-

and-aft length, one frame location marking is to be applied every 14 feet. Lettering is to be two inches high, with a one-inch border on all sides, a maximum of five feet above deck level. The letter and number sizes may be reduced for submarine applications.

- b. Aqueous potassium carbonate (APC) extinguishing system markings are to be installed as near as practical to immediately above the actuators.
- c. The markings for portable and installed firefighting systems and extinguishers are to be located as near as practical, immediately above the extinguisher, hose reel or actuator. The application of these markings directly to the cylinder is prohibited by Federal regulation.
- d. Vertical or horizontal markings for the OBA, SCBA and EEBD storage cabinets and OBA canister stowage cabinets are to be provided. These markings are to be applied to the cabinet door that is normally visible. EEBD stowage cabinets installed under berths shall not be marked.

CAUTION

Do not apply markings directly to OBA or EEBD.

- e. Letter colors are as follows:
 - 1. Red stenciled lettering for painted surfaces (Color No. 11105, Formula 40).
 - 2. Red retro-reflective stenciled lettering for self-adhesive surfaces:
 - Battle dressing stations
 - DCREL
 - DCRS
 - DCUL
 - DCUPS
 - EAB
 - EEBD
 - Exits with Arrows
 - Exits
 - Fire Plug Bull's Eye (Interior)
 - Fire Zone BHD
 - Firefighting System Actuators
 - OBA
 - OBA Canister
 - Red Cross Symbols
 - SCBA
 - SCBA Cylinders
 - 3. Black stenciled lettering for painted surfaces (Color No. 17038, Formula 38).
 - 4. Blue retro-reflective stenciled lettering for self-adhesive surfaces:
 - Compartment Bullseye (Interior)
 - Frame Numbers
 - 5. Green stenciled lettering for painted surfaces (Color No. 14062, Formula 39).
 - 6. Green retro-reflective stenciled lettering for self-adhesive surfaces:

"No Exit"

Decon Arrow with "D"

Decon Stations

NOTE

Ships with Exit Signs painted green fulfill the requirement as is. Replacement of Exit markings should be red retro-reflective material.

7. Black paint (Color No. 17038, Formula 38) will be used for all lettering on the following labels. Where it is not appropriate to apply photoluminescent material, the following colors will be used as background:

LABEL (IN BLACK)	BACKGROUND COLOR
Fire Station	Red
Compartment	Yellow
Frame Number	Yellow
Firefighting System Actuator	Red
Portable Extinguisher	Red
Fire Zone	Red

079-21.7.5 LOCATION OF MARKINGS - SURFACE SHIPS. Following is the guidance for locating and installing markings on surface ships:

- a. The bottom edge of EXIT signs and arrows are to be no lower than 12 inches above the deck or higher than 36 inches. When more than one sign is required in the same location, the top of the highest sign is to be no higher than 36 inches above the deck.
- b. EXIT signs with arrows are to be located within 5 feet of each access (door, hatch) to a compartment, except where the access opens directly to weather. The arrow direction is to indicate nearest egress route to weather area (i.e., main deck, hangar, flight deck). Subsequent EXIT signs and arrows are to be no more than 15 feet apart within the same compartment and along the bulkhead at each ladder. Arrows may be angled to point up or down ladders. Frame and Direction markings are depicted in [Figure 079-21-1](#).
- c. All EXIT signs and arrows are to be on the same side of the compartment or passageway insofar as practical and are to be located in areas that receive direct lighting and are easily seen from the surrounding area.
- d. Double directional arrow EXIT signs (← EXIT →) are to be used in areas where an athwartship passage will provide access to egress routes to weather in either direction (such as in large berthing areas).

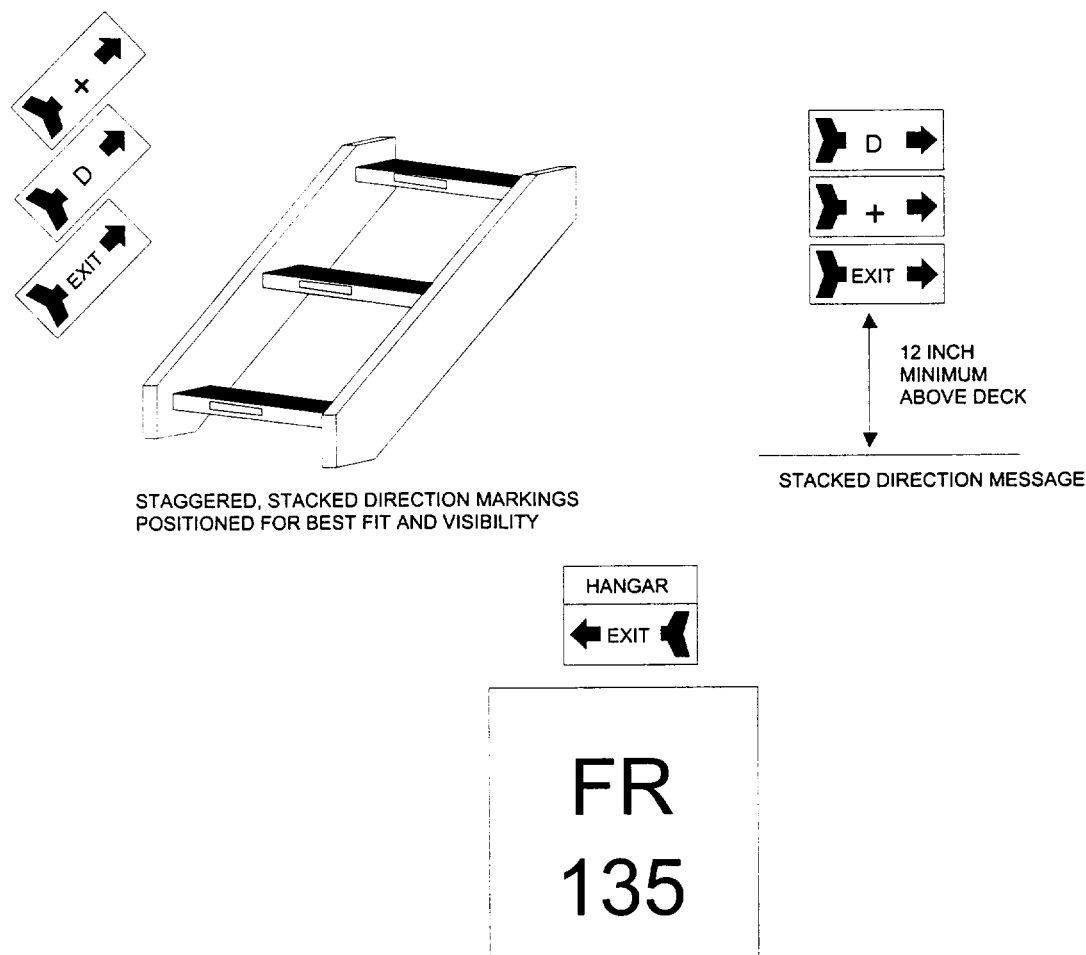


Figure 079-21-1. Frame and Direction Markings

- e. In compartments having dual egress routes through the space, both routes are to be marked.
- f. Egress routes leading either to the hangar or flight deck, but not both, are to be marked with a specific exit sign stating "FLIGHT DECK" or "HANGAR", above the exit arrow.
- g. Signs reading NO EXIT are to be placed at the entrance into blind or dead-end passageways where easily seen.
- h. Where required, first aid and decontamination directional markings are to be stacked above previously applied egress markings as indicated. In instances where stacking is required, the EXIT marking will always be the bottom sign and the first aid directional marking will always be the top sign. The bottom edge of the lowest markings are to be no lower than 12 inches above deck level. The uppermost marking is to be no higher than 36 inches from the deck, except when a HANGAR or FLIGHT DECK strip must be added to a three-high sign stack. EXAMPLES: + = First Aid; D = Decontamination

1	2	3	4	5	6
←+—	—+→	—+→			
←D—	—D→	←+—	—+→		
←EXIT—	←EXIT—	←EXIT—	—D→	—+→	←D—.

- i. Each door passed through along egress routes will be marked by photoluminescent strips around the outside perimeter to illuminate the opening as shown in [Figure 079-21-2](#). The size of strips can be tailored to fit the door requirements. A minimum of one strip on each side, one above and one below the opening will be used.

The same applies to openings without doors that must be stepped through along the route (i.e., knee-knockers, open manways). The word EXIT is to be placed on each door in a normal egress route, six inches above the bottom of the door. This includes doors of berthing compartments and work spaces. Doors opening to weather are not to be marked. Marking of doors leading out of staterooms is optional.

- j. Balanced doors serving machinery spaces shall have an EXIT marker applied in the center of the door only.
- k. The side of a hatch coaming where the ladder attaches will be marked with a photoluminescent strip to indicate the location of the coamings, as shown in [Figure 079-21-3](#). Scuttles shall be marked with photoluminescent strips, also depicted in [Figure 079-21-3](#).
- l. Kickout panels are to have the word EXIT placed in the center of the panel. Kickout panel borders are to be marked around the entire perimeter with a six-inch photoluminescent strip on each side.
- m. Inclined ladders are to be marked by applying photoluminescent strips on the inner frame, alternating sides with each step. The handrails will be marked with six bands wrapped on each side, as shown in [Figure 079-21-4](#). Ladders having folding-leaf ladder chutes installed are to have alternating strips applied to the chute when in the stowed position. Ladders leading to hatches which open to weather are to have photoluminescent material applied half the distance from the bottom of the ladder only (to avoid being visible when the hatch is open).
- n. Vertical ladders are to have photoluminescent strips applied to both rails along the entire vertical length, alternating sides with each rung, also shown in [Figure 079-21-4](#). Vertical ladders leading to scuttles that open directly to weather are to be marked only to midpoint of the ladders' vertical length from the bottom of the ladder. Wrap-around escape trunk ladders will be marked with a band of material wrapped around the ends of alternating rungs.
- o. Entrance doors to damage control spaces shall be painted red. Retro-reflective signs shall be used to identify the space and the numbers shall be placed below the letters.

EXAMPLE			
DCRS	DCUPS	DCUL	DCREL
2	21	31	5R

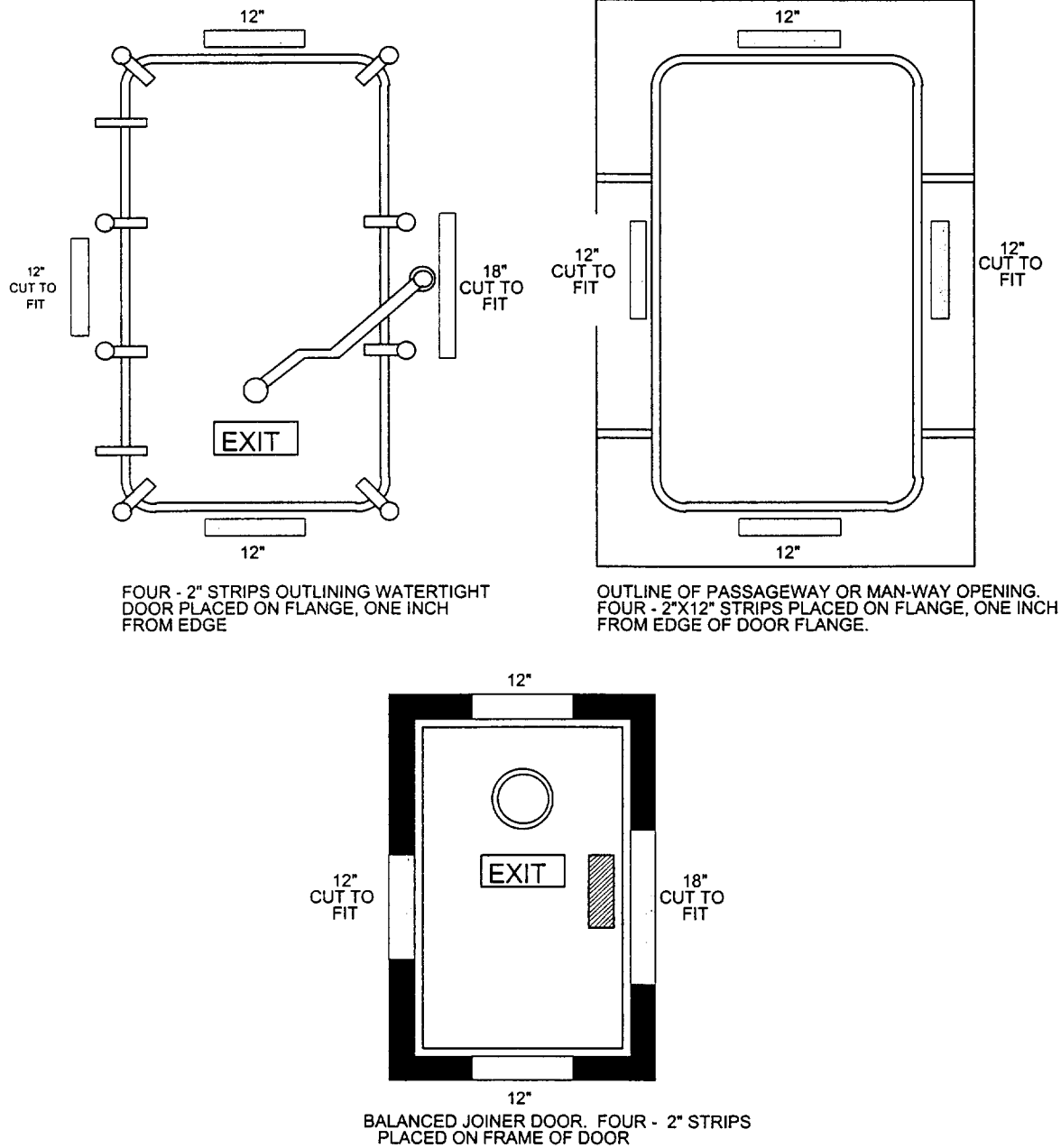


Figure 079-21-2. Markings for Doors

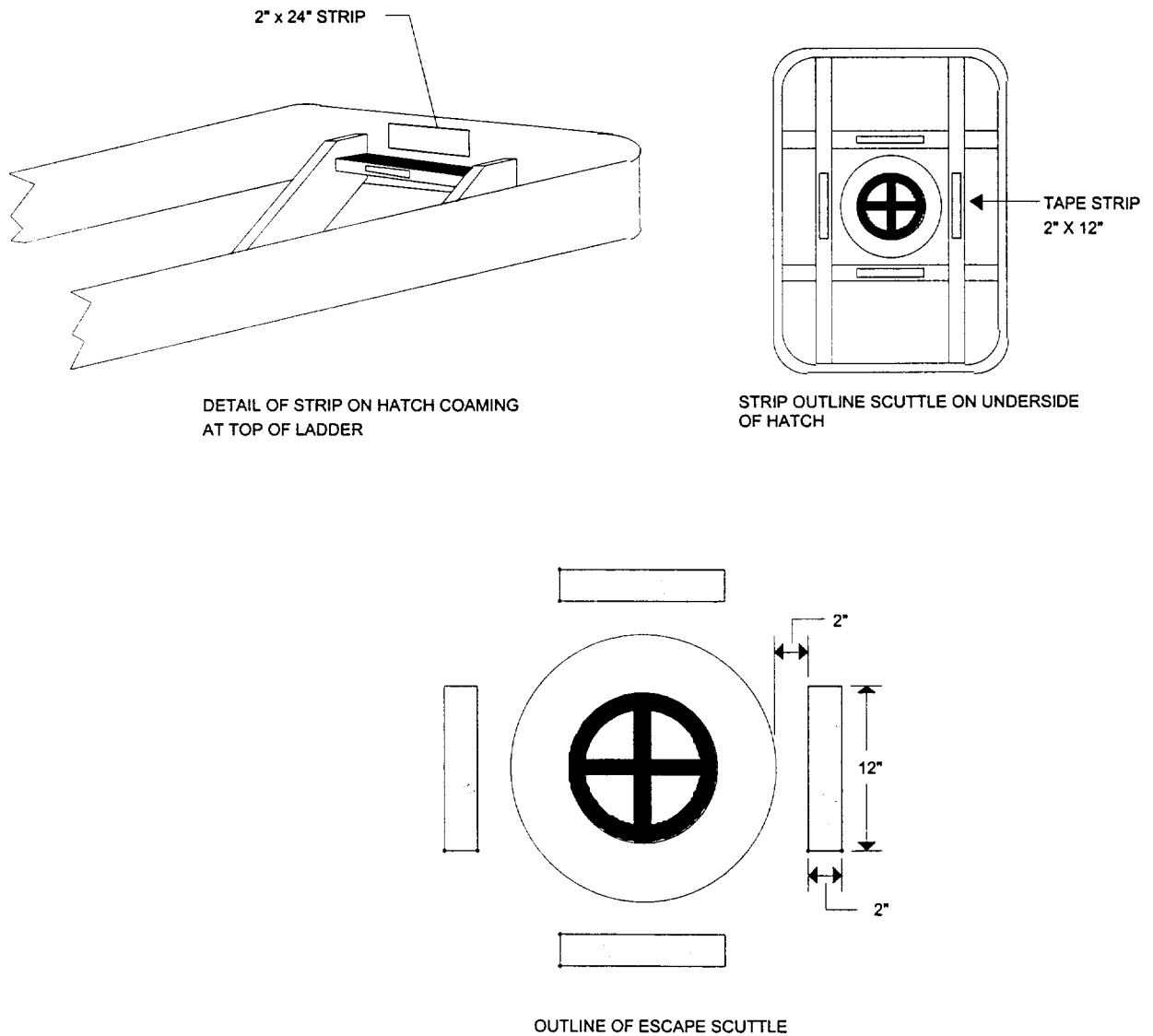


Figure 079-21-3. Example of Strips Outlining Hatch Coaming and Escape Scuttles

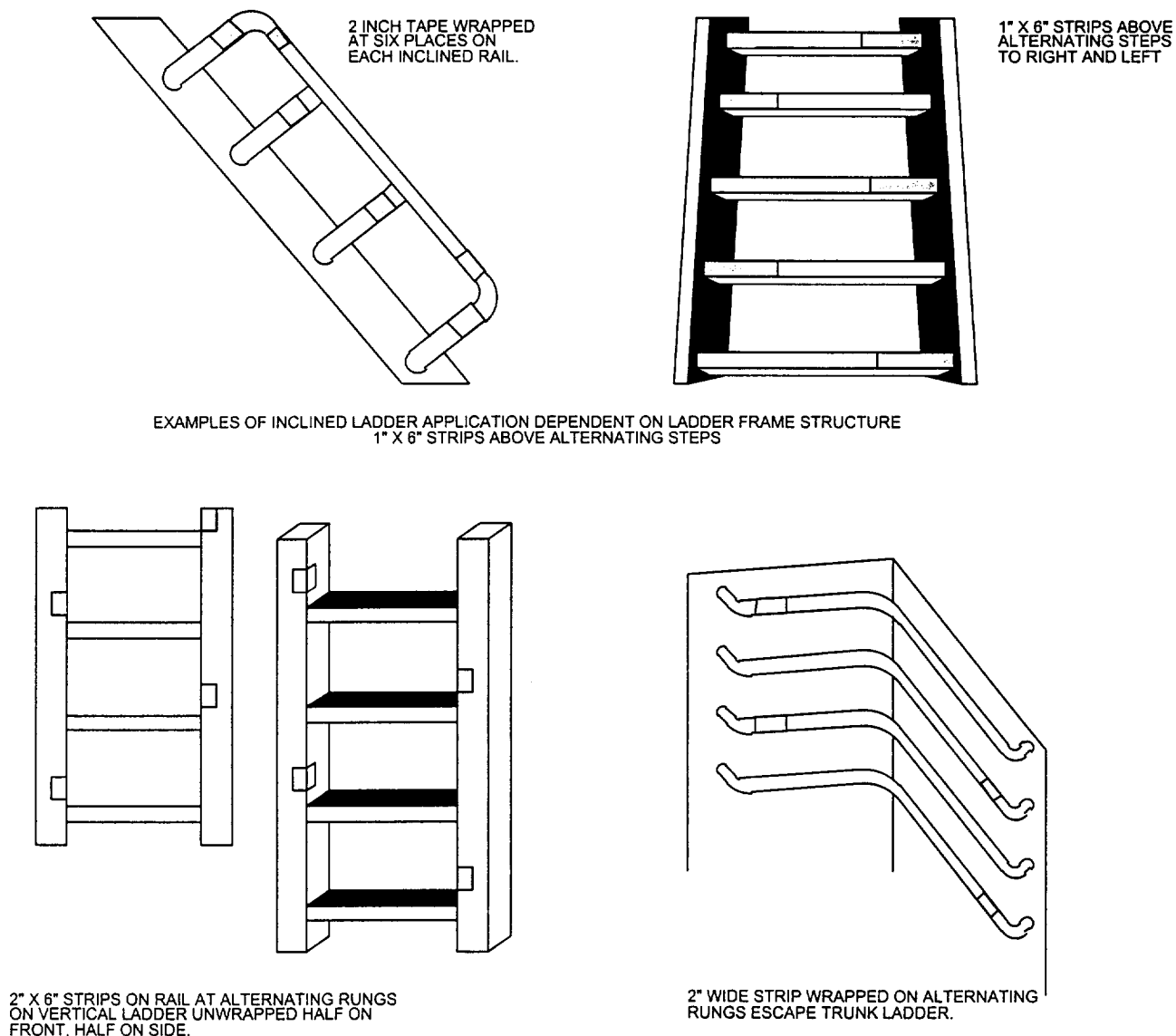


Figure 079-21-4. Ladder Markings

- p. Compartment bullseyes are to be applied in each space or compartment to identify the space, setting forth the frames which bound the space and the division responsible. An example is shown in [Figure 079-21-5](#).
1. A bullseye should be visible from each access to the space.
 2. Lettering will be two inches in height applied over a 12-inch high by 15-inch wide photoluminescent label or yellow painted area.
 3. For photoluminescent adhesive material, use blue retro-reflective lettering, two inches high; for painted bullseyes, use black lettering, two inches high.

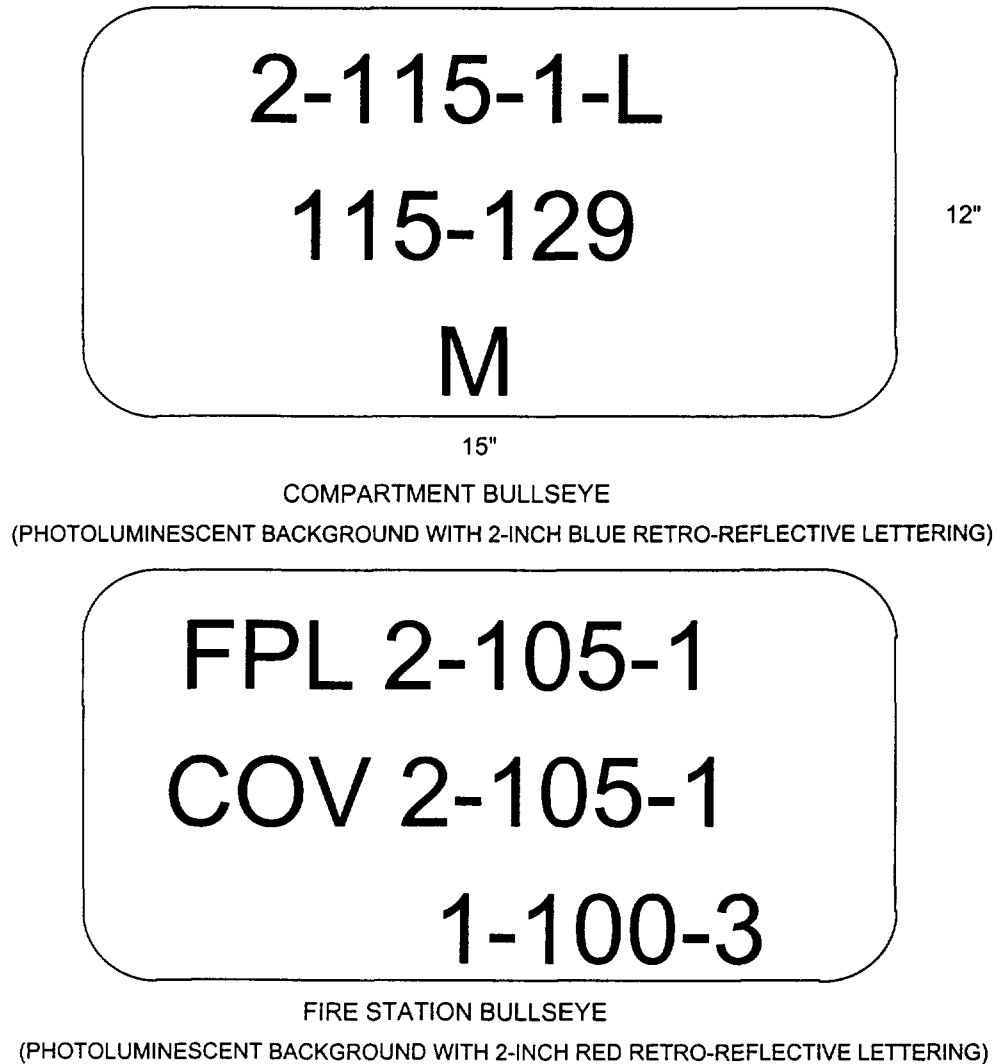


Figure 079-21-5. Compartment and Fire Station Markings

- q. Interior fire station bullseyes are to be applied as near as possible to each interior fire plug, sized to best fit the area available, preferably immediately above the fire plug valve. [Figure 079-21-5](#) also depicts fire station markings.
 - 1. The bullseye will identify the fire plug number and the valve number(s) necessary to isolate the fire plug in the event of damage.
 - 2. The photoluminescent painted area background is 12 inches high by 15 inches wide and has red painted lettering, two inches high.
 - 3. Photoluminescent adhesive material is 12 inches high by 15 inches wide with red retro-reflective lettering, two inches high.
 - 4. The red painted area background is 12 inches high by 15 inches wide with white lettering, two inches high.
- r. Firemain segregation valves classified ZEBRA are no longer to be identified with photoluminescent markings.
- s. All bulkheads designated as fire zone bulkheads in general arrangement drawings, ship's damage control diagrams or the ship's damage control book are to be marked on both sides, as near the doors as practical. These markings are to be applied at eye level in an unobstructed location. The fire zone bulkhead serving as a boundary in any compartment is to be marked at least once. Tanks and voids are not to be so marked.
- t. AFFF markings are to be applied at each actuation point (such as solenoid operated pilot valves (SOPV) not

within an AFFF proportioning pump station) and on bilge sprinkling actuators. Photoluminescent and retro-reflective markings will not be used at exterior (weather deck) locations.

- u. Actuators for Halon flooding systems are to be identified by the photoluminescent marking, HALON, on the actuator bottle cover as close to the actuator as possible.
- v. EAB manifolds are to be marked with a six-inch wide strip of photoluminescent material in the center of the manifold. If EAB manifolds are recessed in the overhead, place an EAB stencil directly adjacent to the opening.

079-21.7.6 LOCATION OF MARKINGS - SUBMARINES. Following is the guidance for locating and installing markings on submarines:

CAUTION

Photoluminescent markings are prohibited where they may be visible from the weather, in control rooms and on portable fire extinguisher cylinders.

CAUTION

Specific NAVSEA 08 approval is required prior to use in reactor compartments or on components under cognizance of NAVSEA 08.

CAUTION

Submarines are not authorized to apply markings without prior approval from individual TYCOMs.

- a. Escape hatches should have a strip around the outside diameter.
- b. Inclined Ladders - Dust shield is to be marked with photoluminescent strips above the lower and upper step.
- c. Vertical ladders leading to emergency escape hatches and scuttles shall have photoluminescent strips applied to both rails, alternating strips with each rung. Vertical ladders leading to hatches that open directly to weather shall be marked only from the bottom of the ladder to midpoint of the ladders' vertical length.
- d. Transverse bulkhead hatches on submarines are to have two-inch wide strips of photoluminescent material applied around the perimeter of the entire hatch.
- e. Lower access hatches on submarines are to have photoluminescent strips applied around the hatch, except where the lower access hatch is visible from the control room.
- f. Flashlights stowed in passageways on submarines are to have a two-inch wide photoluminescent band applied around the flashlight holder or the exposed top portion of the bracket, depending on individual ship installations.
- g. Handset holders for 4MC telephones are to be painted photoluminescent or outlined with photoluminescent tape strips.
- h. Firehose lockers, where installed, are to have the word FIRE HOSE applied in two-inch letters over a photoluminescent background. On submarines having firehose stowage on racks, the "half circle" face is to be painted with photoluminescent paint or outlined with photoluminescent tape.

- i. Fire plug caps are to be painted photoluminescent.

CAUTION

Do not paint over the bleeder hole.

- j. First aid station directional markings shall be applied as required to direct personnel to designated battle dressing stations.
- k. A red cross shall be applied to the portable atmospheric analyzing equipment and the first aid kit.
- l. EAB mask stowage cabinets and doors covering EAB manifolds are to be marked on the door with the EAB stencil, except those at individual berths. EAB manifolds will be identified with a six-inch photoluminescent strip in the center of the manifold. Manifolds at individual berths shall not be marked since they are not normally exposed to illumination. Manifolds recessed in the overhead shall have an EAB stencil placed on the overhead adjacent to the manifold opening.
- m. Damage control repair stations, unit patrol stations, unit lockers and re-entry lockers shall be marked with appropriate lettering. Functional damage control locker numbers shall be two inches in height. The markings shall be placed at the uppermost part of the door.

079-21.8 SHIPBOARD DAMAGE CONTROL SPACES

079-21.8.1 DEFINITIONS.

079-21.8.1.1 Central Control Station (CCS). The area of the ship remotely located from the machinery spaces, which is the central control point from the machinery plant and damage control functions. Damage control central is located in CCS.

079-21.8.1.2 Conflagration Station. Manned space for monitoring areas at high risk of fires, equipped with controls for fixed firefighting systems and communications to report fire or hazardous conditions.

079-21.8.1.3 Damage Control Spaces. Damage control spaces, for the intent of this section include damage control repair stations, damage control unit patrol stations, damage control unit lockers, damage control rescue and assistance/re-entry lockers, secondary damage control central, CCS and DCPO work centers.

079-21.8.1.4 Damage Control Central (DCC). DCC is the nerve center and directing force for the entire shipboard damage control organization. It is the headquarters for information and coordination with damage control repair stations. DCC informs Command of conditions affecting material conditions, readiness and damage assessment of the ship.

079-21.8.1.5 Damage Control Deck. All damage control equipment stowed in the passageways of the DC deck shall be organized and stowed for access and retrieval in order to place the equipment into immediate service for the damage control function required. These functions include firefighting, dewatering, desmoking and shoring.

079-21.8.1.6 Damage Control Area of Responsibility (AOR). That part of the ship, forward and aft, port and starboard and up and down, in which the DCRS is located and for which the damage control repair party from

the DCRS is responsible. The boundaries of the damage control area of responsibility conform to the fire zones. The damage control areas of responsibility are as follows:

079-21.8.1.6.1 Damage Control Repair Station (DCRS). The DCRS directs the actions required to combat and control fire, flooding and other casualties within its assigned area of responsibility (AOR) and keeps DCC informed regarding the situation. A DCRS is fully outfitted with tools and equipment kits, including personnel protective equipment (PPE), required to deal with any damage control situation.

079-21.8.1.6.1.1 The number of repair parties into which available personnel are divided is determined by the number of DCRS provided for in the design and construction of the ship. The size of the ship class determines the number of Parent DCRS (1-10). The designation of the DCRS is classified by its function, location and organization, as follows:

DCRS #		DC REPAIR FUNCTION
1	Main deck repair party	
2	Forward repair party	
3	After repair party	
4	Amidships repair party	
5	Main propulsion repair party	
6	Ordnance casualty control team	
7	Gallery deck and island structure repair party	

079-21.8.1.6.1.2 Due to extended coverage area, construction and the watertight subdivision on some larger ships, the prescribed repair function may be either subdivided or joined. When these subdivisions or joiners occur, the DCRS is designated by the number of the repair function followed by a single letter, i.e., F=forward, B=middle, A=aft, S=starboard, P=port.

EXAMPLE: DCRS 1A, 1B, 1F

DCRS 3P, 3S

DCRS 5P, 5S

DCRS 7A, 7B, 7F

079-21.8.1.6.1.3 The AELs provide the standard equipment inventory for a DCRS. This standard was built on the fact that the equipment inventory should be the same in all DCRSs.

079-21.8.1.6.1.4 Each repair party is provided with a DCRS from which communication is maintained with DCC, other repair stations, its own subdivisions and its own patrols respectively. These patrols include teams from the parent repair stations (i.e., firefighting, desmoking, dewatering), the unit patrol stations and the unit lockers. The repair party's equipment and material for effecting repairs and otherwise controlling casualties is stored in the repair party locker and within the DCRS area of responsibility. Repair party personnel and equipment shall not be concentrated. Dispersion of personnel and equipment is mandatory to avoid the possibility of destroying entire parties in a single casualty. Label designation can be used to identify the team and equipment function area.

EXAMPLE: FF Dressout

Dewatering

Desmoking

079-21.8.1.6.1.5 The DCRS includes the compartment equipment, communications, plotting capability and passageways in the immediate vicinity where repair party personnel and equipment are organized and dispersed.

079-21.8.1.6.1.6 Repair parties shall be thoroughly familiar with all parts of the ship in order to render assistance whenever needed. They may be required to relieve other parties completely or consistent with their qualifications and training.

079-21.8.1.6.1.7 Unit repair parties are organized into a damage control unit locker (DCUL) or a damage control unit patrol station (DCUPS). The DCUL and DCUPS are determined during the initial ship design and construction to cover the outlying areas of responsibility for the parent DCRS when the construction of the ship, either by size or compartmentation, prevents rapid investigation and response. The DCUL and DCUPS shall ensure that watertight integrity is not jeopardized and that classified fittings are maintained in the state of closure required by the material condition in effect.

079-21.8.1.6.2 Damage Control Unit Locker (DCUL). Ships of all sizes have, in addition to DCRSs, manned damage control unit lockers in passageways to provide dispersal of personnel and equipment from the main (parent) DCRS, thus, extending investigation/initial response capabilities within the assigned area of responsibility. AELs 2-990044212 through 4215 provide the required damage control equipment inventory for 1 to 28 DCULs. The DCUL provides a rapid means to thoroughly investigate its assigned area, an immediate response to combat or contain material damage within its capability, and will request assistance from its parent damage control repair station if the situation becomes overwhelming. The DCUL provides the DCRS with a rapid look for damage within the assigned area of responsibility. The DCUL shall ensure that watertight integrity is not jeopardized and that classified fittings are maintained in the state of closure required by the material condition in effect. The DCUL should be composed of 12 personnel, assigned as follows:

- a. One unit locker leader
- b. One phone talker and plotter
- c. One scene leader
- d. A three-person investigating team
- e. Six personnel to set fire and flooding boundaries and to combat damage until assistance arrives from the main repair station.

079-21.8.1.6.2.1 Communication flow is primarily to the parent DCRS, but there is also a requirement to have the capability to connect into the shipboard damage control organization communications network in case the parent DCRS is overtaken by smoke or damage.

079-21.8.1.6.2.2 The passageway stowage facilities required for a DCUL include one (1) four-person OBA locker, one (1) equipment locker, one (1) hinge-leaf unit to hold DC plates, communications jacks, one (1) helmet rack, one (1) CO₂ bottle and one (1) fireplug. (Optional - one (1) five-gallon AFFF can).

079-21.8.1.6.2.3 Designation of DCUL is DCUL with two numbers.

EXAMPLE: DCUL 21 (DCRS Two's Unit Locker #1)

DCUL 33 (DCRS Three's Unit Locker #3)

DCUL 41 (DCRS Four's Unit Locker #1)

DCUL 73 (DCRS Seven's Unit Locker #3)

079-21.8.1.6.3 Damage Control Unit Patrol Station (DCUPS). Aircraft carriers and various large amphibious ships also have manned damage control unit patrol stations, smaller than DCRSs but larger than DCULs, for response to difficult-access areas with high potential for damage, drawing from prepositioned equipment. AELs 2-880044216 and 4217 provide the required damage control equipment inventory for 1 to 14 DCUPSs. Equipment shall be stowed by the function served, available for immediate access and ready for use. Adjacent passageways should be used for equipment stowage of the firefighting, desmoking and dewatering teams so these teams can find their equipment easily and bring it to bear on the casualty. The communication station shall be in the compartment designated. Communication flow is primarily to the parent DCRS, but there is also a requirement to have the capability to connect into the shipboard damage control organization communication network in case the parent repair station is overtaken by smoke or damage.

079-21.8.1.6.3.1 There are 13-20 personnel assigned to perform the following functions:

- a. One unit locker leader
- b. One phone talker and plotter
- c. One scene leader
- d. One firefighting team
- e. A three-person investigating team
- f. Six personnel to set fire and flooding boundaries and to combat damage until assistance arrives from the main repair station.

079-21.8.1.6.3.2 Designation of DCUPS is DCUPS followed by two numbers.

EXAMPLE: DCUPS 21 (DCRS Two's Unit Patrol Station #1)

DCUPS 41 (DCRS Four's Unit Patrol Station #1)

DCUPS 32 (DCRS Three's Unit Patrol Station #2)

079-21.8.1.6.4 Damage Control Rescue and Assistance/Re-Entry Locker (DCREL). Aircraft carriers, LSDs, AOE, MHCs and LHD 1 class ships, as well as all new construction ships are required to have an unmanned space easily accessible to the weatherdecks designated the damage control rescue and assistance/re-entry locker. The DCRELs are equipped to serve dually for rescue and assistance, as well as for a point of reentry into the ship in case the damage control deck is smoked out. Equipment shall be provided to access the shipboard damage control communication networks. AEL 2-880044218 provides the required damage control equipment inventory. Use the correct column for your ship class. The DC equipment locker on the DDS 51 Class is used for the DCREL. The following ship classes also require this function either with a designated compartment, passageway, area or a combination: CV/CVN, LSD 41, LSD 44, LSD 49, AOE 6, AOE 10, MHC 51, MCM and LHD 1.

079-21.8.2 COMPARISON OF LOCKERS. A description of the DCUL, DCUPS and DCREL follows:

- a. DCUL Manned station located in the passageway, 12 personnel with 4 OBAs available, ability to investigate, to initiate firefighting actions, set flooding boundaries and to communicate to parent DCRS for assistance. DCULs are installed on small, medium and large ships.
- b. DCUPS Manned compartment, 13-20 personnel with 6 OBAs available, ability to handle fire, flooding, smoke and communicate to parent DCRS for assistance. DCUPSs are installed on larger class ships.
- c. DCREL Unmanned compartment with 18 OBAs available. Used for R & A and reentry into the ship if the damage control deck is smoked out. Communications available to damage control network, flight deck, hangar bay and boat deck.

SECTION 22.

DAMAGE CONTROL MATERIAL UPKEEP

079-22.1 MATERIAL CONDITIONS OF READINESS

079-22.1.1. OVERVIEW. [Section 21](#) briefly referred to material conditions of readiness as related to compartment readiness. This section discusses in detail, the measures to be taken to ensure that material conditions of readiness are properly established and maintained.

079-22.1.2 COMPARTMENTATION AND SYSTEM SEGREGATION. Ships are designed and constructed to provide increasing degrees of effective compartmentation and system segregation through systematic shutting of closures and fittings in increasing numbers. To allow use of the given compartmentation to its greatest advantage, all closures and fittings in tight decks, bulkheads, piping systems and ventilation systems that have damage control values are classified and marked with their classification.

079-22.1.3 CLOSURES AND FITTINGS. Closures are defined as closable openings in overheads, decks and bulkheads for access by personnel. Fittings are covers, valves, caps and plugs for access other than for personnel and for control of fluid flow. They may be on or in piping and ventilation systems or in overheads, decks and bulkheads. For brevity, where context allows, the term "fitting" is used to include the meaning of both fitting and closure and the term compartmentation is used to include both structural and fluid system segregation.

079-22.1.4 THREE-CONDITION SHIPS. Naval Sea Systems Command (NAVSEA) designs ships to have three material conditions of readiness. These conditions provide three progressive stages of compartmentation of the ship. Ships maintain different material conditions of readiness according to whether contact with an enemy or natural hazard (wind or waves) is improbable, probable or potentially imminent. The basic material conditions of readiness through which all ships progress are XRAY, YOKE and ZEBRA. These three material conditions of readiness provide increasing degrees of protection against the spread of fire, flooding, smoke, dangerous fumes and gases and chemical, biological, and radiological (CBR) agents. Material condition XRAY provides the lowest degree of compartmentation and therefore of protection. YOKE provides a higher degree than XRAY. Condition ZEBRA provides the highest degree of compartmentation and protection. In addition, there are six special classifications (Circle XRAY, Circle YOKE, Circle ZEBRA, Dog ZEBRA, WILLIAM and Circle WILLIAM). These conditions are further defined and described in the following paragraphs.

079-22.1.4.1 XRAY (X). Material condition XRAY is set when the ship is in almost no danger of attack or natural hazard, in a well-protected harbor or secured at home base, in fair weather or during normal working hours. All closures and fittings classified XRAY, even when logged open, should remain closed at all times when they are not in actual operation. They are labeled with a black letter X.

079-22.1.4.2 YOKE (Y). Material condition YOKE is set and maintained at sea, when entering or leaving port during peacetime, in port during peacetime (other than normal working hours) and in port during wartime. When material condition YOKE is set, both XRAY and YOKE closures and fittings are closed. Closures and fittings classified YOKE are labeled with a black letter Y.

079-22.1.4.3 Modified YOKE (Y). Condition YOKE may be modified (reduced in stringency) during normal working hours at sea in good visibility during peacetime cruising. In modified material condition YOKE, XRAY and YOKE closures and fittings below the waterline are closed. YOKE closures and fittings above the waterline may be left open to improve accessibility and habitability.

079-22.1.4.4 ZEBRA (Z). Material condition ZEBRA is set during general quarters. It is also set when the ship is leaving or entering port during wartime or at any time the ship is in danger such as that caused by fire or flooding. When material condition ZEBRA is set, closures and fittings classified XRAY, YOKE and ZEBRA are all closed. Closures and fittings classified ZEBRA are labeled with a red letter Z.

079-22.1.4.5 Modified ZEBRA (Z). There may arise certain situations during which the Commanding Officer may wish to set a modified material condition ZEBRA. Setting modified material condition ZEBRA provides a higher survivability stance than condition YOKE, is less restrictive than ZEBRA and will more readily allow the accomplishment of certain operational requirements. Modified ZEBRA can occur as an upgrade from condition YOKE or as a downgrade from condition ZEBRA. Some situations which may warrant modified material condition ZEBRA include:

- a. Underway replenishment
- b. Vertical replenishment
- c. Air operations
- d. Amphibious operations
- e. Transit of known or suspected hazardous navigation areas.

079-22.1.4.6 SPECIAL CLASSIFICATIONS. Special classifications, which are modifications of XRAY, YOKE and ZEBRA are placed on various fittings to meet special requirements. These special classifications are discussed in the following paragraphs.

079-22.1.4.6.1 Circle XRAY and Circle YOKE. These classifications are designated by a black letter **X** or **Y** within a black circle. These classifications are assigned to fittings that may be opened without special permission by personnel proceeding to or from battle stations, as required for routine inspection or for access to vital spaces. These classifications also apply to limited system isolation valves that are routinely operated. These fittings shall be reclosed immediately after each use.

079-22.1.4.6.2 Circle ZEBRA. This classification is designated by a red letter **Z** within a red circle. In situations where the ship has material condition ZEBRA set for extended periods of time, the commanding officer may authorize Circle ZEBRA closures and fittings to facilitate the feeding of the crew and to allow the use of selected sanitary spaces. When the commanding officer authorizes the use of Circle ZEBRA closures and fittings, they may be used in the same way as Circle YOKE closures and fittings when YOKE is set; that is, they may be

opened to pass through but closed immediately after passing through. If operational requirements create a need for some of these closures or fittings to be opened and left open, they must be closely monitored to ensure rapid closing should the situation require it.

079-22.1.4.6.3 Dog ZEBRA. This classification is indicated by a red letter **Z** enclosed by a large black letter **D**. Dog ZEBRA closures and fittings are those which are required to be closed when material condition ZEBRA is set or during periods of darken-ship when the established material condition of readiness is YOKE. These closures and fittings are normally located in decks and bulkheads exposed to the weather. Therefore, they must be closed during darken-ship to prevent light from showing outside the ship.

079-22.1.4.6.4 Designation WILLIAM (W). Certain fittings, indicated by a black letter **W**, which serve vital piping and ventilation systems, are classified WILLIAM. Even though they have specific damage control value, WILLIAM fittings are not required to be closed when setting any material condition of readiness; that is, WILLIAM fittings may be open and operating regardless of the material condition of readiness set. WILLIAM fittings are secured only to prevent the spread of the effects of damage, to prevent the intake of CBR contamination, to permit maintenance or to allow normal system or equipment shutdown. When contact with CBR material in the water is expected, sea suction fittings that are classified WILLIAM, except those essential for propulsion, shall be closed. Under these circumstances, particular attention shall first be given to securing distilling plants in time to prevent contamination of the distilling plant and of the ship's potable and feed water supply. Closing of WILLIAM closures and fittings may be initiated by the system or space operator in attempting to limit local damage or failure. The damage control organization also may initiate closing of these fittings to prevent the spread of the effects of damage or CBR contamination.

079-22.1.4.6.5 Circle WILLIAM. This classification is indicated by a black letter **W** within a black circle. Circle WILLIAM fittings are access and ventilation fittings that may be open and operating regardless of the material condition of readiness. These fittings are required to be closed only to prevent damage or for CBR defense. Circle WILLIAM closures and fittings are closed upon recommendation of the DCA with approval from the commanding officer.

079-22.1.4.6.6 Normally Open (N-O). This classification is indicated by black letters. **N-O** classifications are assigned to fittings that are normally open for general system operation and do not require special permission for damage control use.

079-22.1.4.6.7 Normally Shut (N-S). This classification is indicated by black letters. **N-S** classifications are assigned to fittings that are normally shut for general system operation and do not require special permission for damage control use.

NOTE

Every valve or fitting should have either a damage control classification or be identified as N-O or N-S in order to eliminate confusion regarding their function.

079-22.2. DAMAGE CONTROL (DC) CLOSURE LOG.

079-22.2.1 DESCRIPTION OF LOG. A record of the status of damage control classified closures and fittings is maintained in the DC Closure Log as required by NWP 3-20.3 1. The closure log and the procedures for its

use were established to facilitate the checking of the setting of material conditions of readiness and to expedite the setting of material condition ZEBRA. The closure log also aids the DCA in controlling the number of fittings that are open in violation of any particular material condition of readiness. The log entry for every closure or fitting that is locked or inoperative shall be annotated with its status. Examples are **locked shut, jammed open, removed, inoperative open or fouled by hoses** . For other possible descriptions, see [Table 079-22-1](#).

079-22.2.2 RESPONSIBILITY FOR SETTING MATERIAL CONDITIONS. All divisions are responsible for securing the XRAY and YOKE fittings in their assigned spaces. Each of the ship's damage control repair stations (DCRS) is responsible for setting material condition ZEBRA in its area of responsibility. Personnel manning battle stations should set ZEBRA in the immediate vicinity of their station. Even though a space may be manned, the DCRS has the responsibility of ensuring that ZEBRA is set throughout its area of responsibility. The setting of material condition ZEBRA and all discrepancies and exceptions that occur shall be reported to damage control central (DCC). Once the DCA gets the report of the setting of material condition ZEBRA and all exceptions, action can be taken to close any fittings that remain open, if possible. These reports and the closure log will give the DCA a clear picture of the status of material condition ZEBRA.

079-22.2.3 LOCKED OR CONTROLLED ACCESS SPACES. There are many spaces aboard ship which, for various and diverse reasons, may be locked or have controlled access. Some of these spaces will have damage control classified closures and fittings within them. These fittings are usually equipped with remote operators so that they may be operated from outside the space. The responsibility for the setting of material conditions of readiness on these remotely operable closures and fittings shall belong to the system operator or damage control organization. Responsibility for closures and fittings within these spaces that are not remotely operable shall belong to the division or work center holding the keys to the lock or controlling the access. CCOLs shall indicate these responsibilities.

Table 079-22-1 REQUIREMENTS FOR DC CLOSURE LOG ENTRIES

Material Condition in Effect	Required To Be Closed; Shall Be Logged If Open	May Be Open or Closed; No Entry Required	If Locked, Shall Be Logged	If Inoperative, Shall Be Logged
X	X ¹	Y, Z, W ⁴ , Circle W ⁴	Y, Z	ALL DC FITTINGS
Y	X ¹ , X ¹	Z ³ W ⁴ , Circle W ⁴	Z	ALL DC FITTINGS
Z	X ¹ , Y ¹ , Z ² , ³	W ⁴	-	ALL DC FITTINGS
Circle W	Circle W ⁴		-	ALL DC FITTINGS

¹Circle XRAY and Circle YOKE closures and fittings may be opened for use, as described in paragraph 079-22.1.6.1, without log entries, but shall be secured immediately after use.

⁴Operation of WILLIAM closures and fittings requires no DC closure log entry. The opening and closing on Circle WILLIAM fittings must be logged in the DC closure log when the situation has mandated the setting of Circle WILLIAM.

³Closing of Dog ZEBRA closures and fittings for darken-ship purposes should be a deck log entry. An entry is not required in the DC closure log. Opening of Dog ZEBRA closures and fittings while material condition ZEBRA is set requires permission from DCC and a DC closure log entry.

²Circle ZEBRA: Use of these fittings (in accordance with [paragraph 079-22.1.4.6.2](#)) does not require a closure log entry. If these fittings are to be opened and left open or used at times other than when the commanding officer has granted permission for their use, then special permission must be requested and a closure log entry must be made.

079-22.2.4 CLASSIFICATION SUMMARY. [Table 079-22-2](#) summarizes the application of damage control closure classifications. The following guidelines apply when using the table:

- a. Operators for remotely controlled fittings shall have the same classification as the fittings they operate.
- b. The following fittings are unclassified: Automatic, check, gauge cutout, reducing and relief valves; ballast valves interlocked with drain valves; drainage valves interlocked with firemain valves; fuel transfer valves in way of pumps; fireplugs and foam outlets; inert gas systems; and fuel valves between service tanks and burners.
- c. Closure classification is shown immediately after the location number of the fitting on the following ship's drawings:
 1. Voice tubes
 2. Drainage systems
 3. Chemical firefighting systems
 4. Vents, air escapes, overflows and sounding tubes
 5. Compartment and access
 6. Ventilation and air conditioning systems
 7. Piping systems.
- d. Where a fan room door is required to be kept open for supplying or exhausting air for a fan, the door shall have the same classification as the highest classification fan served. For example, a fan room containing a single YOKE fan will have a YOKE door, a fan room having both YOKE and ZEBRA fans will have a ZEBRA door.
- e. The material classification of a space and the security classification of that space have no particular relevance to each other.
- f. Chilled water system cutout valves to unit coolers shall have the same classification as the fan serving the cooler.
- g. Fumetight doors that are in fire zone bulkheads and provided with automatic door closer devices are unclassified, as are balanced doors and joiner doors.
- h. The classification of access closures applies to specific compartments as listed in [Table 079-22-2](#). If access to a compartment is through a series of hatches, scuttles or doors, and the compartment closure is classified as Circle XRAY or Circle YOKE, then the series of hatches, scuttles or doors shall be classified the same as the compartment closure. This classification process is to ensure accessibility to spaces that require routine access, during any given material condition of readiness, without requiring special permission for that access.

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5)

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
Access Closures in Watertight, Airtight and Oiltight Structures	Not required for routine access, such as:	-Alternate access to machinery spaces	-Airlock, pressure lock and pressure zone boundary doors	-None	-Ammunition elevators and elevator machinery room	-Air compressor room	-Doors from aviators' flight crew ready rooms to flight deck	-Weather doors (excluding XRAY and YOKE) not equipped with darkening switch or tight trap	-Crew's shelter
	-Arresting gear machinery room	-Drying room	-All doors and hatches for routine access to living spaces not otherwise designated		-Ammunition hoists	-Air-conditioning machinery room	-Limited doors alley, pump rooms, weather deck to crew galley		-Flag bridge
	-Automotive gasoline stowage compartment	-Generator room	-Configuration control station		-Aviation JP-5 fuel and tiller rooms	-Balloon inflation room	-Water closet space (one forward and one aft)		-Pilot house
	-Capstan and winch control room	-Hatches (if provided with scuttle) to shaft alley, pump rooms, eductor room and emergency generator room	-Control rooms		-Doors to forced draft blower rooms	-Chill room			-Repair stations
	-catapult machinery	-Missile director machinery room	-Equipment rooms that are occupied when the associated control is in use		-Doors to magazines and handling rooms	-Doors to shaft alley, pump rooms, emergency generator room and eductor room			-Signal shelter

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
	-Chain locker	-Some alternate access on damage control deck and above	-Flight deck control		-Electronic equipment rooms that are unmanned	-Hatches (without scuttles) to shaft alley, pump rooms, emergency generator room and eductor room			
	-Degaussing motor generator room	-Weather deck hatches not classified XRAY	-Food service spaces		-Escape scuttles	-Refrigerating machinery room			
	- Doors and hatches (on weather deck and below) tar striking down stores and ammunition only	-Windlass room	-Garbage disposal room		-Hatches (without scuttles) to magazines and handling rooms	Scuttle (in deck) to shaft alley, pump rooms, emergency generator room and eductor room			
	-Doors from dedicated decontamination stations to the weather		-Hangar deck control station		-Missile handling and check-out area compartments	-steering gear and power and ram room			
	-Fan rooms		-Hospital areas		-Nuclear support facilities				
	-Hatches (if provided with scuttle) to magazine and handling rooms		-Incinerator		-Oxygen-nitrogen (compressor and producing rooms)				

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
	-Issue room (paint, provision. clothing and small stores)		-Laboratories		-Scuttles (in hatches) to shaft alley, pump rooms, emergency generator room. Eductor room. magazines and handling rooms				
	-Manholes (bolted plates)		-Machinery control station		-Scuttles for passing ammunition				
	-Small arms ammunition		-Machinery spaces (main access)		-Special aviation service shops				
	-Stores elevator and elevator machinery room		-Offices		-Switchboard room				
	-Storerooms and stowage compartments		-Steering gear (station)		-Underwater log room				
	-Troop ammunition		-Trash burner room						
			-Utility rooms						
			-Weather access doors not specified else-where						
			-Workshop						
Air Escapes	-Damage control voids not containing pressure piping			-Damage control voids containing pressure piping					

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
Air Ports		-Lens frames						-Metal covers	
Air Test Fittings	-All								
Automotive Gasoline (MOGAS)	-All valves								
CHT System	-Sewage pump overboard discharge valve		-Bulkhead stop valves (except as listed under Circle ZEBRA)	-Vent valves	-Discharge valves to shore		-Valves to place the galley, one water closet space forward and one water closet space aft in service		
Compressed Air	-Compartment test fittings		-Root valves to branch lines not required for use during General Quarters						
Damage Control Ballast	-All root valves, bulkhead stop valves and tank fill and drain valves								

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
Drain Systems	-Portable submersible pump and eductor overboard discharge shell fittings -Deck drain valves (other than living spaces) -Deck drain valves and scupper valves from operation rooms		-Deck drain valves from living spaces, plug cock valves, scuppers and vent valves from plumbing drains -Gravity overboard discharge valves from unit coolers and from airconditioning units not classified WILLIAM	-Gravity overboard discharge valves from unit coolers and from airconditioning units classified WILLIAM	-Valves to overboard discharge fittings from liquid-fueled missile showers and magazines				
Firemain System	Valves:	-Valves for segregating loop firemain into port and starboard longitudinal sections	Valves.	-Valves to cooling systems for machinery required to be operated during General Quarters	-Eductors of liquid-fueled missile magazines		-Valves to flushing water system for one water closet space forward and one water closet space aft		

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
	-Not segregating into sections and not adversely affecting pressure in main or risers		-For segregating loop tire-main into four or more sections	-Sea suction valves from tire pumps in machinery spaces	-Submersible pump priming				
	-Actuating main, secondary and special drainage eductors not otherwise classified		-For segregating single firemain into two or more for-andaft sections	-Overboard discharge from gasoline tanks					
	-Manual sea suction and pump discharge outside main machinery spaces, pump discharge in machinery spaces		-To flushing system	-Valves to magazines sprinkling group control valves					
	-For draining the tiremain piping		-For cooling water systems not required during General Quarters	-Root valves to remotely-operated water washdown and foam generator systems					
	-To water washdown system		-To eductors from living quarters and shops						
	-To foam generators								

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
Fresh Water System	-Root valve to decontamination station		-Root valves above machinery space	Valves to provide:			-Valves to place the galley, one water closet space forward and one water closet space aft in service		
	-Stop valve for hose connection to decontamination showers			-Drinking fountains in machinery spaces -Eyewash stations and deluge showers -Gun barrel and rocket launcher cooling					
Fuel and Ballast System					-Tank suction and fill valves, root valves to auxiliary service systems, bulk-head stops and cross-connect valves				
List Control Systems	-All								
Miscellaneous Watertight and Airtight Covers	-Deck edge security lights		-All others not specifically classified						

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
Oxygen- Nitrogen Recirculating Air- Conditioning and Chilled Water	-All distribution system valves		-Paint and flammable liquids store- room, gas cylinder stowage and issue room -Rain clothes, ath- letic gear and regis- tered publi- cations locker -Storeroom with heat piping -Other sys- tems and fitting serv- ing spaces normally in use except during Gen- eral Quarters	-Photographic spaces -Squadron ready rooms -Aviation suit drying room -Medical spaces			-Galley and one water closet space forward and one water closet space aft		

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
				-Other systems and fittings serving spaces in continuous use or requiring air conditioning at all times including General Quarters					
Replenishment Air Sounding of Tanks			-Recirculating system	- Recirculating system		-Sounding tube deck plates and valves from voids, oil, fuel and water tanks			
Sprinkling and Water Washdown System	-Group control valves			-Valve to hangar and flight deck foam outlets					
	-Foam and seawater control			-Root valves to remotely-operated water washdown and foam system valves					
	-Water curtain valves and fittings								
	-Fittings for fixed fog								

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
Vent, Blowout	-Water washdown sys- tem valves -Conventional ammunition spaces, store- rooms				-Other than con- ventional ammu- nition spaces -Shaft alley				
Ventilation		-Windlass room	-Paint and flammable liquids store- room, gas cylinder stowage and issue room -Rain clothes, ath- letic gear and regis- tered publi- cation locker -Storeroom with heat piping -Other sys- tems and fittings serv- ing spaces normally in use except during Gen- eral Quarters	-Shaft alley (located in a collective protection system (CPS) enve- lope provid- ing filtration & pressur- ization) -Controllable fire dampers			-The galley, one water closet space forward and one water closet space aft		- Oxygen- nitrogen room - Aviation fuel mainte- nance shops - Gasoline spaces - Battery shop

Table 079-22-2 DAMAGE CONTROL CLOSURE CLASSIFICATION (1 of 5) - Continued

SYSTEM or FITTING	XRAY	YOKE	ZEBRA	WILLIAM	CIRCLE XRAY	CIRCLE YOKE	CIRCLE ZEBRA	DOG ZEBRA	CIRCLE WILLIAM
									- Main and auxiliary machinery spaces - Generator spaces - Other systems and fittings serving spaces in continuous use - Shaft alley (not located in a CPS envelope)
Voice Tubes and Message Passing Facilities (excluding Pneumatic Tubes)					-All				

079-22.2.5 CLOSURE SUMMARY. [Table 079-22-3](#) lists the conditions under which each material condition of readiness is set. It also indicates the classification of closures and fittings required to be closed in each material condition of readiness.

Table 079-22-3 MATERIAL CONDITION SETTINGS

Material Condition	Likelihood of Enemy Contact or Natural Hazard	Classification of Closures and Fittings To Be Secured
XRAY	Improbable (well protected harbor during normal working hours)	X, Circle X
YOKE	Probable (at sea, in unprotected harbors, in protected harbors during nonworking hours)	X, Circle X
ZEBRA	Imminent (battle conditions, extreme hazard situations such as heavy storms or transiting suspected mined areas)	Y, Circle Y
		X, Circle X
		Y, Circle Y
		Z, Circle Z
		Dog ZEBRA

079-22.3 MAINTAINING WATERTIGHT INTEGRITY

079-22.3.1 CAUSES OF DAMAGE. Piping, wiring, air-conditioning systems, shafting and access openings provided in ships penetrate watertight bulkheads or decks; therefore, they create hazards to the maintenance of the ship's tightness integrity. Unless necessary action is taken to counteract and minimize these hazards, an otherwise reliable damage control program may not be able to save the ship when severe damage is experienced.

079-22.3.2 ACTION PRIOR TO DAMAGE. Control of damage is dependent largely upon personnel training and the actions taken prior to damage being incurred. Steps can be taken to reduce and localize the effects of damage, including maintenance of the following:

- a. Ship's tightness integrity
- b. Effective fire prevention program
- c. Hull and engineering systems in their most efficient operating condition
- d. Damage control equipment in its most efficient operating condition, readily available and in full allowance.

079-22.3.3 WATERTIGHT COMPARTMENTS. Every Naval ship is subdivided by decks and bulkheads both above and below the waterline, into as many tight compartments as are compatible with the ship's mission. The more the ship is subdivided, the greater its resistance to the spread of the effects of damage and containment of damage. The condition of this subdivision (the tightness integrity) is of great importance and must be maintained. (The subject is discussed at length in [Section 23](#).) Tightness integrity is established by the designers and builders, who provide the boundaries of these subdivisions in accordance with specified shipbuilding requirements.

079-22.3.3.1 The ship's initial strength and tightness may be reduced or destroyed by negligence, storm damage, collision, stranding or enemy action. It is the responsibility of the damage control assistant (DCA) to ensure that the ship's tightness integrity is not impaired through negligence and that any damage to it is repaired as completely and as quickly as possible.

079-22.3.3.2 NAVSEA emphasizes the importance of maintaining tightness integrity to the highest possible standard and has instituted a program for periodic inspection and test (in accordance with PMS) to determine the degree of tightness being

maintained. It is recognized that this procedure imposes increasing duties and responsibilities on operating personnel but these tasks must be performed to ensure that the designed tightness is being maintained. Further information can be found in *NSTM Chapter 079, Volume 4, Damage Control Compartment Testing and Inspection*.

079-22.3.3.3 It is recommended that work requests involving correction of defects in tightness integrity be given the highest priority by the commanding officer and type commander and that corrective action be instituted at the earliest opportunity. Correction of defects that are within the capability of ship's force shall be accomplished at the earliest possible opportunity. Work beyond the capacity of ship's force shall be undertaken when a maintenance activity becomes available to the ship, even though the period of availability may be of short duration. Type commanders and commanding officers shall appraise the relative importance of these items and prioritize the work accordingly. Defects occurring on or below the damage control deck shall be given the highest priority.

079-22.3.4 DEGREES OF TIGHTNESS. Definitions and symbols for tightness are described in the following paragraphs in decreasing order of effectiveness.

079-22.3.4.1 Oiltight (Symbol OT). Condition denotes tightness that positively prevents leakage of oil or other petroleum derivatives under a pressure specified by test requirements.

079-22.3.4.2 Watertight (Symbol WT). Condition denotes degree of tightness which prevents leakage of water under the pressure specified by test requirements.

079-22.3.4.3 Airtight (Symbol AT). Condition denotes degree of tightness which ensures that when air pressure is applied, it will not drop more than specified in the test requirements.

079-22.3.4.4 Fumetight (Symbol FT). Condition denotes degree of tightness which ensures that there is no visible or discernible opening in the structure.

079-22.3.4.5 Weathertight (Symbol WEAT). Condition denotes degree of tightness which prevents the passage of gale force rain or a driven sea.

079-22.3.4.6 Fire Zone (Symbol FZ). A fire zone boundary is a physical boundary designed to retard the passage of flame and smoke. Fire zones primarily apply to transverse bulkheads. Exceptions are longitudinal bulkheads in the wells on amphibious ships and decks which provide continuity between a stepped vertical boundary at two different frames. Surface ships are divided into main vertical fire zones by utilizing the main subdivision bulkheads and portions of decks where the subdivision may be stepped. Fire zone bulkheads continue from the lowest deck up through the superstructure, being stepped as necessary. For ships over 220 feet in length, the distance between fire zone bulkheads shall not exceed 131 feet. The tightness of a fire zone boundary is never less than fumetight.

079-22.3.5 CAUSES OF LEAKAGE. Of the degrees of tightness, watertightness requires the most careful attention for the maintenance of its integrity. Causes for the loss of tightness are discussed in the following paragraphs.

079-22.3.5.1 Corrosion. Corrosion or rusting is oxidation of metal caused by the combined action of air and electrolysis. Corrosion is accelerated by the presence of salt and has a tendency to increase when dissimilar metals are in direct contact with each other. Corrosion weakens structures, boundaries, joints, piping and ventilation ducts. It hampers the operation of fittings, causing them to become defective. Because corrosion reduces structural strength and attacks tightness integrity, it must be controlled.

079-22.3.5.2 Loosening of Boundaries and Joints. Loosening of boundaries and joints can result from, among other things, the flexing of the ship in heavy weather, shock from gunfire and carrier flight deck operations, rocking of the ship by high-

speed maneuvering or vibration set up by operating machinery. All of these, plus normal usage, tend to cause relative motion between adjacent structural members at riveted or welded joints. This may result in the loosening of riveted joints or the cracking of welded joints. The former is more likely, harder to detect, and more difficult to correct. Repairs to either riveted or welded structures must be made as soon as defects are discovered. A riveted joint is not inherently watertight or oiltight because the surfaces or edges held together are not machined or ground. Such connections are made tight by means of caulking. Figure 079-22-1 indicates the general method of caulking to obtain tightness.

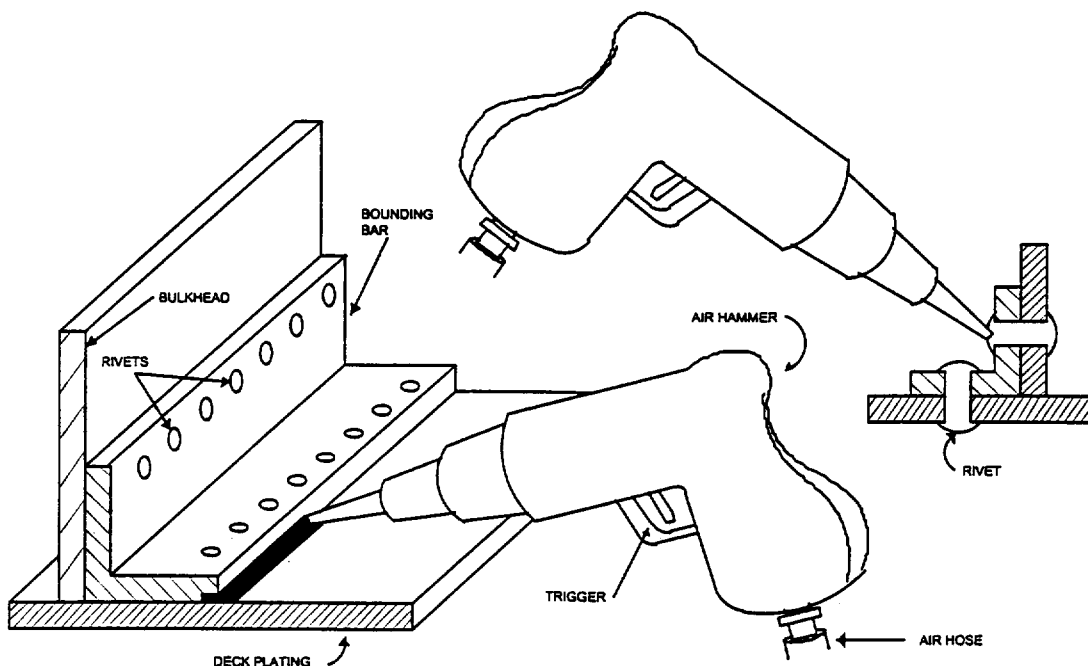


Figure 079-22-1. Caulking Method

079-22.3.5.3 Looseness of Closures. Closures and fittings which pierce watertight bulkheads and decks are potential sources of leakage of the most serious nature. The points of weakness of each must be carefully considered.

079-22.3.5.3.1 For additional information regarding inspection and maintenance of access closures, see applicable PMS requirements. Causes of lack of tightness in access closures are described in the following paragraphs.

079-22.3.5.3.2 Gaskets are installed in doors, hatches, scuttles, air ports, battle ports and dogged manhole covers to provide tightness. Exposure to oil, grease, heat or paint will cause them to deteriorate. They should be protected, frequently inspected and replaced promptly when hardened or cracked. Gaskets used with bolted manhole covers and similar bolted plates are of different types depending upon the system in which they are located. These gaskets shall be replaced if found to be in poor condition when the cover is removed or is observed to be leaking. This is important because when replaced and bolted down, such a closure will appear to be tight, whereas it actually may be a channel through which flooding can progress. It is necessary that the gasket be of the proper material and in good condition when the cover is replaced with bolts set up tightly and evenly all around. (Loosely secured covers have been blown off by explosions while tightly bolted ones have remained securely in place).

079-22.3.5.3.3 Knife edges and bearing surfaces may be distorted by the impact of heavy objects, as when ammunition or similar heavy material is carelessly handled through doors and hatches. Ship's personnel must be trained to avoid handling heavy weights in such a way that this can occur. Damaged knife edges and bearing surfaces should be repaired immediately. Shipyard or tender repairs may be necessary in case of serious damage. Rust and paint must be kept from knife edges and bearing surfaces. Knife edges or bearing surfaces should be cleaned in accordance with PMS requirements.

079-22.3.5.3.4 A common point of leakage is around dog spindles which pass through door frames. Packing inserted at the stuffing box for the dog spindles may deteriorate, loosen and even come out. Frequent inspections should ensure that packings are in good condition and that the packing gland is properly tightened. Dogs are to be repacked when necessary. Dogs

shall also be adjusted occasionally to accommodate the wearing down of the wedges against which they bear. Wedges may have to be built up or replaced when badly worn. Dog spindles equipped with Kamatic type seals shall be maintained in accordance with PMS requirements.

079-22.3.5.3.5 For a door or hatch to be watertight when dogged, the knife edge or bearing surface must be centered on the gasket and must bear evenly and firmly all around. To accomplish this, the door or hatch must be located correctly on its hinges in relation to the frame. Neither the door (hatch) nor the frame should be warped. Knife edges must be straight and even, retainer strips firmly screwed in place and the dogs adjusted to provide equal pressure on all wedges when set up. Incorrect fit may permit the frame or knife edges to come into contact with metallic parts of the closure (i.e., retainer strips) and allow the door to be closed in a nontight condition.

079-22.3.5.4 Defective Fittings. Defective or damaged fittings in the ship's systems will degrade tightness. Such fittings and the areas in which they may be defective are discussed in the following paragraphs.

079-22.3.5.4.1 Covers with gaskets provided in ventilation ducts are subject to the same failures as access closures. Ventilation closures and valves installed in the ducts are subject to lack of tightness due to such causes as dirt in ducts, corrosion and failure of operating gear. Frequent inspection, operation, lubrication and routine upkeep are needed to counteract the effects of dirt and salt air on these fittings.

079-22.3.5.4.2 Electric cables pierce many tight boundaries. Tightness is provided by passing each cable through a stuffing box or tube as shown in [Figure 079-22-2](#). Rust and paint must be kept from knife edges and bearing surfaces. Clean knife edges or bearing surfaces in accordance with PMS requirements.

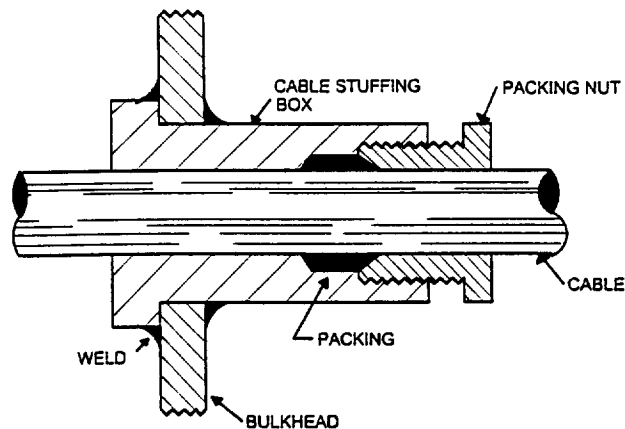


Figure 079-22-2. Stuffing Tube (Box)

079-22.3.5.4.3 Many cables may pierce a small area of a deck or bulkhead, forming a nest of cables and stuffing tubes. The stuffing nearest the center can be repacked only with great difficulty. On new construction ships, this difficulty is alleviated by use of the multi-cable transit device, which is more easily tightened by a compression bolt and the end packing bolts. This packing is most important, for without it the cable provides an easy path for the spread of the effects of damage. The multi-cable transit frame is shown in [Figure 079-22-3](#).

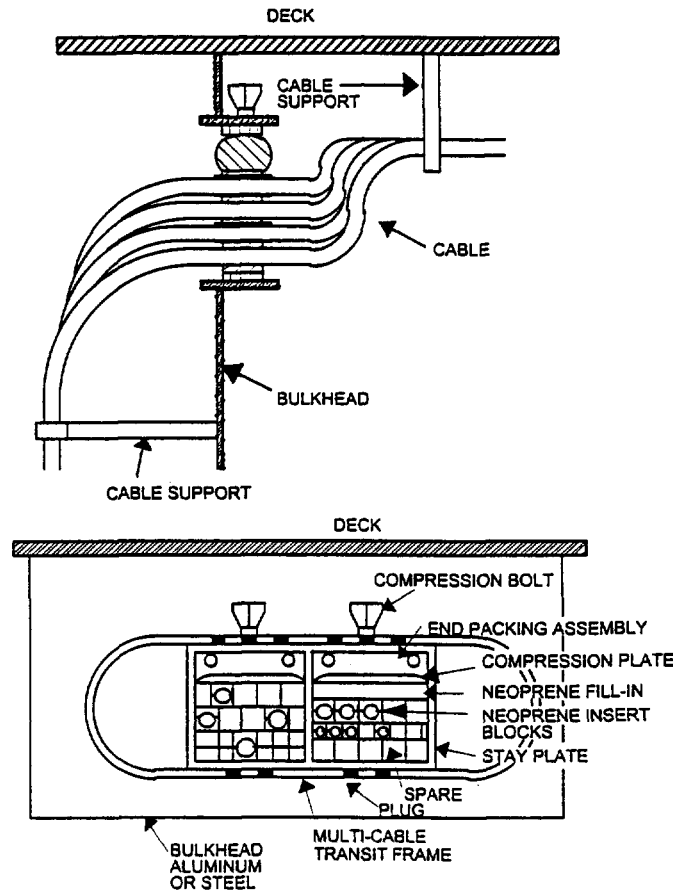


Figure 079-22-3. Multi-Cable Transit Frame

079-22.3.5.4.4 Where piping penetrates bulkheads and decks, the possibility of leakage always exists. Such piping ranges in size from small copper tubing to large steam mains. Various methods are used to make penetrations tight. During construction or installation, welders may fail to complete their welds, or may not make them strong and tight, because the piping passes through bulkheads or decks in locations that are difficult to reach.

079-22.3.5.4.5 Vibration or working of the ship can cause a break in welded and other types of joints. Where flanged connections exist, deterioration of the joints will permit leakage. Valves on piping terminating within a compartment, such as sounding tubes, deck drains and air piping, will leak if they are not maintained in good condition. They must seat properly and tightly. If normally open, it must be possible to close them easily.

079-22.3.5.4.6 Rotating shafts range from small remote control operating shafting to large propeller shafting. In most cases these pass through a packing gland to maintain the tightness of the boundaries which they penetrate. The rotary motion of the shaft will wear or dislocate the packing, causing difficulty in maintaining the proper degree of tightness. If the packing is too tightly compressed, operation is difficult. If too loose, leakage will occur.

079-22.3.5.4.7 NAVSEA-authorized alterations to ship's hull and permanent fittings are made for the purpose of improving the ship's operational capabilities. Many of these alterations require additional penetrations of existing tight bulkheads or decks. New electric cables and wiring, piping and tubing or ventilation ducts may be required. Wherever possible, these new installations should use existing penetrations in bulkheads and decks. Where use of existing penetrations is not possible, new ones must be made in such a manner as to maintain the tightness standard. Any unnecessary cables, wiring or pipe must be removed and the holes left by their removal must be sealed.

079-22.3.5.4.8 In such cases, each new fitting is to be checked by ship's force to ensure that it is properly installed and tight. The blanking of holes following removal of obsolete wiring, piping or fittings shall be accomplished without fail. These pre-

cautions have been found by experience to be necessary regardless of whether the activity performing the alterations is a Naval shipyard, civilian shipyard, tender, base or ship's force. It is particularly desirable that there be full intraship, inter-departmental cooperation to ensure that all possible points of weakness following alterations or repairs are carefully checked. *NSTM 079 Volume 4* gives directions concerning preservation of tightness integrity by shipyard forces upon completion of alterations or repairs. These are to be closely monitored.

079-22.3.5.4.9 The accomplishment of unauthorized alterations in the ship by the ship's force, particularly among engineering, electrical and radio personnel presents a serious hazard to the maintenance of tightness integrity. It must be understood by all personnel that no object requiring the drilling of holes in tight boundaries may be attached to such boundaries, nor should the tight boundaries be drilled, cut or punctured in any manner whatsoever without the express permission of the DCA who is responsible for ensuring tightness integrity. Unauthorized openings in tight boundaries, therefore, are not to be made. Holes or openings for any purpose whatsoever, except those shown or indicated by the drawings and specifications, shall not be made in any tight bulkhead or deck without the commanding officer's request for, and subsequent approval from NAVSEA. It is the responsibility of the DCA to see that this is strictly observed.

SECTION 23.

TESTS, INSPECTIONS AND MAINTENANCE

079-23.1 TESTS AND INSPECTIONS

079-23.1.1 REASONS FOR TESTS AND INSPECTIONS. Naval ships have many test and inspection requirements. Some are done by ship's personnel and some by outside activities. Tests and inspections determine if a ship and its equipment are fit for service and capable of carrying out its mission. Periodic tests and inspections should reveal defects which can then be eliminated before they limit the ship's operational ability.

079-23.1.2 SCHEDULE. Periodic tests and inspections shall be performed by ship's force on damage control equipment and systems in accordance with planned maintenance system (PMS) requirements. These tests and inspections include compartment tightness testing and the use of the schedule of watertight integrity test and inspection (SWITI) for determining the material condition of watertight boundaries. Tests and inspections are discussed in detail in *NSTM Chapter 079 (9880), Volume 4, Damage Control - Compartment Testing and Inspection*. Tests and inspections of Naval ships are also conducted by independent boards such as the Board of Inspection and Survey (INSURV) and the Propulsion Examining Board (PEB). These inspections determine a ship's fitness for service, and its operational readiness. Detailed lists of other types of inspections can be found in *NSTM Chapter 090, Inspections, Tests, Records and Reports*.

079-23.1.3 FREQUENCY. Conscientious inspection by zone inspection personnel, damage control personnel, damage control personnel and damage control petty officers (DCPOs), can reveal visible defects in compartment tightness which might otherwise go unnoticed until the next scheduled test or inspection. These inspections and reports to the commanding officer shall cover, at a minimum, material condition, cleanliness, state of preservation and condition of fittings. Frequent spot checks by chief petty officers and officers at all levels in accordance with the *Maintenance and Material Management (3M) Manual, OPNAVINST 4790.4* improves the efficiency of the maintenance program. Maintenance will be performed more conscientiously if personnel know that spot checks are being made.

079-23.1.4 ZONE INSPECTION CRITERIA. Zone inspections are conducted to ensure that correct measures are taken to maintain the safety and operating efficiency of the ship. This is done by a rigorous inspection plan with follow-up requirements and accountability for the ship's compartments, damage control, firefighting equipment, ship's systems, machinery, weapons, air operations support, supply and electronic spaces to maintain the ship's mission operational readiness status. All spaces should be scheduled and inspected using the planned maintenance system, maintaining a record of inspections and noting previously reported discrepancies. Use the

PMS form, *Compartment Space Inspections 6641*, *OPNAVINST 3120.32C* and the compartment check-off list (CCOL) for guidance. Check for the following equipment and conditions:

1. Fire Hazards Check for oily rags, frayed electrical wire, missing electrical safety checks on personal electronic equipment, improper stowage of flammable liquid and improper waste receptacle management.

NOTE

Check all flammable liquids lockers to ensure compliance with existing hazardous material regulations. Ensure all safety precautions are posted in a well lit location and that they are legible.

2. DC/FF Equipment and Systems Keep all fire stations hoses properly stowed on racks, with nozzles attached. Ensure hydrostatic test dates are stenciled on hoses. Check CO₂ /PKP/AFFF or other fire extinguishers for proper tagging and ensure they are securely stowed. Fire extinguishing systems operating instructions and safety precautions must be posted and legible in a well lit location.
3. Deterioration of the Hull, Structure and Fittings Check condition of deck coverings, deck drains and fittings; eliminate rust on all surfaces.
4. Cleanliness Look under equipment, under and inside lockers (in which division gear is stowed).
5. Material Condition Check condition of all surfaces, systems and machinery. This includes DC classification labels/markings and CCOLs. Make sure DC labeling, markings and identifications are accurate and in proper condition.
6. Piping Check pipe insulation and protective coatings, valves and labels on respective systems. Identify labels that have been painted over, and check for leaks and drips.
7. Watertight Integrity Ensure that gaskets are free from paint on doors, scuttles, hatches and air ports and that the closure mechanism operates properly. Check the swing of the door, dogs, knife edges, coamings, hatch pins, stanchions and stuffing tubes.
8. Lighting/Electrical Check for proper operation of the space lighting system. This includes all lighting fixtures, night lights, batteries in emergency lights and illuminating quality and operation of light system in the space. Check electrical cables, outlets and the casualty power system.
9. Ladders, Trunks Egress Note location, visibility and condition of egress signs, direction arrows, compartment bullseyes and labels on watertight closures. Ensure that escape scuttles are never blocked and are always correctly marked. Check for condition of ladder treads, handrails and safety chains.
10. Ventilation Check fan casings, screens, system markings, labels and mechanical devices to ensure that they are operating properly and in place. Check ventilation FLOW/EXHAUST; if suspected to be inadequate, have system evaluated.
11. Life Rafts and Life Saving Equipment, Markers, Life-Jackets, Life Lines Check the condition and function of life saving equipment.
12. First Aid Boxes Ensure proper location, markings and security seal. If there is a discrepancy, contact the medical department.
13. Communications Check all sound powered phones, IVCS, and internal communications for proper labels and protective caps. Spot check functioning of communications systems in accordance with system's operating procedures.

079-23.1.5 COMPLETED ZONE INSPECTIONS. Upon completion of the zone inspection, the reports should be used to rectify unsatisfactory conditions and coordinate corrective action with division and department maintenance work packages. Sometimes this may lead to the need to request outside assistance during the next ship's availability.

079-23.2 MAINTENANCE OF VITAL SYSTEMS

079-23.2.1 PREVENTIVE MAINTENANCE. Preparing for successful damage control requires that vital systems be maintained to their best operating condition. Systems must be dependable; they will fulfill expectations only if properly maintained through a well planned and supervised preventive maintenance program. Although battle damage may destroy parts of any system, sectionalization of individual vital systems can overcome such damage, provided system components operate properly.

079-23.2.2 SPARE PARTS. Time and manpower will not be wasted when an adequate supply of spare parts and repair materials are available. This includes normal upkeep materials such as lubricants and packing.

079-23.2.2.1 Planning. A sound maintenance program includes advanced planning. It is not possible to have 100 percent spares for everything in the ship, nor is this desirable from a weight standpoint. Intelligent planning based on experience must be applied to the types and amounts of materials to be carried.

079-23.2.2.2 Replacement Parts. A system must be established for replacing materials and spares used in upkeep and repair work, to include submitting requisitions to supply personnel as soon as inventories drop to a certain level, or when spare parts are drawn from the storeroom. Maintenance personnel must know the quantity, location and availability of repair materials and spare parts.

079-23.2.2.3 References. To ensure a compatible interface between the maintenance system and supply system, refer to *OPNAVINST 4790.4* .

079-23.2.3 EQUIPMENT AVAILABILITY. A reliable program is required to ensure that all necessary damage control equipment and materials are available and in good condition. Damage control personnel must ensure that damage control repair stations (DCRS) have all the equipment and material required by the allowance equipage lists (AELs) 2-8800442XX (series). It must be in good condition and properly stowed. The equipment shall be tested and inspected in accordance with the planned maintenance system (PMS). Only that equipment listed on the 2-8800442XX (series) AELs and other items authorized by NAVSEA (Damage Control) or the type commander shall be stowed in the DCRSs.

079-23.2.4 REPAIRS TO EQUIPMENT. A reliable test and inspection program shall be followed closely by maintenance and repair. The maintenance program shall provide for immediate correction of any defective or inoperative fittings. Even when repair will be made by an intermediate maintenance activity (IMA) or shipyard, ship's force will make emergency or partial repairs. If repair is beyond the ship's force capability, a notation of the defect shall be entered in the damage control log, and the current ship maintenance project (CSMP) file in accordance with the *Maintenance and Material Management (3M) Manual, OPNAVINST 4790.4* . This is to ensure that repairs will be scheduled at the next shipyard or IMA availability.

079-23.2.5 CASUALTY REPORTING. A casualty report (CASREP) is used to report the occurrence of a significant equipment casualty. A casualty is defined in *NWP 10-1-10* as an equipment malfunction or deficiency

which cannot be corrected within 48 hours. When a casualty is discovered during PMS or is identified by other tests and inspections, the affected system shall be the subject of a CASREP with PMS reported as the cause.

079-23.2.6 REFERENCE PUBLICATIONS. For additional information refer to the following list of reference publications to assist in managing your program:

- a. *NSTM Chapter 079 Volume 4, Damage Control - Compartment Testing and Inspection*
- b. *Schedule of Watertight Integrity Test and Inspection (SWITI) SELECTED RECORD and SHIP SPECIFIC*
- c. *Maintenance and Material Management (3M) Reports and Records, OPNAVINST 4790.4*
- d. *NSTM Chapter 090, Inspections, Tests, Records and Reports*
- e. *Standard Organization and Regulation of the U.S. Navy (SORM), OPNAVINST 3120.32*
- f. *Casualty Reports, NWP 10-1-10.*

SECTION 24.

DAMAGE CONTROL SYSTEMS

079-24.1 OVERVIEW

079-24.1.1. PRINCIPAL DAMAGE CONTROL SYSTEMS. Damage control systems are those fluid, electrical and ventilation systems which could contribute to combating fires, controlling or removing flooding water and smoke or transmitting power and communications. A casualty to any damage control system could endanger the ship or reduce its offensive capability. Under normal operating conditions these systems are the responsibility of the various departments of the ship according to the ship's organization. When systems are properly maintained, they can be quickly restored to service when damaged, ensuring the ship will be in operating condition sufficient to survive further damage from combat or accidents and fulfill its mission. The principal shipboard systems that affect damage control operations aboard ship consist of the following:

- a. Firemain, including Sprinkler, Washdown and Decontamination Showers
- b. Chemical Firefighting
- c. Drainage and Flushing
- d. Flooding and Ballasting
- e. Fresh Water
- f. Ventilation
- g. Collective Protection System (CPS)
- h. Compressed Air
- i. Fuel
- j. Oxygen-Nitrogen
- k. Liquid Propellants (hypergolic)
- l. Damage Control Communications

m. Casualty Power.

079-24.2 DAMAGE RESISTANCE FEATURES

079-24.2.1 DESIGN FEATURES. All systems vital to continued mission capability and effective damage control are designed with resistance to damage, to the maximum extent possible, to prevent disruption of vital services. Maximum benefit of these design features can best be gained by a thorough knowledge of ships' systems by damage control personnel. Training exercises must be scheduled on a regular basis to maintain personnel at a high level of readiness. The design features contributing to damage resistance and rapid recovery of these services consist of the following:

- a. Segregation
- b. Multiple sources of supply
- c. Duplication
- d. Flexibility
- e. Protection
- f. Resistance to shock and vibration
- g. Remote operation.

079-24.2.2 SEGREGATION. Segregation in fluid systems is provided by valves in strategic locations which permit sectionalized operation of a system. Segregation, combined with proper alignment of piping, valves and pumps, allows the system to be operated as several independent sections, taking full advantage of the availability of multiple sources of supply in various parts of the ship. Segregation not only aids in temporary repair, or reestablishment of services in the damaged area, but decreases the number of avenues for progressive flooding after damage. The firemain in the combatant ship is an example of a system with effective segregation. It is designed so that each section can operate independently. The benefits from segregation are twofold:

- a. Damage to one section of the system results in minimum disruption of a vital service to the ship, since the other sections are undamaged.
- b. Damage can be isolated by proper operation of valves to restrict the effects of the casualty, even within the damaged section.

079-24.2.3 MULTIPLE SOURCES OF SUPPLY. In order to take advantage of segregation, several pumps or sources of service (supply) are provided in well-distributed locations throughout the ship. This minimizes the potential adverse consequence of damage and allows the separate sources to be aligned with intact segments of the system. Multiple power sources are provided wherever possible so that loss of main power will not result in total loss of vital services. For example, each motor driven fire pump has a main and an emergency source of power. When the main source is damaged or lost due to damage, power to pumps is shifted automatically to the emergency source. The electric pumps may also be powered through casualty power systems from emergency generators.

079-24.2.4 DUPLICATION. This is provided by independent parallel runs of piping on opposite sides of the ship or at different levels or both. Generally, such runs are cross-connected through segregation valves. Damage to a run on one side or level of the ship may be isolated by closing these valves, and the intact run on the other

side or level will be capable of continued use. A loop system is an example of duplication since it consists of two parallel mains connected at each end. Normal segregated operation divides the loop system into a number of individual sections, isolated from each other by segregation valves. The ship service electrical system is designed with inherent damage control features to provide a continuous supply of power under casualty condition, such as duplicate wire runs, bus-tie breakers and selective tripping. See *NSTM Chapter 079, Volume 3, Damage Control - Engineering Casualty Control*. Independent power supply circuits are separated vertically and athwartships as much as possible to minimize the loss of all wire runs from the same casualty.

079-24.2.5 FLEXIBILITY. Systems incorporating the features of segregation, multiple sources of power and supply and duplication are inherently flexible and adaptable. In case of casualty to any portion of the system, the damaged section can readily be isolated and bypassed quickly to reestablish necessary services. The ship should make prior provisions for running emergency leads or jumpers. The systems, in general, lend themselves to the installation of such temporary repairs. The principal purposes of flexibility are to minimize the effect of a single hit and to aid in reestablishment of services. The additional design features are primarily intended to improve overall resistance to damage.

079-24.2.6 PROTECTION. In armored ships, piping and cables are run, as much as possible, behind vertical armor and below horizontal armor. Necessary risers lead to the unprotected upper portions of the ship. Leads at the ends of protected cable and piping runs serve the portions outside the protected area.

079-24.2.7 RESISTANCE TO SHOCK AND VIBRATION. The shock effect following an explosion or collision can be devastating and widespread. To avoid damage, piping, pipe hangars, bulkhead fittings, valves, pumps and associated equipment are protected from shock, and do not incorporate brittle materials, such as cast iron and pot metal.

079-24.2.8 REMOTE OPERATION. Since piping is run below the main deck or below the water line for protection, vital valves are frequently in locations difficult to access. Manual operation of such valves in unmanned compartments under battle conditions would require opening watertight doors and hatches, resulting in a loss of watertight integrity. Also, the time required to get to the valve and operate it may prove critical. Remote-operating gear is installed to permit the operation of such vital valves from normally manned or readily accessible stations.

079-24.2.8.1 Remote-operating gear is classified as the following four types:

- a. Mechanical
- b. Hydraulic
- c. Electrical
- d. Pneumatic.

079-24.2.8.2 Regardless of type, such gear must be rugged, shock resistant and dependable, particularly after damage.

079-24.2.8.3 Mechanical remote-operating gear consists of arrangements of flexible reach rods, connected by universal joints and bevel gears. Flexible reach rods are used because they are less susceptible to shock and blast effects (bending) than rigid reach rods.

079-24.2.8.4 Larger valves are equipped with hydraulic remote operated gear powered by hand-operated pumps located in the operating stations. Each pump is capable of operating several valves in a designated area through a selective hydraulic valve manifold at the operating station. Although the oil piping for these systems is susceptible to damage, these installations are rugged and dependable.

079-24.2.8.5 For certain shipboard applications, it is convenient to operate valves electrically either from a remote station or automatically. Examples are the opening or closing of valves used in the operation of the AFFF system, operation of the hangar sprinkler system and automatic starting of emergency diesel driven generators. These systems are closely allied with damage control or the operation of a ship under emergency conditions.

079-24.2.8.6 Electrically operated valves are either motor or solenoid actuated. In general, the motor operated valve is electric motor-driven through a gear box. Electrically or manually operated solenoid operated pilot valves (SOPV) actuate hytrol or powertrol-type valves. For further information see *NSTM Chapter 555, Volume 1, Surface Ship Firefighting* .

079-24.2.8.7 The pneumatic remote control system is designed to operate damage control valves located within the protected area of armored ships. The control panels of this system are divided into two sections, one for operating valves in the main drainage and seawater systems, the other for operation of engineering valves (steam and fuel). In normal operation of these valves, air is supplied from the low pressure air main (ship's service air system). In an emergency, air can be taken from air flasks. This system consists of an air motor, a clutch, a hammer blow gear drive (that provides the initial force for starting) and a hand wheel for manual operation.

079-24.2.8.8 Automatic starting of emergency diesel-driven generators is accomplished through the operation of either one or two air valves which admit air to the diesel starting system upon failure of ship's power. Air is shut off when the emergency generator comes up to speed and its voltage is applied to the solenoid. Refer to *NSTM Chapter 505, Piping Systems*, for additional information .

079-24.3 PURPOSE OF CASUALTY POWER

079-24.3.1 SYSTEM FUNCTIONS. The casualty power system is arranged to provide temporary transmission of power to damaged areas. It provides temporary power to vital ship functions requiring continuity of service for sustaining ship control, maintenance of systems, communications, detection, interior communications and lighting. Casualty power also is designed to provide a source of temporary power for damage control functions and limited operation of ordnance and aircraft facilities. Detailed description of this system can be found in *NSTM Chapter 079, Volume 3, Damage Control - Engineering Casualty Control* .

SECTION 25. FIREMAIN SYSTEM

079-25.1 GENERAL

079-25.1.1 No information is of greater importance to the damage control organization than a complete knowledge of the ship's firemain system. Details of this system can be found in *NSTM Chapter 555, Volume 1, Surface Ship Firefighting* and *NSTM Chapter 555, Volume 2, Submarine Firefighting* .

SECTION 26.

SPRINKLER SYSTEMS

079-26.1 GENERAL

079-26.1.1 Information regarding sprinkler systems, vertical launch systems (VLSs) deluge and the booster suppression systems can be found in *NSTM Chapter 555, Volume 1, Surface Ship Firefighting* and *NSTM Chapter 555, Volume 2, Submarine Firefighting* .

SECTION 27.

WASHDOWN AND SHOWER SYSTEMS

079-27.1 GENERAL

079-27.1.1 Information regarding washdown and shower systems can be found in *NSTM Chapter 470, Shipboard BW/CW Defense and Countermeasures* .

SECTION 28.

CHEMICAL FIREFIGHTING AGENTS

079-28.1 GENERAL

079-28.1.1 Aqueous film forming foam (AFFF), dry chemical extinguishing agents, inert gas systems, carbon dioxide (CO₂) and halon systems are important fire extinguishing agents for fighting shipboard fires. These agents are provided both as portable units and as installed systems.

079-28.1.2 For information on firefighting systems and their uses see *NSTM Chapter 555, Volume 1, Surface Ship Firefighting* and *Volume 2, Submarine Firefighting* .

SECTION 29.

DRAINAGE AND FLUSHING SYSTEMS

079-29.1 DRAINAGE SYSTEMS

079-29.1.1 DESCRIPTION AND PURPOSE. All ships have some means for removing normal waste and flood water from within their hulls. Systems of piping, with or without pumping facilities installed for this purpose, are termed drainage systems. The flushing system includes all piping that serves plumbing fixtures and other low pressure seawater services for which no other source of supply is specified. Efficiently operated drainage systems can keep compartments operating when they would otherwise have to be abandoned because of leakage or progressive flooding. The several drainage systems installed in a ship provide an immediately available and effective method for removing flooding water. Personnel must be trained in the proper operation and control of drainage facilities to ensure not only usability, but also maximum efficiency. Thorough knowledge of these systems could be vital in keeping the ship afloat and fighting when damage occurs.

079-29.1.2 COMPONENT PARTS. A drainage system fundamentally consists of the following:

- a. A length of suction piping (drainage main)
- b. Branches from the main leading 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.

079-29.1.3 PRINCIPAL DRAINAGE SYSTEMS. The following principal drainage systems are installed in the ship:

- a. Main drainage system
- b. Secondary drainage systems
- c. Certain special drainage systems.

079-29.1.3.1 Actuation. Drainage systems can be actuated either by power or gravity or a combination of both. Power can be applied either as a positive pressure or by suction. Pumps can be electric, steam, internal combustion or water driven. Gravity flow can be directly over the side into the sea through scuppers or similar fittings, or downward in the ship into bilges, tanks or similar wells from which the water is then pumped up and over the side through discharge systems.

079-29.1.3.1.1 The design, installation and operation of a specific drainage system in a ship can best be obtained through a study of the actual installation and reference to the ship's damage control book.

079-29.1.3.1.2 Portable pumps used to drain flooded areas are not provided with drainage facilities. Additional information regarding portable pumps can be found in *NSTM Chapter 555, Volume 1, Surface Ship Firefighting and NSTM Chapter 555, Volume 2, Submarine Firefighting* .

079-29.1.3.1.3 War damage reports have repeatedly emphasized the trouble caused by clogged drainage suction. While much of this difficulty has been caused by battle damage debris, a considerable part is caused from the unnecessary accumulation of miscellaneous material which finds its way into sumps. Proper stowage and securing of loose items will prevent or minimize this situation.

079-29.1.3.2 Main Drainage System. The main drainage system runs throughout the machinery compartments. In some ships, however, it may extend forward and aft of the machinery compartments. In smaller ships, the drainage main consists of a single pipe running fore and aft, usually along the centerline. In larger ships, it is a loop system extending along both sides of the engineering compartments and joined at the ends. Main drainage systems may be used in many newer ships to drain floodable voids used in counterflooding, after such voids have been flooded, and to empty fuel tanks which have been ballasted with seawater. Main drain piping is 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 than the main line. Two and one-half-inch hose fittings are installed in the main so that standard two and one-half-inch suction hoses can be connected.

079-29.1.3.2.1 The following types of pumps are installed in the main drainage systems:

- a. Steam-driven reciprocating pumps (in older type ships)
- b. Turbine or motor-driven centrifugal pumps
- c. Eductors (jet pumps).

079-29.1.3.2.2 The main drainage system is segregated by bulkhead stop valves. These valves can be remotely operated from the damage control deck and are classified **Circle X** which, in effect, breaks the main into independent systems, each served by an eductor. So long as the piping is intact, any eductor may take suction from any space by opening the proper cutout and suction valves.

CAUTION

It is important that bilge suctions which are not fitted with remote control devices be closed at all times when not in use. This will prevent an open main in a compartment being flooded because it is open to the sea. This situation will render the drainage system inoperative for pumping other spaces.

079-29.1.3.3 Secondary Drainage System. Secondary drainage systems drain spaces forward and aft of main machinery compartments. The piping is smaller in size than that used in main drainage and independent systems, each with its own pumps or eductors. The following types of pumps are used in the secondary drainage systems:

- a. Electric motor-driven centrifugal pumps
- b. Eductors (jet pumps)
- c. Portable electric submersible pumps.

079-29.1.3.4 Plumbing And Deck Drains. Plumbing and deck drains are provided to gravity drain compartments within the ship. Gravity drainage piping is installed most extensively in compartments above the waterline. In large ships, some compartments near or below the waterline may be drained to compartments or spaces lower in the ship, from which the water can then be pumped overboard. These lower spaces may be in bilges and bilge wells, shaft alley sumps, drain tanks or sanitary drain tanks. Deck drains below the tightness level are provided with closure valves. These valves usually require frequent attention to ensure proper operation. Great flooding danger exists from 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, water will flow back through drainage piping unless some positive closure is provided. Compartments far distant from damaged areas have been flooded by water flowing through damaged drain piping.

079-29.1.3.4.1 Where gravity drains pierce the side of the ships, scupper castings and core valves (plug cocks) or gagged scupper valves are installed.

079-29.1.3.4.2 Gag scupper valves, classified **W** in drainage lines from medical areas, have remote mechanical control from the damage control deck. Other gag scupper valves and valves required for damage control, which are located in inaccessible or locked compartments, have remote mechanical controls operated from an accessible area in order to permit setting material condition of readiness corresponding to the classification of the valve.

079-29.1.4 HOSE VALVE DRAINAGE CONNECTIONS. Some tanks and compartments low in the ship have a suction pipe running from a low point within them to a more easily accessible compartment, terminating in a hose connection. This connection is a gate or globe stop valve to which a 2-inch suction hose may be connected. The other end of the suction hose may be connected to a submersible pump. Another possibility, in some locations, is to connect the other end of the suction hose to another hose connection in the main or secondary drain piping.

079-29.2 DRAINAGE AREAS

079-29.2.1 REQUIREMENTS. Drainage systems are required for several reasons, discussed in the following paragraphs.

079-29.2.2 MAGAZINES. All magazines with sprinkler systems have a drainage capability. Magazines which are located above the weather deck and adjacent to the weather, drain through a check valve installed in the bulkhead to the weather. Where the magazine is not located adjacent to the weather, overboard drainage is provided through deck drains in the magazine with independent drain piping having a check valve at the shell. Magazines below the waterline are drained by installed secondary drainage eductors.

079-29.2.3 WEATHER DECKS. Weather deck drains are provided for draining exposed superstructure decks and main decks. They drain entirely by gravity, overboard, above the water line.

079-29.2.4 ENGINE ROOMS. For emergency engine room drainage, ships use large capacity 8-inch or 10-inch eductors in an installed primary main drainage system that discharge overboard.

079-29.2.5 SHIP'S SERVICE. Drainage from heads, washrooms, food preparation compartments and sickbays are combined wherever possible and lead overboard by gravity through scuppers at least one deckheight above the waterline. When this is not practicable, eductors are used to pump the drainage water from the combined drains, through the hull below the waterline. Compartments ordinarily dry are not provided with deck drains or connections to fixed drainage systems. Such drains would increase the ship's vulnerability to progressive flooding and the capacity of this type of installation would be ineffective in combating flooding.

079-29.3 DEWATERING OPERATIONS WITH PORTABLE PUMPS

079-29.3.1 DISCHARGE PRESSURE. When a portable pump is used for dewatering purposes, the discharge pressure which the pump is required to develop is lower than that required for effective firefighting. Only enough pressure is needed to move water from the elevation of the pump to the elevation at which the water is discharged, and to overcome the friction head caused by the resistance of the discharge hose to the flow of water.

079-29.3.2 OVERBOARD DISCHARGE CONNECTIONS. Overboard discharge connections, one port and one starboard, are installed through the hull of each main transverse subdivision. They are four inches in diameter, made flush with the outer hull surface. They are not fitted with valves, but are fitted with watertight screw caps over the inboard ends.

079-29.3.2.1 Connections are located on the damage control deck level and as close to the damage control deck as practicable.

079-29.3.2.2 The inboard end of each overboard discharge connection is fitted with a four-inch female swivel hose connection attached by a safety chain to a four-inch male connection by a 2-1/2 inch female swivel hose adapter coupling. A 2-1/2 inch plug closure with standard fire hose coupling lugs is attached to the adapter by a safety chain. A spanner wrench of suitable size is to be stowed nearby. In some cases, an adapter fitting will be required to ensure threads and adapters are aligned.

079-29.3.2.3 Where hull scuppers for plumbing or deck drains are available, the overboard discharge connections are provided on these scuppers instead of the usual cleanout opening.

079-29.3.2.4 On destroyer types and smaller ships, compartments forward and aft not served by the main drainage systems, have a secondary drainage system terminating in a manifold located in the compartment, which provides the most efficient arrangement for draining compartments. An overboard discharge line with a stop-lift-check valve at the hull and terminating in a 2-1/2inch hose connection near the manifold is installed.

079-29.3.2.5 Hull discharge openings may be used to discharge exhaust fumes from portable pumps.

079-29.3.3 PUMPING COMBUSTIBLE LIQUIDS. When pumping combustible liquids, or water contaminated with combustible fuels, the use of eductors is required with the water supply being received from the sea or an uncontaminated source.

079-29.3.4 DEWATERING BY GRAVITY SUCTION. There could be a situation in which a compartment would be taking on flooding water without having a fitted or operable drainage system. This water can be removed by a gravity-suction rig. The procedure is as follows: couple several lengths of noncollapsible hose, cap one end and lower it into a compartment below (such as a bilge or shaft alley fitted with operable drainage facilities). Fill the hose with water and cap the upper end. Lower the upper end into the flooded compartment and, on signal, uncapped both ends of the hose simultaneously. Dewatering of the compartment will take place through the siphon thus created.

NOTE

When dewatering by gravity suction, the discharge must be below the suction.

079-29.3.5 EMERGENCY DRAINAGE. With damage control and main engine personnel thoroughly acquainted with the regular methods of drainage, improvising in emergencies will be less difficult. 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.

079-29.4 FLOOD CONTROL

079-29.4.1 BACKGROUND. One of the most important damage control activities is to control flooding. Drainage by fixed systems or portable pumps is ineffective to handle flooding, because there is a risk that damage will occur before the rate of flooding has been controlled. The entire pumping capacity of drainage systems is sufficient to care for only minor damage where leaks are small.

079-29.4.2 **EXAMPLE OF FLOODING.** A hole in the shell, with an area of only one square foot, fifteen feet below the surface, will admit water at the rate of 13,900 gpm. The total pumping capacity of the fixed drainage systems in a large combatant ship, for example, is 12,400 gpm, exclusive of main condensers, each of which is available only for pumping the machinery room in which it is located.

079-29.4.3 **COMPARTMENT ISOLATION.** Since all pumping facilities cannot be brought to bear on any single flooded compartment, it is essential that flooded compartments be isolated by watertight subdivision before dewatering efforts can accomplish any degree of success. Leakage into compartments with relatively small leaks, on the fringe of the damaged area, can be combatted by concentration of drainage facilities, including the damage control pumping system and portable pumps.

079-29.4.4 **METHODS.** Basically, there are two methods that can be used to control flooding. The primary method is to restrict, or entirely stop, the flow of water entering the hull. The secondary method is to confine and remove water that has entered, or is entering, the ship. An assessment is required by the scene leader/team leader to determine proper action, with the goal of containing and stopping flooding. Action may include dewatering through a hatch while the space is still flooding.

079-29.5 FLUSHING SYSTEMS

079-29.5.1 **DEFINITION.** Flushing systems include all piping that serves plumbing fixtures and other lowpressure seawater services for which no other source of supply is specified.

NOTE

Seawater is not to be supplied to food handling or other commissary facilities.

079-29.5.2 **LOCATIONS.** Garbage grinders are provided with seawater connections for flushing ground garbage through the drainage system or through a separate overboard discharge.

079-29.5.2.1 A seawater outlet is installed in a central location port and starboard, in the vicinity of the boat davits, for supplying boat engine exhaust cooling pumps. The seawater outlet riser is provided with a means of draining during freezing weather.

079-29.5.2.2 Water for flushing services is taken from the firemain by branches, each containing a root cutout valve, a wye-type strainer, a reducing valve and a relief valve. The relief valve is located on the low pressure side of the reducing valve and discharges to a shower stall or other deck drain. Bypass lines for the reducing valves are required only if the ship has one flushing service from the firemain. If a bypass is required, a needle valve is installed in the bypass line.

079-29.5.2.3 To keep the number of branches from the firemain to a minimum, flushing services are grouped where practicable. Each group would ideally be served from a single branch. The piping is arranged so that a continuous supply of flushing water is available for sickbay heads when the supply to other sanitary facilities is secured.

079-29.5.2.4 Pressure on the firemain for flushing purposes is maintained by the pumps provided for fire service. Individual flushing pumps are not installed.

079-29.5.2.5 Cutout valves in the flushing system may be of a non-rising stem type; in such instances open/closed position indicators are provided.

079-29.6 INSTALLED EDUCTORS

079-29.6.1 **USAGE** Shipboard spaces that could potentially flood have installed eductors to dewater and pump out the compartments. These eductors are part of the installed drainage system. Many times these spaces do not have installed, natural or forced ventilation. Ensure that the following steps are followed when using installed eductors:

CAUTION

Using suction on a space with the water level below the suction line will remove air from the space.

1. Identify confined or closed spaces which could pose a threat to life by asphyxiation, through the use of an installed eductor in a dry sump when ventilation is secured, inadequate or does not exist.
2. Post warning signs at all accesses to spaces identified as meeting threat-to-life criteria.
3. Train personnel working in closed or confined spaces to recognize the potential for hazards of asphyxiation when operating an installed eductor.

SECTION 30

FLOODING AND BALLASTING SYSTEM

079-30.1 SYSTEM FUNCTION

079-30.1.1 **INTRODUCTION.** In order to maintain proper list, trim, draft, stability and torpedo protection, most ships are provided with a ballasting system which allows fuel and certain other tanks to be filled with seawater as the fuel is expended. These tanks are generally flooded or filled with seawater through a manifold from the firemain system. Ballast water is removed from the tanks through the drainage-main connected with eductors and possibly to the fire and bilge pumps.

079-30.1.2 **LOCATION OF CONTROLLED ARRANGEMENTS.** Controlled ballasting arrangements are provided for the following:

- a. Fuel tanks
- b. Diesel oil or JP-5 tanks
- c. Ballast tanks
- d. Fuel overflow tanks.

079-30.1.2.1 Controlled flooding arrangements are provided for the following:

- a. Underwater side protective system floodable voids
- b. Peak tanks
- c. Trim tanks.

079-30.1.2.2 Piping from the firemain system, or from sea chests to manifolds for ballasting, is generally sized to ballast the tanks served in one to one and one-half hours. For ballasting from the sea, this time requirement applies to ballasting within one foot (12") of the waterline.

079-30.1.2.3 Combined ballasting and drainage systems are fitted so that compartments can be drained separately or simultaneously by the drainage pumps or eductors, and so that all compartments can be ballasted separately or simultaneously.

079-30.1.3 SIZE AND CAPACITY OF SYSTEM. The capacity and extent of clean ballast systems, including manifolds, ballasting and transfer mains, eductors and other components, are sufficient to ensure that compartments can be ballasted and dewatered separately or simultaneously at the rates specified.

079-30.1.3.1 Sea chests and valves for flooding underwater side protection tanks and voids are of sufficient size to require not more than six minutes to fill to within one foot of the full load waterline when flooding directly from the sea. The largest sea valve for flooding any tank or void is not more than 10 inches iron pipe size (IPS), and no more than one such valve is fitted, even though the six-minute flooding time may be exceeded.

079-30.1.4 VALVES. Fuel, ballast, JP-5 and diesel oil tanks are ballasted, drained and stripped through a three-valve interlocked manifold to prevent more than one valve being opened at any one time. Valves in fuel, diesel oil and JP-5 tank ballasting manifolds are locked closed by an approved locking device.

079-30.1.4.1 Where fuel transfer tailpipes are used for ballasting and drainage, 3/4-inch leakoff valves are installed to prevent leakage from one system to the manifold of another system.

079-30.1.4.2 Sea valves for underwater side protective system and floodable voids are operated hydraulically from the damage control deck. The hydraulic controls are arranged in groups, located for ready access, and preferably close to the vent valve for those voids. Hydraulic power is generated by hand-operated rotary pumps of an approved design with piston type valves.

079-30.1.5 DAMAGE CONTROL CLOSURE CLASSIFICATION. Damage control closure classification of the flooding and ballasting system is detailed in [Table 079-22-2](#).

SECTION 31. POTABLE WATER SYSTEMS

079-31.1 DESCRIPTION

079-31.1.1 Fresh water is stored in ships in special tanks located low in the ship. From these tanks, fresh water is delivered through the fresh water system to outlets such as drinking fountains, wash basins, galley faucets, rocket launcher barrel sprinklers, photographic laboratories and other necessary services. Current practice provides ships with a pressure tank system or a continuously operating centrifugal, constant pressure pump system. The pumps for these systems are located either near the fresh water tanks or in other engineering compartments.

079-31.1.2 The fresh water system can be a possible source of progressive flooding if damaged. Cutout valves are installed to permit segregation. Further information on fresh water systems can be found in *NSTM Chapter 533, Potable Water Systems*.

SECTION 32. HEATING, VENTILATION AND AIR-CONDITIONING (HVAC) SYSTEMS

079-32.1 DAMAGE CONTROL CONSIDERATIONS

079-32.1.1 GENERAL. The continuous demand on the ventilation system for large volumes of air for habitability and equipment operations requires careful consideration from the damage control point of view. Ducting may provide the path for water to flow from one compartment to the next as well as providing the route for gas, smoke or fire to enter and move throughout the ship. A 10-foot by 18-foot compartment of average deck height can be completely flooded in about five minutes through a six-inch diameter hole under a 10-foot head.

079-32.1.2 HVAC SYSTEMS NSTM. For operation, care and maintenance of HVAC systems, including the collective protection system (CPS) and the chilled water (CW) system, see *NSTM Chapter 510, Heating, Ventilating and Air-Conditioning Systems for Surface Ships*.

079-32.1.3 DESMOKING NSTM. For desmoking procedures, see *NSTM Chapter 555, Firefighting, Volumes 1 and 2*.

SECTION 33. COMPRESSED AIR SYSTEMS

079-33.1 DESCRIPTION

079-33.1.1 Compressed air systems are installed in ships according to the demand requirements of the ship's mission. Essentially, available compressed air systems include the following:

- a. Low pressure - having pressure below 150 psig
- b. Medium pressure - having pressure from 150 to 1000 psig

c. High pressure - having pressure over 1000 psig.

079-33.1.2 There can be other air systems for specialized use. These are supplied with air at the required pressure through reducing valves.

079-33.1.3 For additional information concerning compressed air systems, See *NSTM Chapter 551, Compressed Air Plants and Systems* .

SECTION 34.

FUEL SYSTEMS

079-34.1 INTRODUCTION TO FUEL OIL SYSTEMS

079-34.1.1 TRANSFER AND OVERFLOW. The fuel system consists of a loop serving all fuel tanks, permitting transfer of fuel between service fuel tanks and fuel service pumps. Included in the system are topside fuel filling connections which lead down to the loop for fueling the ship. Cutout valves are installed in strategic locations as well as in cross connections at the forward and aft ends and at the transfer pumps. For additional information prior to entering a fuel tank, refer to *NSTM 074, Volume 3, Gas Free Engineering* .

079-34.2 DAMAGE CONTROL ELEMENTS OF FUEL SYSTEMS

079-34.2.1 PURPOSE. Fuel systems are important to damage control because they are used to transfer liquid for correction of list and trim and for the improvement of stability or reserve buoyancy after damage.

079-34.2.2 SEQUENCE TABLE. A sequence table for emptying fuel tanks is included in the engineering casualty control book. It is prepared by the engineer officer and should be approved by the type commander or the fleet maintenance officer, as applicable. The sequence table shall provide for ballasting certain tanks with seawater as specified on the liquid loading diagram in the damage control book. In cases in which the liquid loading diagram contains instructions as to the sequence to be followed in using fuel, those instructions shall be followed, except for modifications which may be necessary to ensure a reliable fuel supply for split plant operation.

079-34.2.3 TYPE OF BALLAST. Seawater ballast is preferable to fuel as a protective measure, since it removes the fire hazard in the event of damage while opening the tank top and releasing the contents. On some ships, wing tanks abreast boiler rooms are required to be ballasted with seawater before other wing tanks, in order to remove the threat of fire hazard.

079-34.2.4 DETERMINING SEQUENCE. Where a sequence for emptying fuel tanks is not included on the liquid loading diagram, it is necessary to consider the following (in addition to avoiding fire hazard) to arrive at a proper sequence:

- a. To lighten the ship early to improve reserve buoyancy and freeboard, empty innerbottom tanks which are not required to be ballasted for stability purposes.
- b. Partial emptying of wing tanks to the external waterline affords the same advantages as described in (a).
- c. The sequence should be such as to avoid extreme trim by the bow or stern.

079-34.2.5 TIMING. There is some advantage in using fuel from tanks near the ends of the ship at an early stage, because the longer the pipe line leading to the tank, the more the fuel system is exposed to damage. Effective operation on a split-plant basis should not be jeopardized by the sequence adopted.

079-34.3 FUEL HANDLING NSTMs

079-34.3.1 WRITTEN GUIDANCE. Fuel handling and stowage must be conducted by personnel who are fully aware of the hazards and who are trained in proper precautions which must be taken to protect the ship and personnel. For a further discussion of fuel systems, see *NSTM Chapter 541, Ship Fuel and Fuel Systems and NSTM Chapter 542, Gasoline and JP-5 Fuel Systems* . For information regarding containment of fuel-fed fires, see *NSTM Chapter 555, Shipboard Firefighting, Volume 1* . A complete description of precautions to be taken prior to and upon entering fuel tanks can be found in *NSTM Chapter 074, Volume 3, Gas Free Engineering* .

SECTION 35.

OXYGEN-NITROGEN SYSTEM

079-35.1 GENERAL

079-35.1.1 For information concerning the oxygen-nitrogen system, see *NSTM Chapter 550, Industrial Gases; Generating, Handling and Stowage* .

SECTION 36.

SHIPBOARD AMMUNITION

079-36.1 GENERAL

079-36.1.1 Spillage or leakage of highly toxic and corrosive liquid propellants creates hazardous conditions to the ship and ship's force. For information on handling shipboard ammunition, see *NSTM Chapter 700, Shipboard Ammunition Handling and Stowage and NAVSEA OP-4, Ammunition Afloat* .

SECTION 37.

DAMAGE CONTROL COMMUNICATIONS

079-37.1 DESCRIPTION OF COMMUNICATIONS

079-37.1.1 OVERVIEW. Establishing effective communications is the most important element in successfully combating casualties. Major shipboard communications subsystems include sound-powered telephones, IVCS, ship's service telephones, announcing systems, intercommunications systems and DC WIFCOM. In addition to information contained in this section, also see *NWP 3-20.3 1, Surface Ship Survivability, Chapter 4, Damage Control Communications*.

079-37.1.2 SOUND-POWERED TELEPHONE SYSTEM. The sound-powered telephone system provides the principal means of communications for damage control operations. This system operates without any external source of energy other than that provided by the talker's voice. A listing of circuits in the sound-powered telephone system is described in [Table 079-37-1](#).

079-37.1.3 FUNCTIONAL CLASSIFICATION OF CIRCUITS. Sound-powered telephone system circuits are classified according to functions as described in the following paragraphs.

079-37.1.3.1 Primary. These circuits provide communication for primary control and operating functions associated with ship control, weapons control, aircraft control, engineering and damage control.

079-37.1.3.2 Auxiliary. These circuits provide alternate means of communication for certain of the principal primary circuits in the event of damage to either a portion of a circuit or to the entire circuit.

079-37.1.3.3 Supplementary. These circuits provide the means of communication for various subordinate control, operating and service functions.

079-37.1.3.4 Emergency. These circuits provide communication for information required by the engineer and damage control officer(s) during emergencies, either to establish temporary communication required because of damage or for the control of emergency equipment.

079-37.1.3.5 Miscellaneous. These circuits provide a means of communication for information of direct concern to the engineer and damage control officer(s).

079-37.1.4 PRIMARY CIRCUITS. The primary sound-powered telephone circuits assigned specifically for damage control communications are described in the following paragraphs.

079-37.1.4.1 JA - Captain's Battle Circuit. This circuit provides communication between the commanding officer and various department heads during general quarters and condition watches.

Table 079-37-1 SOUND-POWERED TELEPHONE CIRCUITS

CIRCUIT	CLASSIFICATION	PURPOSE
JA/NET 51	Primary	Captain's Battle; all Control Stations
1JG/NET 12	Primary	Aircraft Control
3JG	Primary	Aircraft Service
4JG1	Secondary	Aviation Fuel Control
4JG2	Secondary	Aviation Fueling Forward
4JG3	Secondary	Aviation Fueling Aft
JL/NET 52	Primary	Battle Lookouts
1JM	Primary	Minesweeping Operations
1JS	Primary	Sonar Control; Sonar, CIC and Bridge
1JV/NET 53	Primary	Maneuvering and Docking; Ship Control Stations
2JV	Supplementary	Engineer's Circuit (engines)
3JV	Supplementary	Engineer's Circuit (boilers)
4JV/NET84	Supplementary	Engineer's Circuit (fuel and stability)
5JV/NET 85	Supplementary	Engineer's Circuit electrical

Table 079-37-1 SOUND-POWERED TELEPHONE CIRCUITS - Continued

CIRCUIT	CLASSIFICATION	PURPOSE
6JV	Supplementary	Ballast Control Circuit
2JZ/NET 80	Primary	Damage and Stability Control; DC Central and all Damage Control Repair Stations (DCRS)
3JZ	Primary	Main Deck Repair Circuit: DC Central and DCRS 1
4JZ/NET 81	Primary	Forward Repair Circuit; DC Central and DCRS 2
5JZ/NET 82	Primary	After Repair Circuit; DC Central and DCRS 3
6JZ/NET 85	Primary	Forward Propulsion Repair/Engineers Circuit (electrical)
7JZ/NET 86	Primary	Engineer's Repair Circuit; DC Central; Main Engineering Control and DCRS 5
8JZ	Primary	Crash and Salvage Repair
9JZ	Primary	Crash and Salvage Repair
10JZ	Primary	Magazine Sprinkling and Ordnance Repair, forward
11JZ	Primary	Gallery Deck and Island Structure Repair
12JZ	Primary	Fire Pump Control
XJA	Auxiliary	Auxiliary Captain's Battle
X1JG	Auxiliary	Auxiliary Aircraft Control
X1JV	Auxiliary	Auxiliary Maneuvering and Docking
X1J2	Auxiliary	Auxiliary Damage and Stability Control
X2JZ	Auxiliary	Auxiliary Damage and Stability Control Circuit
X1J2	Auxiliary	Auxiliary Damage and Stability Control
X2JZ	Auxiliary	Auxiliary Damage and Stability Control Circuit
X6J	Supplementary	Electronics Service
X40J	Emergency	Casualty Communication (may be run anywhere)
X50J	Emergency	Fog Foam Circuit (AFFF)
X63J	Auxiliary	Electronic Service
WIFCIM AN/SRC-53(V)	Primary (where installed)	In Damage Control Repair Station area
WICS	Primary (where installed)	In Damage Control Repair Station area

079-37.1.4.1.1 Telephone outlets are provided in the following locations:

- a. Pilot House
- b. Auxiliary Conn
- c. Secondary Conn
- d. Combat Information Center (CIC)
 - 1. Surface Operations Area
 - 2. Air Operations Area
 - 3. Electronics Countermeasure (ECM) Area
 - 4. Weapons Control Area 105
- e. Weapons Coordination Center
- f. Air Intelligence Office
- g. Flight Control

h. Central Control Station

1. Engineer Officer
2. Electrical Officer
3. Damage Control Assistant
4. Main Propulsion Assistant.

079-37.1.4.1.2 As an alternate to a telephone connection to the central control station (previous h.), the captain's battle circuit might have telephone outlets in the following areas:

- a. Damage Control Central
- b. Main Engine Control
- c. Secondary Damage Control Station
- d. Ship Weapon Unit (SWU) Offices.

079-37.1.4.1.3 An XJA circuit tie switch is provided. The switchboard, or switchbox circuit switchbox, is located in the pilot house.

079-37.1.4.1.4 The JA circuit is provided in combatant ships and armed auxiliary ships.

079-37.1.4.2 3JG - Aircraft Service Circuit. This circuit provides communication between stations concerned with lubricating and servicing aircraft on the flight and hangar decks.

079-37.1.4.2.1 Telephone outlets are provided at flight control, hangar deck control, and lubricating oil stations on hangar deck and gallery deck walkways. They also are provided at lubricating oil pump controllers, flight deck control and air group maintenance control stations, crew shelters, squadron plane captain shelters, helicopter crew shelter and conflagration stations.

079-37.1.4.2.2 The switchboard or switchbox circuit is located in the flight deck control station.

079-37.1.4.2.3 The 3JG circuit is provided in aircraft carriers and amphibious assault ships.

079-37.1.4.3 4JG1 - Aviation Fuel and Vehicular Control Circuit. This circuit provides communication for the supervision of various elements of the JP-5 and gasoline systems.

079-37.1.4.3.1 Telephone outlets are provided at flight deck control and air group maintenance control stations, central control station or damage control central, secondary damage control station, aviation fuel repair team stations, JP-5 pump rooms, gas pump rooms, gasoline filter rooms, gasoline and JP-5 filling connections, gasoline motor rooms, gasoline and JP-5 fueling stations and helicopter fueling stations.

079-37.1.4.3.2 The switchbox or string circuit switchbox is located in the flight deck control station.

079-37.1.4.3.3 The 4JG1 circuit is provided in aircraft carriers and ships having helicopter platforms.

079-37.1.4.4 4JG2 and 4JG3 - Aviation Fueling Circuit Forward and Aft. These circuits provide communication for the coordination of fueling and defueling aircraft. The stations connected to each circuit are segregated in their respective switchboxes according to port and starboard circuits. Grouping switches are installed in the forward and after JP-5 pump rooms to provide a grouping of four sectors.

079-37.1.4.4.1 Telephone outlets are provided in associated forward stations, and associated after stations such as JP-5 pump rooms, gasoline pump and motor rooms, gasoline filter rooms, oxygen-nitrogen producer rooms, aircraft fueling stations, boat and vehicle fueling stations, engineering department office, central control station or damage control central, secondary damage control station, JP-5 manifolds, sounding tubes for JP-5 tanks and aviation fuel repair team stations.

079-37.1.4.4.2 The switchbox, or string circuit switchboxes, are located in their respective forward and after JP-5 pump rooms.

079-37.1.4.5 1JV - Maneuvering and Docking Circuit. This circuit provides communication for the coordination of the following ship operations: changes in engine speed, steering orders in the event of failure of the steering system, checking gyro and standard compasses, reports of derangement of steering gear system and orders to line handling and transfer-at-sea stations (except replenishment type ships).

079-37.1.4.5.1 Telephone outlets are provided in the pilot house, open bridge or bridge wings, secondary conn, central control station (engineer officer, main propulsion assistant, and electrical officer), or damage control central, secondary damage control, machinery rooms (enclosed operating station), steering gear power rooms, IC and gyro rooms, emergency steering stations, standard compass, CIC (display and decision area, surface operations area), line handling and replenishment stations and aircraft crane control station. The circuit is also provided with a docking bus for the line handling, replenishment stations, and aircraft crane control station. This bus is segregated from the maneuvering bus through a tie switch. A tie switch is provided from each bus to X1JV (auxiliary maneuvering circuit) and a tie switch from the docking bus. A tie switch also is provided to circuit 4JV (forward repair circuit).

079-37.1.4.5.2 The 1JV circuit is applicable to ships in general.

079-37.1.4.6 2JZ - Damage and Stability Control Circuit. This circuit provides means for the damage control officer to receive reports from various control stations and repair stations, and to issue orders and information to the repair stations. In ships provided with individual repair circuits, such as circuits 3JZ through 11JZ, the repair stations report to the damage control officer over the individual repair circuits.

079-37.1.4.6.1 Telephone outlets are provided at damage control central or central control station (engineer officer, main propulsion assistant, electrical officer, damage control assistant, and division supervisor) secondary damage control, all repair stations, flight control, anti-aircraft stations, conflagration stations, each missile launcher safety observer station (via 10JP-2JZ transfer switch), SWU offices, CIC, weapons control area, weapons control center, port and starboard missile launcher safety observers' stations, aviation missile movement control station and the draft gauge. An X2JZ tie-line is provided.

079-37.1.4.6.2 For ships not provided with individual repair circuits, the applicable functions and stations of those circuits are included in circuit 2JZ.

079-37.1.4.6.3 The 2JZ circuit is applicable to ships 220 feet and over in length.

079-37.1.4.7 3JZ - Main Deck Repair Circuit. This circuit provides communication with the damage control assistant and coordinating damage control operations on and above the main deck areas.

079-37.1.4.7.1 Telephone outlets are provided at repair 1, damage control central or central control station secondary damage control central, associated conflagration stations, associated battle dressing stations and each unit patrol station.

079-37.1.4.7.2 In aircraft carriers, separate circuits 3JZ1 forward and 3JZ2 aft are provided. Each circuit serves its associated stations; a tieline is provided between the circuits.

079-37.1.4.7.3 The 3JZ circuit is applicable to aircraft carriers, amphibious assault ships and cruisers.

079-37.1.4.8 4JZ - Forward Repair Circuit. This circuit provides communication with damage control central for coordinating damage control operations in the forward damage control area.

079-37.1.4.8.1 Telephone outlets are provided at repair 2, central control station or damage control central, secondary damage control central, forward battle dressing stations, forward fire pump local and remote control stations (except in ships provided with 12JZ), forward remotely-operated valve control stations, forward conflagration stations, forward local and remote valve control stations (except in ships provided with 9JZ and 10JZ), forward fog-foam stations and each unit patrol station.

079-37.1.4.8.2 The 4JZ circuit is applicable to combatant ships (frigates and larger).

079-37.1.4.9 5JZ - After Repair Circuit. This circuit provides communication with the damage control assistant for coordinating damage control operations in the after damage control area.

079-37.1.4.9.1 Telephone outlets are provided at repair 3, central control station or damage control central, secondary damage control central, after battle dressing stations, after fire pump control stations (except in ships provided with 12JZ), after remotely-operated valve control stations, after conflagration stations, after local and remote valve control stations (except in ships provided with 9JZ and 10JZ), after fog-foam stations and each unit patrol station.

079-37.1.4.9.2 The 5JZ circuit is applicable to combatant ships (frigates and larger).

079-37.1.4.10 6JZ - Amidship Repair Circuit. This circuit provides communication with the damage control assistant for coordinating damage control operations in the amidship repair area.

079-37.1.4.10.1 Telephone outlets are provided at repair 4, central control station or damage control central, secondary damage control central, amidship battle dressing stations, amidship fire pump control stations, each remotely operated valve control station, amidship fog-foam injection station and each unit patrol station.

079-37.1.4.10.2 In certain aircraft carriers and cruisers, repair parties 4 and 5 are combined into one propulsion repair party. This combination is divided into two groups, one designated "forward propulsion repair" and the other designated "after propulsion repair." The sound-powered telephone circuits provided to these two groups are described in the following paragraphs.

079-37.1.4.11 6JZ - Forward Propulsion Repair Circuit. This circuit provides communication with the damage control officer for coordinating damage control operations in the forward propulsion control area.

079-37.1.4.11.1 Telephone outlets are provided at repair 4 and repair 5 forward, central control station or damage control central, secondary damage control central, each associated amidship battle dressing station, propulsion control station, firemain, auxiliary machinery room, fire pump local and remote control station (except ships provided with 12JZ), remotely-operated valve control stations and high capacity fog-foam stations and each unit patrol station.

079-37.1.4.12 7JZ - After Propulsion Repair Circuit. This circuit provides communication with the damage control assistant for coordinating damage control operations in the after propulsion repair area.

079-37.1.4.12.1 Telephone outlets are provided at repair 4 and 5 aft, central control station or damage control central, secondary damage control central, each associated amidship battle dressing station, propulsion control station, firemain, auxiliary machinery room, fire pump local and remote control station (except in ships provided with 12JZ), remotely-operated valve control station, high capacity fog-foam stations and each unit patrol station.

079-37.1.4.13 7JZ - Engineer's Repair Circuit. This circuit provides communication for the coordination of the engineer's damage control facilities, a means of reporting machinery derangements and communication to the engineering relief crew stationed adjacent to the accesses to the engineering spaces.

079-37.1.4.13.1 Telephone outlets are provided at propulsion repair 5, central control station or damage control central, secondary damage control station, each engine room, each fireroom and each engineer's unit patrol station associated with repair 5.

079-37.1.4.13.2 The 7JZ circuit is applicable to frigates and amphibious assault ships and is normal for other surface ships.

079-37.1.4.14 8JZ - Crash and Salvage Repair Team Circuit. This circuit provides communication with the damage control assistant for coordinating damage control operations on the flight deck and helicopter landing areas.

079-37.1.4.14.1 Telephone outlets are provided at crash and salvage repair team station, central control station or damage control central, secondary damage control, associated battle dressing stations, flight control and each unit patrol station. This circuit is applicable to aircraft carriers and amphibious assault ships.

079-37.1.4.15 9JZ and 10JZ - Magazine Sprinkling and Ordnance Repair Forward and Aft Circuits. These circuits provide communication for the coordination of magazine sprinkling and reporting of ordnance derangements.

079-37.1.4.15.1 Telephone outlets are provided for communication between the associated forward stations, and between the associated after stations such as magazine sprinkling distant control station, central control station, or damage control station, secondary damage control station, CIC (weapons control area), repair 6 forward and aft stations, special weapons compartments, missile check-out compartments, weapons control stations, security stations and sprinkler valve control stations. Circuit 9JZ is provided with a 10JZ tie and tie CO switches.

079-37.1.4.15.2 The 9JZ and 10JZ circuits are applicable to combatant ships (cruisers and larger).

079-37.1.4.16 11JZ Gallery Deck and Island Structure Repair Circuit. This circuit provides communication for the coordination of damage control facilities on the gallery deck and island structure.

079-37.1.4.16.1 Telephone outlets are provided at central control station, secondary damage control, gallery deck and island structure repair station 7, unit patrol stations and battle dressing stations.

079-37.1.4.16.2 The 11JZ circuit is applicable to aircraft carriers.

079-37.1.4.17 12JZ - Fire Pump Control Circuit. This circuit provides communication for the control of fire pumps and for the maintenance of firemain pressure in the event of damage.

079-37.1.4.17.1 Telephone outlets are provided at damage control central or central control station, secondary damage control central, each conflagration station and each fire pump local and remote control station.

079-37.1.4.17.2 This circuit is applicable to aircraft carriers and amphibious assault ships.

079-37.1.5 AUXILIARY CIRCUITS. The auxiliary sound-powered telephone circuits provide an alternate means of communication in the event of damage to the associated primary circuits. Their wiring is run in separate cables installed as remote as possible from the primary circuit cables. Tie-lines provided between associated primary and auxiliary circuits originate at the TIE + SW (normally closed) on the auxiliary circuit bus and terminate in the TIE SW (normally open) on the primary circuit bus.

079-37.1.5.1 Procedures. In the event of damage to a portion of the primary circuit the TIE SW should be closed, and communication will be maintained after the stations which were lost have plugged in their telephones to the auxiliary circuit outlets. In the event a major portion of the primary circuit is lost, the TIE + SW should be opened, and communication should be maintained over the auxiliary circuit after all stations have plugged in their telephones to the auxiliary circuit outlets. These circuits are described in the following paragraphs.

079-37.1.5.2 XJA - Auxiliary Captain's Command Circuit. This circuit provides an alternate communications link between the same stations listed under the JA circuit. This circuit is applicable to combatant ships (cruisers and larger).

079-37.1.5.3 XJA - Auxiliary Captain's Battle Circuit. This circuit provides an alternate means of communication between the same stations specified for circuit 1JG, with a tie CO switch to circuit 1JG provided.

079-37.1.5.4 X1JV - Auxiliary Maneuvering and Docking Circuit. This circuit provides an alternate communications link between the same stations served by the maneuvering portion of 1JV circuit. This circuit is applicable to combatant ships (destroyers and larger), tenders and large repair ships.

079-37.1.5.5 X2JZ - Auxiliary Damage and Stability Control Circuit. This circuit provides auxiliary communications between the same stations served by the 2JZ circuit. This circuit is applicable to combatant ships (cruisers and larger).

079-37.1.6 SUPPLEMENTARY CIRCUITS. The telephone circuits described in the following paragraphs are primary circuits as related to their principal functions. They are considered supplementary only in their relation to damage control, and for the purpose of this section, are so considered.

079-37.1.6.1 2JV - Engineer's Circuit (Engines). This circuit provides communication for the coordination of the propulsion plant, auxiliary machinery, refrigeration machinery, air-conditioning machinery, catapult control rooms, reporting condition of propulsion shaft bearings and stuffing glands and other reports to the propulsion repair station.

079-37.1.6.1.1 Telephone outlets are provided in central control station (engineer officer, main propulsion assistant), machinery rooms (EOS), engineering department office (log room), auxiliary machinery room, refrigeration machinery, air-conditioning machinery rooms, catapult control rooms, smoke watch, shaft alleys and damage control repair station 5.

079-37.1.6.1.2 In those ships not provided with individual engineer's circuits 3JV, 4JV and 5JV, the applicable functions and stations of those circuits are included in circuit 2JV.

079-37.1.6.1.3 This circuit is applicable to ships with separate machinery spaces.

079-37.1.6.2 3JV - Engineer's Circuit (Boilers). This circuit provides communication between stations involved with the operation of the steam generating plant.

079-37.1.6.2.1 Telephone outlets are provided at central control station, auxiliary control engine room, boiler operating stations, water tender's station, main feed water and booster pumps, smoke watch and propulsion repair 5.

079-37.1.6.2.2 This circuit is applicable to combatant ships (cruisers and larger).

079-37.1.6.3 4JV - Engineer's Circuit (Fuel and Stability). This circuit provides communication for the coordination of the transfer of fuel and ballast, for reporting soundings of fuel tanks and for fueling at-sea operations.

079-37.1.6.3.1 Telephone outlets are provided at central control station (engineer officer, main propulsion assistant, and oil king) or damage control central, secondary damage control station, propulsion repair 5, pump rooms, fuel oil manifolds, combustion control repair shop and test laboratory, fuel oil fueling stations, fuel oil sounding tubes, fueling-at-sea stations and piston engine aviation lube oil main stowage tank station.

079-37.1.6.3.2 This circuit is applicable to combatant ships (cruisers and larger).

079-37.1.6.4 5JV - Engineer's Circuit (Electrical). This circuit provides communication for the coordination of electrical power distribution.

079-37.1.6.4.1 Telephone outlets are provided at central control station (engineer officer, main propulsion assistant, electrical officer), switchboard rooms (including load center switchboard rooms), catapult power panels, deck-edge elevator machinery rooms, missile power rooms, auxiliary machinery rooms, emergency generator room, IC and gyro rooms, steering gear rooms, machinery rooms (enclosed operation station), secondary damage control station and propulsion repair station 5.

079-37.1.6.4.2 This circuit is applicable to combatant ships (frigates and larger).

079-37.1.6.5 6JV - Ballast Control Circuit. This circuit provides communication for the coordination of ballasting and deballasting operations.

079-37.1.6.5.1 Telephone outlets are provided in the pilot house, engineering department office (log room), damage control central, ballast control room, air deballasting compressor rooms, cargo control station, each sea valve hydraulic control station and circuit 6JV-2JZ tie switch.

079-37.1.6.5.2 This circuit is applicable to combatant and auxiliary type ships provided with a ballasting-deballasting system.

079-37.1.7 EMERGENCY CIRCUITS. Emergency sound-powered telephone circuits provide a means of establishing necessary communication lines after casualty has occurred and are described in the following paragraphs.

079-37.1.7.1 X40J - Casualty Communication Circuit. This circuit provides a means of rigging communications lines between vital stations during an emergency condition.

079-37.1.7.1.1 Permanent vertical riser cables are installed between single telephone jackbox assemblies (port and starboard) in certain below deck stations, and corresponding four-gang telephone jackbox assemblies (port and starboard) on the first weather deck above each below deck station (hangar deck in aircraft carriers). The jack-outlets in each four-gang jackbox assembly are connected in parallel. Below deck stations include central control stations (or damage control central), engine rooms, firerooms, steering gear rooms, emergency generator rooms, auxiliary machinery rooms and IC rooms.

079-37.1.7.1.2 On aircraft carriers, four-gang jackboxes are installed port and starboard on the forward and after sides at each hangar division door. The respective forward and after jackboxes are permanently connected and are used to facilitate patching when the doors are closed.

079-37.1.7.1.3 Four 200-foot lengths of telephone cable, having a telephone plug at each end, are contained on reels and stowed in each repair party locker. The portable cables are used to rig communication lines between the topside jackboxes and from these jackboxes to stations requiring emergency communication.

079-37.1.7.1.4 Two sound-powered telephone headsets and eight two-gang telephone jackboxes (jacks wired in parallel) are stowed in each repair party locker. Each topside jackbox is provided with an information plate identifying the circuit and the associated below-deck station.

079-37.1.7.1.5 This circuit is applicable to combatant ships, and auxiliary ships fitted with weapons, 200 feet and over in length.

079-37.1.7.1.6 Some Naval ships are provided with telephone cables having jackbox outlets built into the cable ends. Separate eight two-gang telephone jacks are not provided on these ships.

079-37.1.7.2 X50J - Fog-Foam Circuit. This circuit provides communication between associated conflagration stations, fog-foam injection stations and each fog-foam outlet.

079-37.1.7.2.1 Telephone outlets are provided in conflagration stations, fog-foam injection stations and at each fog-foam outlet.

079-37.1.8 INTERIOR COMMUNICATIONS SYSTEMS. These systems provide a fast and direct means of communication between stations. They must be energized from an electrical source. [Table 079-37-2](#) lists those circuits of the interior communication system which have damage control applications.

Table 079-37-2 INTERIOR COMMUNICATION CIRCUIT

Circuit	System
DG	Remote draft indicator
F	High temperature alarm
9F	High temperature alarm, ASROC
FD	Flooding alarm
FH	Sprinkling alarm
FR	CO ₂ release alarm
FZ	Security alarm
G	General and chemical attack alarm
1MC	General announcing
4MC	Damage control announcing
21MC	Captain's command announcing
26MC	Machinery operations control announcing
29MC	Sonar control and information
30MC	Special weapons control

079-37.1.8.1 DG - Remote Draft Indicator System. This system provides a means of indicating the draft of the ship at a specific location. The installation consists of a pressure-operated transmitter at a designated location in the ship's hold and an operating air indicator installed adjacent to the profile draft indicator.

079-37.1.8.2 F - High Temperature Alarm Systems. This system provides a means of indicating the presence of high temperatures in certain compartments.

079-37.1.8.2.1 The installation consists of two or more thermostats, of several types located in the following compartments: pilot house, damage control station or central control station, IC gyro, magazines (and other compartments where ammunition or critical propellants are stowed), ready service rooms, handling rooms, check-out areas, flammable liquid storerooms, paint mixing and issue rooms, compressed gas stowage compartments, aviation storeroom and other storerooms containing flammable materials and nuclear facilities (other than weapons), cargo holds, cargo spaces and helicopter hangar.

079-37.1.8.2.2 In addition to thermostats, manually-operated lever switches are installed in each conflagration station and OOD station in aircraft carriers, amphibious assault ships and at each exit from helicopter hangars.

079-37.1.8.2.3 Audible and visual extension alarm signals are installed in the pilot house, each deck office (OOD Station), secondary damage control and each IC room.

079-37.1.8.2.4 In aircraft carriers, the special weapons unit compartments are provided with a separate installation for forward and after compartments. A separate installation also is provided for airborne systems support center S-D shop and the aviation photo interpretation storeroom.

079-37.1.8.3 9F - High Temperature Alarm System (ASROC). This system provides a means of indicating when the temperature in the ASROC launcher cells is above or below specified limits.

079-37.1.8.3.1 The installation consists of eight sets of thermostatic switches (one set installed in each launcher cell) connected to activate audible and visible alarm signals on an alarm switchboard installed in the ASROC launcher station.

079-37.1.8.3.2 Extension signals (common high and low temperature) are provided by connections to two-line units of the alarm switchboard (circuit F). A resistor is connected across the contacts of each extension signal relay to provide for the supervisory feature of the alarm switchboard in damage control central.

079-37.1.8.4 FD - Flooding Alarm System. This system provides a means of indicating that the level of water in a monitored compartment is above the limits prescribed for the required conditions.

079-37.1.8.4.1 The installation consists of magnetically-operated liquid level switches. The operation of the switches activates visual and audible alarm signals in the engineering operating station.

079-37.1.8.5 FH - Sprinkling Alarm System. This system provides an indication of leakage or flow of water in the sprinkling system lines serving compartments specified by NAVSEA.

079-37.1.8.5.1 There are two types of sprinkling systems: one a dry type, the other a wet type. The dry-type system is provided in all conventional ammunition magazines, handling rooms and similar areas. The wet-type system is provided in all missile and nuclear magazines as specified by NAVSEA.

079-37.1.8.5.2 The dry-type system consists of a water switch installed in the piping system at the dry side of each sprinkler control valve. Where projectile hoists are provided with sprinkling systems, a water switch is installed at the top and bottom of the hoist. Each switch activates audible and visual alarm signals on the alarm switchboard specified.

079-37.1.8.5.3 The wet-type system consists of a water switch installed in the fresh water accumulator tank, and a pressure-operated switch installed in the supervisory pipe line to the sprinkling headers. The switches are connected in parallel to activate audible and visual alarm signals on the alarm switchboard specified.

079-37.1.8.6 FR - Carbon Dioxide Release Alarm. This system provides an indication when CO₂ is released in compartments protected by a fixed CO₂ flooding system.

079-37.1.8.7 FZ - Security Alarm System. This system provides an alarm at remote stations when unauthorized entry is attempted at certain security areas or when an attempt is made to disable the system.

079-37.1.8.8 G - General and Chemical Attack (as in previous table) Alarm System. This system provides an alarm which sounds throughout the ship. The installation consists of a self-locking manual-release lever-operated switch installed in the pilot house, auxiliary steering station, and each deck office, connected to activate 8-inch or 10-inch bells in all living and working compartments and all recreational areas. The power is supplied by batteries.

079-37.1.8.9 1mc - General Announcing System. This system provides a means of transmitting general orders, information and alarm signals to all areas in the ship and to all topside areas where personnel are stationed or may normally be located.

079-37.1.8.9.1 The installation consists of an amplifier-oscillator group located in the IC and gyro room, a microphone control station and portable microphones at each of the following stations: pilot house, Secondary conning station (when station is enclosed), and deck offices (OOD stations), with loudspeakers in quantities and types to provide satisfactory sound coverage.

079-37.1.8.9.2 The following alarm signals, as applicable, can be transmitted over all loudspeakers. The priority of the alarms shall be in the following order:

- a. General Alarm
- b. Chemical Attack Alarm
- c. Collision Alarm.

079-37.1.8.10 4MC - Damage Control Announcing System. This system provides communication between central control station or damage control central, secondary damage control station and repair party stations and between each repair party station and its associated repair party patrol areas.

079-37.1.8.10.1 Units are installed in central control station or damage control central, secondary damage control station and each repair party station and unit patrol areas.

079-37.1.8.10.2 To provide communication between repair party stations and their respective repair party patrol areas, the intercommunication units are provided with selection switches as required.

079-37.1.8.11 21MC - Captain's Command and Announcing System. This system provides communication for the issuing of ship control orders and information between the pilot house and principal control and operating stations. Units are installed in the pilot house (with parallel units at the captain's chair or OOD and tactical desk), enclosed secondary conning station, exposed conning station, captain's tactical plot, CIC (CICO, display and decision area, surface operations area, weapons control area, ASW control area, and air operations area), flight control station, central control station (engineer officer) or main propulsion control station and damage control central, special weapons coordination center, signal bridge, air intelligence office, surface look-out station, fly and debarkation control station, anti-aircraft station, helicopter direction center, hangar and flight deck control station, helicopter control station, message processing center, radio central, director control officer and ballast control station.

079-37.1.8.12 26MC - Machinery Control Announcing System. This system provides communication between machinery operating stations.

079-37.1.8.12.1 Units are installed in the engineering department office, central control station (engineer officer and main propulsion assistant), each engine room, each fireroom, each auxiliary machinery room and propulsion repair 5.

079-37.1.8.12.2 In ships not provided with 23MC circuit, the stations associated with electric power generation and distribution are included in the 26MC system.

079-37.1.8.13 29MC - Sonar Control and Information System. This system provides communications between stations.

079-37.1.8.14 30MC - Special Weapons Control Announcing System. This system provides for two-way transmission of orders and information between special weapons magazines and SWU offices. Intercommunication units are installed in SWU offices (2 units), weapons coordination center (coordinator and weapons employment officer in parallel), CIC (air operations areas), aviation missile office, aviation ordnance officer, special weapons magazines and central station or damage control central.

079-37.1.9 SHIP'S SERVICE TELEPHONE SYSTEM - J CIRCUIT. Ship's service telephones are available for use where they are installed at or near repair stations. Repair personnel should not rely on them too much because they are not part of a rugged battle system and may be out of commission early in action. If sound-powered telephones, intercommunications and ship's service methods using portable telephone systems should fail, alternate methods using portable telephones and messengers must be organized.

079-37.1.10 WIRE-FREE COMMUNICATIONS (WIFCOM). DC WIFCOM is a non-secure, limited range, UHF communications system consisting of an antenna system, portable transceiver units, base stations and scanners. It uses the same frequencies to transmit and receive. WIFCOM units are hand-held, battery-powered two way radios. These units may be used as the primary means of communication between repair party personnel and between the repair station and damage control central. Because of the wire-free nature of these units they are more likely to survive damage intact than wired units. The requirements for users of WIFCOM are the same as those provided in [paragraph 079-37.4](#) for phone talkers. For detailed operating and maintenance instructions, see the manufacturer's manual provided with the unit.

079-37.2 MESSENGER SERVICE

079-37.2.1 Repair party personnel should be trained as messengers for relaying orders and information. When all electronic methods of communication have failed, messengers shall be employed. The damage control organization is to provide for messengers. A written message is more reliable than an oral message. However, messengers are to be trained to convey oral orders without error.

079-37.3 DAMAGE CONTROL SYMBOLOGY/PLOTTING

079-37.3.1 DC symbology is the "shorthand" used by the DC organization to communicate and plot damage throughout the ship. Damage control plots are used to illustrate the ship's overall survivability status. Plotting is done on the DC subdivision plates to summarize the damage in each compartment. The standard handwritten

symbology used for DC reports and plotting techniques is found in [Appendix B-1](#). The standard computer-generated symbology used for damage control action management (DCAMS) electric reports and casualty plotting is found in [Appendix B-2](#).

079-37.4 TELEPHONE TALKERS

079-37.4.1 MANNING. Telephones are to be manned promptly at general quarters by personnel first arriving on the station. Until communications are established, the damage control organization may not function in an orderly manner. Several talkers should be trained for each station.

079-37.4.2 TALKER PERSONNEL. Regardless of rating, a telephone talker shall be able to speak clearly and receive messages intelligently despite outside noises and distractions. The talker shall be thoroughly familiar with the type of information to be transmitted on the circuit to which assigned and be able to use standard damage control manual plotting symbols to maintain either a talker log or a status board which can be read and clearly understood. The talker/plotter must be familiar with using standard casualty icons for electronic plotting referenced in [Appendix B-2](#) and embedded in DCAMS.

079-37.4.2.1 Drilling. During cruising conditions at sea, a telephone watch normally is not an exciting watch. There is a tendency for the talker to become bored and careless. The talker shall be kept alert by frequent instructions and drills.

079-37.4.2.1.1 As a drill, it is a good idea to parallel circuits and have excerpts from damage control publications read to all talkers during each watch. The messages are to be read through once, without repeating, at a normal writing rate. Talkers are to be required to write the message and read it back to the damage control station. The drill is to be made competitive so a stimulus is provided. A sample preprinted message form is shown in [Appendix B](#).

079-37.4.2.1.2 Reading from damage control publications has the added advantage of acquainting the talker with damage control nomenclature, systems and subject matter. The message is to be transmitted slowly enough for the receiver to write the message. A good training procedure is for the person transmitting to write the message as he reads. Otherwise it will be found that the rate of transmission is faster than the average person can write. There is no advantage in a fast transmission if, at the conclusion of the transmission, the receiver has only partially received the message and asks for a repeat. Considerable time is lost in repeating a message, so there is a delay before action can be taken. The aim of damage control communications is to transmit orders and information expeditiously and correctly. All instructions and procedures contained in [Appendix B](#) are to be observed during both training and operational conditions.

079-37.4.2.2 Rules. Some general rules for telephone talkers are given in the following paragraphs.

- a. Be alert. Pay attention to what is said over the telephone. A written log of the activities of other stations on the circuit is to be maintained so the station properly can assume control for damage and be informed of the activities of all other stations. Pay attention to the officer or petty officer in charge of the station.
- b. Repeat all messages word for word. Messages shall not be paraphrased. Changing of a single word can often change the meaning of an entire message.
- c. Do not indulge in idle conversation on the telephone. Keep your mind and actions on your assigned duty. Do not smoke. You can't talk and smoke at the same time.

- d. Speak into the transmitter in a loud clear voice. Do not shout or whisper into the telephone: shouting will result in mushy and slurred words; a whisper cannot be heard. Enunciate words distinctly. Pronounce every syllable. Restrict dialect or exaggerated accents.
- e. When using the headset, hold the button down when talking. Do not touch it when listening. When the handset is used, hold the button down for both speaking and listening.
- f. Hold the transmitter about 1/2-inch from the mouth when talking, to ensure most effective communication.
- g. An ear piece may be used as a transmitter in the event something goes wrong with the transmitter. (In such instances, the button is not used.)
- h. Test the circuit regularly. A line may go dead as a result of damage or faulty equipment. Unless tested regularly the talker may be unaware of this fact and fail to receive an important message. The talkers at repair stations may restore a dead circuit by opening the switch that ties in the faulty line to the telephone switch-box.
- i. Never secure your station until properly relieved or released by the officer or petty officer in charge of your station.
- j. Talkers are important members of the repair party. Each shall be familiar with the duties of the repair party, with damage control phraseology, nomenclature, damage control systems and the duties of the repair party. Such knowledge will enable each talker to perform duties more efficiently.
- k. Strive to be the best talker on the circuit. Confidence in the ability of the talker is reflected in the efficiency of the repair station.

079-37.4.3 STANDARD PHRASES AND PRACTICES. It is not enough to train talkers for the individual ship. Because of the high turnover of personnel aboard ships, training shall be along standard lines in order to fit into the organization of ships to which they may be transferred. Following are some standard phrases that shall be learned:

- a. All Stations - (name your station) - Testing.
- b. Bridge (or station you are calling) - Damage Control (or the name of your station).
- c. Say Again. If the message is not understood do not say, "Control, would you please repeat all after the word..." Keep the text of the message to a minimum but do not sacrifice its meaning.
- d. Silence. All stations immediately maintain silence. Care should be exercised in authorizing this command. The damage control assistant may reserve the exclusive right to use this command or may permit a station with a priority order, command or message to use it when other stations are talking to each other. Control of the circuit is of paramount importance.

079-37.4.3.1 Testing. As stations are manned at general quarters, all communications systems should be tested. Damage control central sends out the following message: "All stations, central phone check." Repair parties then answer, "Repair two, loud and clear," - "Repair three, loud and clear" and so forth. All other circuits are tested in the same manner. All stations are to be checked off to ensure that communications with them have been established. If a station fails to answer, the difficulty could be the telephone at that station; therefore, they must be contacted by messenger and directed to shift telephones. When communication is not established, the DC repair station talker will shift telephones immediately. Once all personnel have reported to the DC repair station, the talker will contact DC central, stating, "Repair two, manned and ready," "Repair three, manned and ready" and so forth.

079-37.4.3.2 Data Requirements. In general, messages are divided into the following three parts:

- a. Name of the station called
- b. Name of the station calling
- c. The message.

These steps follow in order without waiting for an acknowledgement from the station called. Stations will acknowledge the message after it has been received and is understood. The standard procedure of calling the station addressed first, then identifying yourself, must always be observed.

079-37.5 CARE OF TELEPHONES

079-37.5.1 INSTRUCTIONS FOR CARE. In most ships, telephones are the primary means of communication. They are essential to the operation of the ship. When the telephone is in use, observe the following precautions:

- a. Do not allow wire leads to dangle or permit the weight of the equipment to hang on them.
- b. Keep the wire leads free from turns and kinks.
- c. Put the headset on before plugging into the jackbox.
- d. See that plug is straight in the jackbox and that it is tight.
- e. Be careful with the wire leads. Do not allow anyone to walk on them or allow trucks or dollies to run over them. See that they do not become fouled. Do not put a strain on them.
- f. Adjust ear pieces to fit the head.

079-37.5.2 SECURING THE PHONE. The following procedures are followed when securing the telephone:

1. Disconnect the jack-plug from the receptacles before removing head set. (When being relieved, remove and hand entire phone set, using both hands, to relief.)
2. Remove the head band and ear pieces from the head.
3. Place the metal head band over the metal arm from the breast plate to the transmitter.
4. Place the head band over the arm from the chest plate to the transmitter and coil the wire leads around the assembly.
5. Wrap the neckstrap around the wire leads, head band and transmitter arm, then secure to the catch on the chest plate.
6. Stow the telephone in the box provided. See that ear pieces and transmitter do not touch metal inside the box.
7. Close and secure the box. This is important in order to keep water out and to avoid shorting the telephones, as well as to prevent deterioration of the rubber wire leads.
8. Place cap on the jackboxes. Dampness, dirt and foreign matter will short out the jackbox or prevent tight connections.
9. Do not let telephones hang by the wires connecting chest plate to the ear pieces.
10. Do not attempt to repair telephones. When they do not work properly, have them replaced with a good set.

079-37.5.3 PROPER STOWAGE. Telephones, though rugged, must be treated with care. Their replacement is difficult and sometimes impossible. Proper care when handling and using telephones, combined with proper stowage, will prolong usefulness and life.

079-37.6 COMMUNICATIONS AND CHAIN OF CONTROL

079-37.6.1 CHAIN OF CONTROL. Each ship shall designate a DC repair station as secondary DCC. In addition, a complete succession to command of damage control will be promulgated and posted in each repair station. Physical location of each station, seniority of the repair station officer and the communications facilities available should each be considered when designating succession to command. Every ship must also establish a permanent line of succession to control damage in the event DCC becomes a casualty. There must be no possibility of losing control. The chain must be widely understood and tested to the last station that could assume control.

079-37.6.2 DAMAGE CONTROL CENTRAL OUT OF COMMISSION. In order to test the efficiency and speed with which stations can take over control, DCC may simulate being out of commission by not answering to communications. The next station in the chain of control, by testing at regular intervals, should soon discover that DCC is out, when they can communicate with other repair stations and cannot contact DCC by any means. They are then to take over the control and notify all other repair stations, the commanding officer, and main engine control. This information must be positive and there must be no doubt who has control. After assuming control, an investigating party is to be sent to DCC. This procedure must be followed until all stations have succeeded to control and have exercised this control properly. DCC can resume control by saying, "Damage control central taking over control" and receiving proper acknowledgements. This drill must emphasize the necessity for keeping written logs of all information and orders given by DCC, whether or not it applies to the specific station. In order to act intelligently, when a repair station succeeds to control, it must know what casualties all other stations are handling.

079-37.6.3 DAMAGE CONTROL COMMUNICATION BILL. A recommended type of bill lists circuits alphabetically with the location of their outlets. The systems are also cross-indexed, listing individual stations and showing the various circuits installed at these stations. This information not only duplicates the damage control circuits shown on communication diagrams, but also lists all sound-powered telephone circuits in the ship. It is not enough to list the circuits and locations as shown on the diagram. The bill must be created by actually sighting the circuits and locations. This physical check validates the diagram and can find unrecorded changes.

079-37.6.4 ACTION CUTOFF SWITCHING. When preparing the communication bill and organizing for the use of alternate circuits when damage causes loss of communication on primary circuits, it is necessary to recognize the importance of action cutout switches. All telephones in a circuit are connected in parallel; consequently, if any one telephone, cable, jackbox or any component part of that circuit should become short-circuited, all communication on the circuit is lost until the affected portion is isolated. Isolation may be accomplished by means of action cutout switches in the respective circuit switchboxes or on the telephone switchboard. The switches can prevent partial or total loss of communication if their operation and importance are fully recognized.

079-37.6.5 FLEXIBILITY OF DAMAGE CONTROL COMMUNICATIONS. The vulnerability of the communications on which damage control largely depends for its reports has been demonstrated in action. Various methods of communication in the ship must be so thoroughly understood that, should the communication system or circuit normally used become damaged, other available communication system circuits can readily be utilized. All communication systems must be tested periodically.

079-37.6.6 FAMILIARITY WITH VARIATIONS IN INDIVIDUAL SYSTEMS. In all damage control communications systems on every Naval ship, designers have provided those features which impart resistance to damage in as great a degree as is compatible with the system concerned, the size of the ship and its general design. The systems in large combatant ships offer more opportunity for incorporation of such measures than do those in small ships or auxiliaries. Thorough familiarity with the designer's aims will assist the damage control assistant of any ship to obtain the best results from the damage control communications systems in the ship, both in maintaining a condition of readiness (maximum resistance) before damage and in restoring vital services after damage.

079-37.6.6.1 The damage control communications systems as described in this section are not typical of any specific ship. There can be considerable variation in individual systems in ships of a specified class as a result of alterations and improvements to individual ships.

079-37.6.6.2 Familiarity with each system is requisite for successfully fighting the ship. When inspecting a damage control communications system in a specific ship, it is important to assess the general damage resistance features, the capabilities and limitations of the system, its weakness and sources of possible trouble and to define the means of handling possible damage.

SECTION 38.

DAMAGE CONTROL TOOLS, EQUIPMENT AND MATERIALS

079-38.1 GUIDANCE FOR USE

079-38.1.1 AVAILABILITY. Due to the possibility of fires, explosions, flooding and battle damage, it is essential that proper tools and equipment are available to combat casualties and make repairs. The types of equipment and material required to make repairs will vary based on the nature of the damage. Since several types of damage can occur aboard ship, damage control personnel must know how and when to use the wide variety of equipment and materials provided to the damage control organization. A reliable program is required to ensure that all damage control tools, equipment and materials are on hand, available, in good condition and properly stowed when not in use. Repair party personnel are personally responsible to the damage control assistant to ensure that repair parties have all equipment and materials required by the allowance equipage lists (AELs). Defects discovered should be repaired immediately by repair party personnel. If unable to make certain repairs, repair facilities must be called upon promptly to effect them. Prompt submission of requests to requisition equipment and materials which require replacement is imperative. This section discusses where to find information concerning the tools, equipment and materials used to effectively administer damage control.

079-38.2 EQUIPMENT FOR SHIPBOARD DAMAGE CONTROL

079-38.2.1 DAMAGE CONTROL EQUIPMENT CATEGORIES. Damage control equipment is subdivided into the categories of personnel protection, firefighting, CBR-D, gas free engineering and damage control.

079-38.2.2 PERSONNEL PROTECTIVE EQUIPMENT. Protective clothing and equipment are critical to successful survival, safety and rapid response by personnel to shipboard casualties. As such, all personnel shall wear long-sleeved uniform items when underway. Detailed descriptions and information concerning personnel protective clothing and equipment is found in *NSTM Chapter 077, Personnel Protection Equipment*.

079-38.2.3 FIREFIGHTING EQUIPMENT. Detailed descriptions and information concerning firefighting equipment will be found in *NSTM Chapter 555, Firefighting, Volume 1 and Volume 2* .

079-38.2.4 CBR-D EQUIPMENT. Detailed descriptions and information concerning CBR-D equipment is found in *NSTM Chapter 470, Shipboard B W/CW Defense and Countermeasures* .

079-38.2.5 GAS FREE EQUIPMENT. Detection equipment and testing procedures for toxic gases are discussed in detail in *NSTM Chapter 074, Volume 3, Gas Free Engineering* .

079-38.2.6 DAMAGE CONTROL EQUIPMENT REFERENCES. Several references are available to help manage onboard damage control equipment. A brief description of each follows:

079-38.2.6.1 Damage Control Allowance Equipage Lists (AELs). The DC AELs determine the damage control equipment outfitting requirements for ships and provide the standard inventory requirements for damage control spaces aboard U S Navy surface ships. The DC AEL User's Guide, available through NAVSEA, provides guidance on how to read and understand DC AELs. The DC AELs are organized to create a fleet standard and uniform inspection standard that will provide commonality among all ship classes, increase familiarity with equipment for personnel conducting DCRS inventories and maintain repair locker stowage for rapid response. These AELs are first organized by the number of repair stations, then subdivided into kits organized by the equipment's function.

079-38.2.6.2 Damage Control Operating Space Items Management System (DC-OSIMS) Software. This software package is the repair station logistics support management tool designed to monitor onboard allowances, on-hand materials and equipment and shortage or excess asset determination. In addition to the software, the initial package comes with a detailed user's manual and installation instructions. DC-OSIMS shall be used for inspection purposes, since it is an extract of the DC AELs in the weapons systems file.

079-38.2.6.3 Inventory Aid Booklet for Damage Control Equipment (S5090-BL-DCB-010). Because most ships in the fleet have three DCRSs, this booklet provides damage control equipment illustrations (listed in alphabetical order) for a three-DCRS-ship parent AEL. (Equipment is also listed in the same order as the parent DCRS AELs for ships having 4, 5, 6, 7, 8 and 9 DCRSs. Variations exist in the parent AELs for ships with modified DCRSs, 1 DCRS and 10 DCRSs.) The DC kit AELs section of the booklet assumes the same equipment for each ship class. The DC kits sections are followed by DC unit lockers (DCULs), DC unit patrol stations (DCUPSs), DC rescue and assistance/re-entry lockers (DCRELs), shoring supplement kits, safety and survivability non-developmental items (NDI), equipment and a deleted items section. There is a helpful hints statement as well as the quantity required for each item in the booklet. This inventory aid booklet is updated via change pages when damage control equipment is added, deleted or improved. Damage control personnel are authorized to make copies to assist with shipboard DC repair stations inventories. It is recommended that a hard copy of the ship's AELs be placed with each kit in the booklet for use as a ready inventory reference.

079-38.2.6.4 Damage Control/Firefighting Equipment Layout Booklet (SS-100-AG-MAN-010). This booklet conveys the means to rapidly set up equipment for the functions of access, dewatering, desmoking, shoring, hull repair, pipe patching, personnel protection and firefighting. The layouts presented in the booklet provide shipboard repair party personnel with effective ways of utilizing damage control repair station equipment when combating casualties involving flooding, smoke and fire. The booklet also assists shipboard personnel in training or in actual emergencies to identify equipment setups. The sketches included illustrate the intended use of the equipment so that repair party personnel can gather the proper equipment and arrange the layout as required.

079-38.2.6.5 Stowage Aid Booklet for Damage Control Equipment (S5090-B1-MM0-010). This booklet assists shipboard DC personnel in planning, developing and manufacturing DC equipment, stowage devices and brackets to improve the ship's overall damage control casualty reaction time. It illustrates acceptable passageway stowages for DC equipment by functions such as firefighting, desmoking, dewatering and shoring.

079-38.2.6.6 Damage Control Action Management Software (DCAMS). This damage control management software program provides shipboard personnel with the ability to map and track portable, consumable and fixed damage control equipment and personnel during normal and casualty operations. For a more specific description of DCAMS, see [Section 39](#), Damage Control Automation and [Appendix B-2](#), Standard Symbolology for Damage Control Computer Casualty Reporting and Plotting.

079-38.2.6.7 Damage Control Watertight Closures Inspection, Maintenance and Repair Booklet (S9169-AW-DCB-101). This booklet serves as a reference document for Navy watertight closures. It should be used to assist with training, maintenance and repair of watertight closures for the shipboard program. The booklet will enable personnel to supplement current requirements, guidance and PMS to help improve shipboard watertight door, hatch and scuttle maintenance. (It is in no way to be considered a replacement for established PMS procedures). The booklet also explains watertight closure functions and inspection techniques and allows cross-referencing of vendor part numbers to NSNs which simplifies repair acquisition. It contains a comprehensive list of repair parts and repair kits cross-referenced by NSNs and all known commercial sources.

079-38.2.7 MANUFACTURERS' INSTRUCTION BOOKS. This volume of *NSTM Chapter 079* contains general instructions for the operation, maintenance and repair of damage control equipment. However, not all equipment can be covered, because of the great number of makes, types and designs found aboard ship. Equipment manufacturers supply instruction books for most equipment. Each instruction book should be studied carefully before the equipment is operated or serviced. If conflicts arise between the instructions given in this volume and the manufacturers' instructions, contact NAVSEA to resolve the issue.

079-38.3 DAMAGE CONTROL HAND TOOLS

079-38.3.1 HAND TOOLS AND EQUIPMENT REMINDERS. To ensure that the necessary tools are available and in useable condition it is important to properly care for them. Following is a checklist to assist with this responsibility:

- a. Make sure that all tools and equipment used by personnel in the workplace are in good condition.
- b. Replace or recondition hand tools (such as chisels, punches, etc.) which develop mushroomed heads during use.
- c. Replace broken or fractured handles on hammers, axes and other tools with handles.
- d. Replace worn or bent wrenches.
- e. Use appropriate handles on files and similar tools.
- f. Promptly clean, dry and lubricate hand tools used in and around wet environments.
- g. Wear appropriate safety glasses, face shields and other job-specified safety protection while using hand tools or equipment which might produce flying materials.
- h. Periodically check jacks to ensure they are in good operating condition.

- i. Keep tool cutting edges sharp (but protected when not in use) so tools will perform smoothly without binding or skipping.
- j. Store tools in a dry, secure location where they will not be tampered with or pilfered.
- k. Use eye and face protection when driving wood plugs, wedges or nails in place.
- l. Freshwater flush mechanical pumps, nozzles and eductors to prevent binding from salt water.

079-38.3.2 ELECTRICAL HAZARDS. The following list highlights potential dangers that could pose a threat from electrical tools and equipment.

- a. Damage to insulation on electrical cords and welding conductors
- b. Detached conduits, missing covers, defective wiring, wiring violations
- c. Lack of ground fault circuit interrupter protection while using portable cords and tools in wet areas
- d. Exposed wires or terminals in out-of-the-way spaces
- e. Lack of proper lockout/tagout
- f. Missing or broken ground prongs on power cords
- g. Misuse of electrical testing equipment
- h. Insulated tool handles that are damaged or are missing insulation.

SECTION 39

DAMAGE CONTROL INFORMATION AND AUTOMATION

079-39.1 INTRODUCTION

079-39.1.1 RESPONSIBILITIES. Damage Control information and automation are considered to be the responsibility of all hands. In reality, they are the sum of all efforts which relate to maximizing material readiness of the ship so the ship will be able to prevent, localize and contain the spread of damage whenever the ship is faced with a hazard situation or actual casualty.

079-39.1.2 SURVIVABILITY DEFINED. Prior to discussing the specifics of damage control information and automation, a definition of survivability helps to set the stage. Survivability is made up of three components—susceptibility, vulnerability and recoverability. Susceptibility is a measure of how well a ship can avoid being hit. Susceptibility is more a function of naval tactics and doctrine than of ship design. In the past, naval ship susceptibility was driven by the protection provided in turn by the combat air patrol, the weapons of the escorting ships and, finally, the ship's own weapon batteries, speed and maneuverability. In the 1990s, susceptibility is greatly reduced by advances in signature management and electronic countermeasures. Vulnerability is a measure of how well a ship can withstand a hit from a damage mechanism given that it has been found, engaged and hit. This is a function of armoring and damage control. The final aspect of survivability is recoverability, which is the measure of a ship's ability combat and repair the effects of primary and secondary damage. Damage Control information and automation have a direct effect on vulnerability and recoverability.

079-39.1.3 DAMAGE CONTROL FUNCTIONS. When one considers the term "control", it is obvious that containment of damage is the primary consideration. Damage control in this context relates to measures to insure

that small fires do not develop into conflagrations, that flooding is contained to localized areas, and that structural damage is minimized by appropriate and timely action so that critical structural overloading is prevented. A complex tactical survivability information management system must be able to detect hazards and to maintain a proper flow of information after an actual casualty has occurred. Corrective maintenance actions and machinery performance information must be an integral part of such a system. Serious damage to main machinery components are considered non-restorable; efforts to bring machinery systems back into operation under an automated system will be limited to system realignment, rigging of emergency power and the elimination of piping leaks or ruptures to the machinery components. By isolation and segregation the information system must be structured in such a fashion that it can use data inputs from new installed technologies. Finally, the information system must consider the overall arrangement of the ship so the information displays and interior communications enhance the transmission of damage control data in a user-friendly format. Information and automated systems must address the casualty effects including:

- a. Lost communications (voice and data)
- b. Electrical power loss
- c. Damage control/fire protection and casualty detection systems degradation and loss
- d. Ship mission-critical system degradation and loss
- e. Harmful Spread of Smoke, Hazardous Fumes, and CBR Warfare Effects
- f. Personnel casualties and blocked personnel access routes
- g. Structural damage

079-39.2 SHIPBOARD ORGANIZATIONAL CONSIDERATIONS AFFECTING DAMAGE CONTROL AUTOMATION AND INFORMATION

079-39.2.1 MANNING ADJUSTMENTS. The personnel organization of any combatant ship adjusts to a variety of operational states of readiness. The damage control organization also adapts to these operational states. The manning level available for an immediate action response to a hazard or casualty increases as a function of the degree of operational readiness.

079-39.2.2 OPERATIONAL STATES OF READINESS. The four operational states of readiness, prevalent in all ship classes, are used as baseline organizational structures from which the damage control organization must function. Only the number of personnel assigned to the damage control organization will vary. A brief look at these operational states of readiness is necessary in order to describe the environment existing aboard ships.

079-39.2.2.1 Basic In Port Watch - Services From The Pier. Generally, basic in port watch is the minimum manning condition aboard ship, adjusted to the port involved. If the ship is in its homeport, the manning will, in all probability, be adjusted to the absolute minimum. If the ship is in a foreign or unfamiliar port, the number of personnel required on board will be adjusted upward. Manpower level is a command decision. Since basic in port watch encompasses the minimum manning level, it is a condition which forces a heavy reliance on remote sensing capability in order to detect shipboard hazards which can rapidly deteriorate into a serious casualty. This situation also mandates consideration of a centralized location for sensor display, interpretation and initiation of corrective action. Sensor displays, where utilized, should indicate the area of the ship where hazard conditions exist. Immediate action, when warranted, also includes mustering all available manpower to restore conditions to nor-

mal. In addition, other personnel may need to be summoned from dockyard facilities and neighboring ships to assist on-scene members of the crew. Information as to the type of casualty and location must be available to assistance teams as they arrive on board.

079-39.2.2.2 Ship Underway - Normal Peacetime Steaming. This state of readiness means the ship is fully manned or near fully manned and a large percentage of installed machinery is functioning. People are present in the area of operating machinery and watch stations, so designated, are manned. The amount of overall activity decreases at night but, nevertheless, is significantly greater than the pier-side situation. Operating machinery can be considered as a hazard source, but normally personnel are in the area to rapidly secure malfunctioning equipment. And personnel, through poor judgement, can, in fact, also be considered a hazard source. Weather, water temperature and sea state can aggravate scenarios. In general, the potential for hazards and subsequent casualties increases, but no significant problems are considered to exist in this state. Ship activity is intense by comparison to the pier-side situation.

079-39.2.2.3 Flight Quarters, Underway Replenishments and Amphibious Operations. This state of readiness arises at anchor, during normal steaming conditions, or at general quarters. These represent a unique hazard state superimposed on a normal state of readiness; and recognition of the potential of a conflagration is acknowledged by the activation of a damage control team who will respond in the event of an incident. Personnel are suited and sequestered and prepared for immediate action and rapid response, should a casualty occur. The area is isolated and access is limited to essential personnel. Specialized damage control and firefighting systems are aligned and prepared for immediate activation. Information relating to any casualty encountered must emanate from an observer somewhat remote from the immediate area who can direct the initial efforts of the sequestered response teams.

079-39.2.2.4 General Quarters - Combat Conditions. This state of readiness is the maximum degree of readiness of the ship. All combat systems, engineering systems and communications systems are activated and readied for use. Every person is assigned a particular watch station. Installed systems are aligned so that vital systems are segregated and are capable of performing at maximum capability; semi-vital systems are maintained in operation; and non-vital systems are secured. The maximum closure condition for the ship is invoked. This includes watertight doors and hatches, piping systems segregation, ventilation realignment and segregation of the electrical system. Additional machinery is placed on line in a standby status. Personnel stations of the damage control organization are aligned as follows:

- a. Repair stations are activated.
- b. First aid stations are activated. The primary station is medical sick bay, and a secondary station is usually in one of the mess areas aboard ship. Medical personnel direct activities at the first aid stations and are usually assisted by logistics personnel. Casualty clearance facilities are utilized if necessary.
- c. Damage control actions are coordinated and directed from a central location manned by experienced personnel. The damage control officer is assigned the overall responsibility for directing damage control actions. Similar to combat systems these actions include: planning - detecting - assessing - engaging-containing - and preventing secondary effects.

079-39.3 HISTORY OF DAMAGE CONTROL INFORMATION AND AUTOMATION

079-39.3.1 INFORMATION MANAGEMENT HISTORICALLY. Damage control information and automation in the early 70s was limited to a manual process involving many personnel passing information via sound-powered phones, plotting manually on damage control charts, and personnel using local control to operate dam-

age control and firefighting systems. In part because the manual system was so slow, it was difficult for the DCA to process all the information quickly and determine proper action. The effect was that the casualty typically got worse over time, requiring even more personnel to combat damage and pass information.

079-39.3.2 INFORMATION MANAGEMENT TODAY. Damage control management is still performed manually; that is, communications, investigations and decision-making are totally made by the human element. The major deficiency in the way we conduct damage control is still the amount of time involved from the initial identification of damage to when corrective action is taken to control damage and restore mission capability. A secondary, but not insignificant, deficiency is the inability to know the actual conditions (i.e., load status and resultant inherent damage) of ship systems prior to, and immediately following, actual damage. The majority of damage control and fire protection systems in the fleet still use manual activation and mostly local control. Advances have been implemented to improve casualty response time through the remote actuation of limited damage control systems (firemain) and the monitoring of fire and flooding sensor alarms on centrally-located damage control consoles and alarm panels.

079-39.3.2.1 Description of Consoles. The DC consoles used on many ships have a firemain-mimic panel that provides the status of key firemain components and allows the console operator to remotely start/stop fire pumps or open/close firemain cutout valves to reconfigure the firemain system into survivable loops. This remote capability becomes important when a firemain casualty requires portions of the system to be reconfigured, rerouted or secured. Some DC consoles show the status of the ship's countermeasures washdown system and deballasting system information. These consoles usually also have a ship mimic panel, showing fire and flooding alarms from sensors located throughout the ship. Ship hard-wired DC consoles are becoming harder to maintain and are being replaced with upgraded computer workstations with processors that can communicate information over a data bus throughout the ship, even into DC repair stations.

079-39.3.2.2 Other Transitions. The traditional manual plotting function is also transitioning onto workstations; and ruggedized portable laptops; sound-powered communications are being replaced by wireless communications. Additionally propulsion, electrical and auxiliary machinery systems are becoming increasingly complex with increased use of computer-based control and monitoring. As systems are further automated with engineering machinery control systems, each has a direct influence on the ability to understand and respond to the damage control picture, including taking full advantage of the sensor, control and monitoring data available. Casualty data is also obtained and evaluated from a variety of sources, including alarm panel sensors, operational personnel evaluations, CCTV information, technical manuals, repair party notebooks, DC plates, books and practical knowledge. All this data is used by the DC organization to develop a constantly-evolving casualty damage picture. However, operators are seeing a trend toward data overload as the damage control organization gathers casualty data.

079-39.3.3 INFORMATION MANAGEMENT IN THE FUTURE. Current ships under construction will have even more automated systems with reduced manning, thereby creating additional data and information overload for operators. In order to meet this challenge today and in the future, a building block concept is needed. The Advanced Damage Control System (ADCS) provides the means to develop a damage control process similar to combat systems process improvements. The ADCS process enhances the ability to plan, detect, assess, engage, contain primary damage and prevent secondary effects. This process, at the same time, requires constant, continuous tactical action decisions by damage control organization decision-makers.

079-39.4 THE ADVANCED DAMAGE CONTROL SYSTEM VISION.

The ADCS vision is to utilize the ship's data backbone so that shipboard damage control (DC) software can rapidly and accurately display information to quickly locate and effectively contain and control damage. Ulti-

mately, through the integration of remote DC communication, including video sensors, alarms, and the networking of the information through the ship's DC organization, ADCS will facilitate the prioritization of DC responses an assets, communication status and actions. ADCS will also provide for the remote actuation of damage control/ fire protection systems and assist with the segregation and reconfiguration of ship system control elements.

079-39.4.1 ADCS OVERVIEW. The ADCS concept was developed in response to a need for both a DC control and monitoring system and a tactical damage control system to aid the ship's crew in effectively combating damage. There are two pieces to the Advanced Damage Control System concept: The damage control tactical management component provides an automated tracking capability for all the ship's actions of recoverability. The sensor, control and monitoring component provides the automated ability to keep a finger on the pulse of ship systems. [Figure 079-39-1](#) illustrates how the two components of ADCS function in tandem.

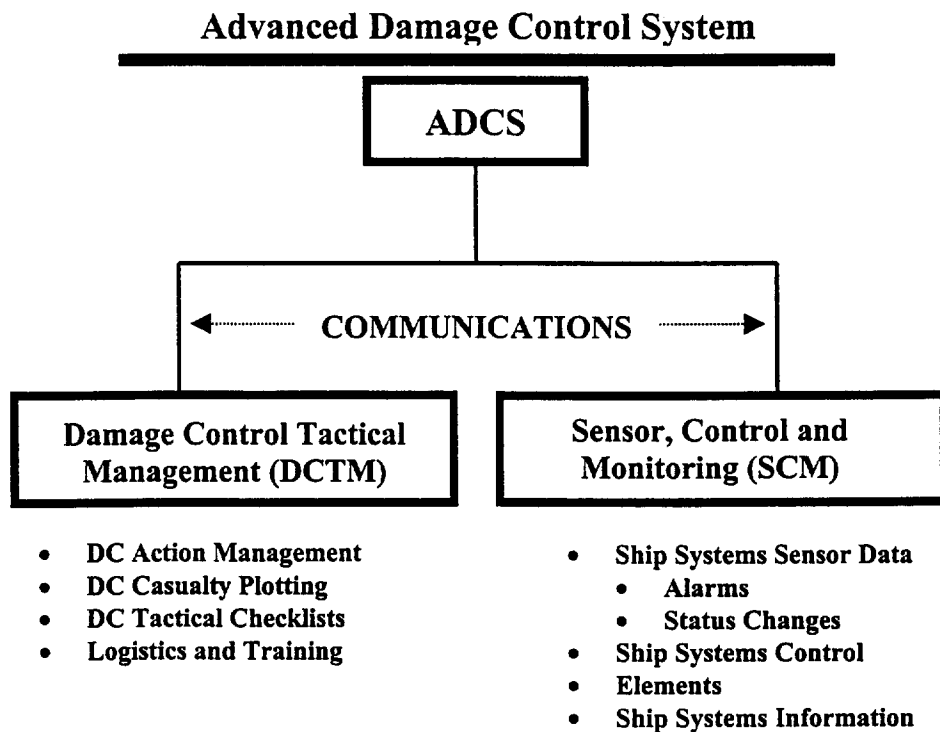


Figure 079-39-1. Advanced Damage Control System

079-39.4.2 ADCS TACTICAL MANAGEMENT SYSTEM PARAMETERS. The DC tactical management concept is structured on the use of computer workstations networked in a peer-to-peer LAN architecture. Sensor, control and monitoring, artificial intelligence and system tactical decision aids (derived from data available from the DC control and monitoring system) will also be used to resist primary and secondary damage by rapidly and accurately displaying information to quickly locate, contain and control damage. Ultimately, through the integration of remote DC communications, including voice, video, sensors, alarms and networking of information through the ship's DC organization, damage control tactical management will facilitate the prioritization of DC responses and assets, communicate status and actions, and permit automatic response to DC casualties. The ADCS will be a modular and easily upgraded system that can assist the DC organizations aboard ship in decreasing the amount of time and number of personnel now required to recover from casualties. The system will be capable of receiving data from ship's systems to allow prediction of location of weapon impact(s) and spread of fire or flooding. Graphical displays will consist of both the traditional DC plates (isometric views) to trace systems between decks, and a two-dimensional graphical view (plan and profile) of the ship by deck, layered for the purposes of plotting casualties, boundaries and for performing other DC tactical management functions. ADCS will provide watch standing and damage control personnel with a graphical depiction of the location of vital DC equipment (i.e., pipe jumpers, electrical jumpers, shoring equipment and fixed fire-extinguishing systems) and personnel. ADCS will also provide the ability to automatically detect and electronically depict fire, flooding and

smoke damage and provide recommended response actions to DC personnel. ADCS will automatically provide administrative information on ship's personnel (i.e., whether personnel are aboard ship, and if so, their location) and recommendations for the optimum use of personnel when responding to casualties. Recognizing that there is continual change and advancement of DC tactics and doctrine, ADCS will be constructed in a modular fashion to permit rapid upgrades to be developed for new functions as they evolve. The major components of ADCS will contain ship-specific databases that provide plan and profile and isometric views for all ship classes. For each ship class, the ADCS will be able to display a detailed view of any compartment and the associated equipment with the compartment, as well as the systems that transverse the compartment. The location of different types of damage, as well as the location/proposed placement of damage control equipment, will also be displayed. The location of passive damage control/fire protection features (i.e., fire zone bulkheads, thermal insulation materials) will be displayed, in addition to kill cards for mechanical and electrical isolation of each compartment. The development of a Window/NT interface boundary will be defined for other damage control program. Additional features of ADCS will include:

- a. Display of fixed fire protection system coverages (i.e., for AFFE, halon, CO2, water mist)
- b. Location of drainage systems
- c. Location of desmoking routing
- d. Location of evacuation routing
- e. List of compartment adjacent to damaged spaces
- f. The closure status of compartments
- g. Ability to replay tactical user inputs for lessons learned after training exercises
- h. Ability to provide compartment detailed views.
- i. Real-time personnel location tracking via short-range transmitters worn by personnel.

079-39.4.2.1 Hardware Considerations. Ships have a variety of hardware installations, LANS, networks, software products and internal voice communications systems. This makes it difficult to have standard training throughout the Navy, when technology is moving so fast. In fact, ship class-specific training to understand the new systems must occur. This involves a major paradigm shift in the damage control community, moving them to a standardized damage control action management system of information, training and logistical support.

079-39.4.2.1.1 LAN Drops. A key way to accomplish standardization is to have shipboard LAN drops in each DC central and DCRS so all the ship's software products can be displayed and accessed from ruggedized, portable computers. Also, a flat panel display device should be mounted in front or behind the current DC plates to provide a larger viewing area for ship's detailed diagrams and drawings.

079-39.4.2.1.2 DCC Workstations. If a LAN or computers are not available in the ship's DCRS, a stand-alone workstation in DC central will still be a valuable tool to the DC organization, who could then take advantage of the software program available onboard ship. The next improvement is to hook to the ship's LAN, then add LAN drops and ruggedized, portable computers in the DCRS during ship upkeep availabilities.

079-39.4.2.1.3 Support. As shipboard hardware improvements continue, the Damage Control Action Management System will evolve to support shipboard rapid response to casualties. It will also be capable of launching to an interface with logistics and training software, continuously improving damage control readiness.

079-39.4.3 ADCS TODAY. The components of ADCS are being used today as a means to move the manual manpower-intensive damage control process to a more automated, evolving rapid response casualty management system. The first part of this evolving automated damage control system is the DC tactical management component. Following is a brief summary of causative factors which have led to the development of the DC tactical management system.

079-39.4.3.1 Response Time. While fire, flooding and smoke have caused extensive damage onboard U.S. Navy ships, some, if not all, of these casualty impacts to the ships could have been reduced with quicker dissemination of information and resultant decisive actions. Extensive exercises and tests have demonstrated that the lack of "situation awareness" during a casualty has resulted in slow response times and delayed or incorrect decisions being made, due to slow information dissemination. Real world experience with severe casualties, corroborated by manned firefighting tests, show that the lack of flexible situation awareness is a key factor in poor damage control performance. For example, sometimes more water is poured into compartments containing only smoke than is applied to the actual fire. If the USS STARK crew had known that the fire encountered during their casualty was about to spread into the RICER room, boundaries could have been set to prevent the millions of dollars of damage experienced to the combat systems computer, cables and equipment. However, the use of extensive situational awareness systems and extensive use of information system technology to improve situation awareness is considered a high risk, because of numerous sources and interfaces of data available from numerous systems throughout the ship. This is not only because of the nature of a potentially complex system of sensors, data, data networks and computers. It is also because of the human-systems integration required to expeditiously display the information in a usable format and the current acquisition environment that stresses the use of performance requirements for ship design and construction without access to valuable past lessons learned experiences.

079-39.4.3.2 Design Limits, Criteria. U.S. Navy ships are designed and constructed with a degree of resiliency to receive a certain amount of damage without catastrophic results. Examples include flooding up to a specified portion of the length of the ship without sinking; destruction of a portion of the hull girder without complete failure of the hull; or destruction of a certain volume of the ship without the complete loss of critical functions. When one or more of these design limits is reached, the ship is said to be "overmatched" and the ship is then either lost or loses the ability to perform some critical functions. If the primary damage exceeds the design limits, damage control. No matter how effectively organized, cannot save the ship or restore it to battle readiness. When primary damage is less severe, effective damage control can save the ship while preventing the complete loss of critical functions. Clearly, the greater the primary damage, the smaller the margin for additional secondary damage before the ship becomes a liability, rather than an asset, to the operational commander. This principle was demonstrated during the Falklands War. Of the 24 British ships hit, six were lost. Of the six ships lost, three were lost due to overmatching threats, and three were lost due to the inability to control the spread of damage. Many of these losses are attributable to ineffective damage control, caused by slow or non-existent communications, as well as incorrect initial actions. The accuracy and rapid dissemination of initial casualty information determines the validity of the first key decision in DC tactical management. As the life of the ship, and perhaps the crew, hinges on the quality and timeliness of these decisions, the importance of providing the right information at the right time to the right people cannot be overstated. In ships with relatively smaller crews, the timeliness of DC casualty information is of even greater importance. The timeliness and accuracy of DC casualty information will not only have a direct impact on the decision-maker's initial damage control actions, but also on the number of personnel needed to successfully carry them out.

079-39.4.3.3 Lessons Learned. Even if a ship is not lost when initially damaged, allowing damage to spread increases repair time and rapid damage progression into ship's computer electronic infrastructures, as well as risking additional personnel injury. The TATTNALL, STARK and CONYNGHAM fires demonstrated the consequences of damage spread. The failure to prevent the spread of smoke during the TATTNALL fire forced the abandonment of much of the interior of the ship, including engineering spaces. The only fatality in CONYNGHAM was as a result of smoke spreading throughout the ship; however, much of CONYNGHAM's damage resulted from the fire progressing beyond the initial area because boundaries were not rapidly established. Similarly, the costly damage to the STARK's RICER room and CIC was caused by failure to ascertain the location of the initial fire and stop its eventual vertical spread.

079-39.4.4 TODAY'S GOALS. Fleet experience, exercises, tests and analyses provide specific information about today's damage control performance. All this data must be incorporated into computerized applications of damage control principles and personnel actions, replacing extremely manpower intensive manual applications. The goal is not data overload but rather to provide rapid, accurate voice and data communications, displays of key useful information to key stations, visual displays that are clear, easy to understand and transmitted throughout the ship. This information must reduce the workload on the damage control organization during day-to-day operations as well as workload reductions during general quarters, thereby improving rapid response tactical actions.

079-39.4.5 DC TACTICAL MANAGEMENT. Shipboard personnel use computers during day-to-day operations. Stand-alone computers are now being incorporated onto the 1T2 1 LAN. Technical documentation used to be delivered to the ship in hard-copy paper format; many technical documents are now being delivered in electronic-only format. Many electronic products are also used by the damage control organization to ensure that the damage control readiness is maintained to the highest standards. On some of the newer ships, LAN drops and portable computers are being installed in the DCC and DC repair stations. This is an improvement for the DC organization, which gives them the capability to instantaneously access technical publications, maintenance, training, supply and logistics data. These hardware and software improvements reduce the workload and improve efficiency within the DC organization, because ship's information can be brought into the DC repair stations where personnel are working, rather than personnel having to find a computer in another space. Tools, equipment and technical documentation are becoming more available to DC personnel every day.

079-39.4.5.1 Damage Control Action Management Software (DCAMS). DCAMS is the cornerstone of damage control tactical management. It improves situational awareness through flexible graphical user displays.

079-39.4.5.1.1 Software Parameters. DCAMS provides shipboard personnel with the ability to map and track portable, consumable, and fixed damage control equipment and personnel during normal and casualty operations. DCAMS replaces traditional manual plotting and triangle DC casualty plotting symbology with graphical casualty icons, DC action checklists and enhances utilization of internal and wireless communications to increase rapid tactical casualty evaluation responses. DCAMS provides a rapid and accurate presentation of actual tactical information to shipboard decision-makers so they can combat and dominate the internal environment on the ship during casualties. Using a standard keyboard and a pointing device, users can display images on screen of the ship's profile view, deck plans, compartment and access drawings and are provided with the ability to overlay icons representing DC information on the drawings. DCAMS is capable of stand-alone operation or in a peer-peer network configuration over installed local area networks such as the 1T22 1 LAN. Capabilities include display and plotting of the following:

- a. Locations of fixed, portable and consumable damage identified using color-coded icons on deck plans. A viewable asset icon list allows the operators data filter that limits display of selected assets or those related to a selected casualty type.
- b. Real-time tracking of the location of DC personnel and equipment during casualty and general quarters situations.
- c. Status of fire, smoke and flooding boundaries.
- d. Ship's passive damage control features (watertight bulkheads, CPS zones, fire zone bulkheads, etc).
- e. Casualty and damage location, type and severity.
- f. Sensor locations and type for each compartment.
- g. Fire protection and suppression system coverages.
- h. Kill card and space isolation data for each compartment that includes mechanical, electrical, ventilation isolation and subsequent reactions.
- i. DC checklists for tracking actual actions taken.
- j. Compartment details and notes.
- k. NWP 3-20.31 color-coding as displayed on the DC plates.
- l. Hazardous materials information for each compartment.
- m. Gas free status for each compartment or space.
- n. Help feature, including Power Point presentation and user's manual.

079-39.4.5.1.2 DCAMS Configuration. The DCAMS is populated using data from a password-protected relational database. The DCAMS can be configured to interface with other databases, including DC OSIMS, CCOLs

and other software modules to enhance damage control readiness, reporting and tactical management capabilities. [Appendix B-2](#) depicts the new damage control icons and examples of screens showing DCMAS being used to perform a casualty plotting function.

079-39.4.5.1.3 DCAMS Software Updates. Program software will be maintained at NAVSEA for configuration control. Ship's force has the capability (under their user password-protected version) to update ship-specific data to match the ship configuration.

079-39.4.5.1.4 Shipboard Usage of DCAMS. There are a number of shipboard uses DCAMS. These include:

- a. Performing advance planning and post debriefing for shipboard damage control drills to DCTT and repair party personnel.
- b. Tool for part of indoctrination training for newly-reporting crew members to enhance ship familiarization.
- c. Rescue assistance training between ships.
- d. Tracking contractor work during pier side availabilities and overhauls.
- e. Increasing DCA's situational awareness, helping to proactively control casualties with easily accessible master check-off list.
- f. Expediting communications between all stations. Plotted casualties, boundaries and personnel are instantly transmitted to all other repair stations on the ship's LAN, which removes the need for station-to-station comms using phone-talkers and plotters.
- g. Eliminating paper documentation. Each item plotted is time-stamped and recorded, eliminating the need for message blanks.

079-39.4.5.1.5 DCAMS TRAINING AIDS. DCAMS training aids are designed to support the DCTT as they introduce DCAMS and the new standard computer-generated symbology to shipboard personnel. Training support devices, such as the damage control flag sets, The Sounds of Damage CD and the icons provided in [Appendix B-2](#), will allow the DCTT to introduce the new symbology even on those ships currently not yet equipped with DCAMS. DCAMS training aids support the DCTT's ability to provide more effective training, permitting the DCTT to conduct drill evolutions with minimum verbal disclosure, thereby addition realism and standardization to shipboard training. Below are two examples of how to use DCAMS and the training aids:

079-39.4.5.1.6 Example One, DCTT and DCAMS Symbology - Underway During General Quarters:

- a. Select Bravo to start the drill.
- b. The ship sets general quarters due to the detection of incoming unidentified aircraft.
- c. From DCC or the bridge, the sound of a missile being launched, striking the ship, exploding, then secondary explosions is played, using The Sounds of Damage CD.
- d. Pre-staged DCTT selects a space:
 - Add smoke to space, using smoke machine.
 - Play Fire section of hit Alpha from The Sounds of Damage CD on CD player.
 - Display red and white strobe lights from fire flag kit.
 - Stand ready with class Alpha Fire flags (with DCAMS symbology) from fire flag kit.
- e. Repair locker leader deploys investigators:
 - As investigators approach space, they will hear low sounds of fire through bulkhead or door.
 - Investigators open to view smoke, flashing lights and DCTT waving flag, indicating class Alpha fire, using DCAMS symbology; investigators heads loud fire noises (from Sounds of Damage CD).
 - Investigators report damage, proceed with initial actions. Drill actions start.

079-39.4.5.1.7 Example Two, DCTT and DCAMS Symbology - In Port, Flooding

- a. DCTT sets up a space for flood drill.
 - Uses DCAMS symbology Flooding flag from DC training flag kit.
 - Displays DCAMS Ruptured Firemain flag from firemain piping in ship.
 - Plays high or low pressure from The Sounds of Damage CD.
- b. Crew members from duty section who are passing by are attracted by sound of water.
 - Open door, views Flooding flag (from DCAMS symbology).
 - Hears water spray from The Sounds of Damage CD.
 - Views Ruptured Firemain flag hanging from piping system.
- c. Crew members report flooding due to ruptured firemain to quarterdeck.

979-39.4.5.2 Additional Software that Enhances Damage Control Readiness. Some of the software packages currently available on the ship's IT21 LAN for the DC organization are described in the following paragraphs.

079-39.4.5.2.1 Ship Information Book (SIB). The purpose of the automated Ship Information Book is to provide technical information for ship's force, building, planning and overhaul yards, for fleets and training commands, tenders and other naval activities. The scope of technical information includes a general description of the ship's design characteristics and the major shipboard arrangements and systems.

079-39.4.5.2.2 Compartment Check-Off Lists (CCOLs). CCOL software is used to update the hard copy CCOLs posted in every compartment.

079-39.4.5.2.3 Flooding Casualty Control Software (FCCS). FCCS is capable of extensive analyses of ship's loading and stability status. The program is intended to be used for all monohull naval surface ships.

079-39.4.5.2.4 Damage Control Operating Space Inventory Management Software (DC OSIMS). Dc OSIMS was designed to provide visibility for each damage control AEL and kit contents. It provides inventory management, asset review and inventory posting capabilities (shortages and excesses), as well as the ability to generate selected reports.

079-39.4.5.2.5 COMPASS. This software is designed to manage all of a ship or shore command's administrative, training, PQS and Watchbill functions. It integrates many past stand-alone programs into one, easy-to-use platform.

079-39.4.5.2.6 Planned Maintenance Service (PMS) Scheduler. This software is used to automate procedures within the 3M shipboard maintenance program.

079-39.4.5.2.7 Interactive Damage Control CDs (IDCCD). Produced by Puget Sound Naval Shipyard in an Adobe Acrobat format, this software shows the damage control diagrams and damage control book for ships under PSNS cognizance. Classes include ARS 50, AOE 1, AOE 6, MHC 51, MCM 1, CVN 65 and CVs.

079-39.4.5.2.8 Ship Familiarization CDs. This software provides ship and system features for precomm crews, especially during new construction.

079-39.4.5.2.9 Ship Training Enhancement program (STEP). This software on CD contains many courses to assist with onboard training in damage control. Examples include SEED Maintenance and Management Training, P100 Maintenance and SCBA Maintenance Training.

079-39.4.5.2.10 Shipboard Supply Information. Available electronically to order and maintain damage control equipment.

079-39.4.5.2.11 Planned Maintenance Service (PMS). Provides automated planned maintenance for shipboard damage control, firefighting and CBR equipment.

079-39.4.5.2.12 Personnel Qualification Standards (PQS). Tracks the qualifications of all ship personnel's damage control qualifications and training requirements.

079-39.4.6 DAMAGE CONTROL SENSOR, CONTROL AND MONITORING. The second part of the Advanced Damage Control System (ADCS) is the DC sensor, control and monitoring component. It is comprised of the sensors used to detect fire, smoke, flooding, closure, and CBR incidents. It is also part of the engineering machinery control system, which provides damage control and fire protection system support to the DC organization during casualty operation. Sensor, control and monitoring gives early warning, including how equipment is reacting in the casualty, to assist in containment of primary and secondary damage. Some ships have very limited sensor, control and monitoring capability today but with improvements in engineering machinery control automation, more systems are being automated during ship availabilities and overhauls. The following is an example of the DC/fire protection systems that will continue to evolve toward automation as part of the engineering machinery control system upgrades.

079-39.4.6.1 Firemain. With this automated system, the operator(s) must be able to:

- a. Control each remotely-operable piece of equipment
- b. Set material conditions X, Y and Z for the firemain
- c. Initiate module deluge.

079-39-4.6.2 HVAC. The operator(s) within a control station that is in control of a fire zone must be able to:

- a. Individually start and stop Class W and Class Z air conditioning fans serving a zone, except for fan coil unit fans.
- b. Start and stop all Class W fan coil units serving non-vital spaces in that fire zone with a single control action.
- c. Stop Class Z fan coil unit fans via a single control action. The station that is in control of a fire zone shall be able to stop all other Class Z air conditioning systems serving that fire zone with a single control action.
- d. Individually start, stop and select the speed of all vent fans serving SSDG modules located within that fire zone.
- e. Individually control fans serving that fire zone.
- f. Individually control each Class Y fan serving that zone.
- g. Individually start, stop and select the speed of Class Z ventilation fans serving that zone.
- h. Individually start and stop each of the Class X fans serving that fire zone.
- i. Individually start and stop and, if applicable, provide the ability to select the speed for each Class Circle W ventilation fan serving that fire zone.
- j. Turn SES dampers on and off.
- k. Turn Class W vent fans on and off.
- l. Set vent fans high or low speed.
- m. Turn Class Circle W vent fans on and off.
- n. Turn Class X vent fans on and off.

- o. Turn Class W air conditioning fans on and off.
- p. Turn Class X vent fans on and off.
- q. Set Class X vent fans high or low speed or reverse.
- r. Turn Class Y vent fans on or off.
- s. Turn Class Z vent fans on or off.
- t. Set Class Z vent fans high or low speed.
- u. Turn Class Z air conditioning fans on and off (except fan coil units).
- v. Stop Class Z fan coil unit.
- w. Restart air conditioning plant.

079-39.4.6.3 Smoke Ejection System (SES). The operator within a control station must be able to:

- a. Initiate SES mode for that fire zone via a single command.
- b. Re-establish normal mode within that fire zone via a single command.

079-39.4.6.4 AFFF. The operator(s) must be able to:

- a. Start proportioning pumps.
- b. Open and close AFFF sprinkling valves for the groups and zones.
- c. The operator(s) shall NOT be able to secure proportioning pumps.

079-39.4.6.5 Water Mist. An operator using the control system must be able to:

- a. Operate any water mist pump or motor-operated valve regardless of the logic or sequencing
- b. Designate the lead pump for each protected space.
- c. Initiate actuation of the water mist system.
- d. Stop the water mist flow to any protected space.

079-39.4.6.6 400 and 60 Hz System. The operator(s) must be able to monitor the systems:

079-39.4.6.7 Drainage and Ballast Systems. The operator(s) must be able to:

- a. Open and close main drain bilge suction valves.
- b. Open and close main drain bulkhead cutout valves.

079-39.4.6.8 Fire Extinguishing Systems. The operator(s) must be able to:

- a. Start AFFF proportioning station pump.
- b. Actuate AFFF sprinkling.
- c. Actuate SSDG enclosure (HFP actuated from MCC) primary shot.
- d. Open and close water mist main isolation valves.
- e. Open and close water mist primary distribution control valves.

- f. Open and close water mist secondary control valves.
- g. Turn on and off water mist pumps.

079-39.4.6.9 Freshwater Service Systems. The operator(s) must be able to:

- a. Open and close chilled water motor -operated ball segregation valves.
- b. Turn chilled water pumps on and off.

079-39.4.6.10 Auxiliary Seawater Cooling Systems. The operator(s) must be able to:

- a. Open and close SW main bulkhead valves.
- b. Open and close SW hull valves.
- c. Open and close sea chest valves.
- d. Start and stop fire pumps.
- e. Open, close, and segregate washdown countermeasures groups.
- f. Open and close fire pump sachets valves.
- g. Open and close firemain valves (Class W, Y and Z).

SECTION 40.

INVESTIGATING DAMAGE

079-40.1 CASUALTY DAMAGE

079-40.1.1 OVERVIEW. When a casualty initially occurs, every crew member is an investigator for the ship and is responsible for accurately assessing, investigating and reporting damage either to or in working spaces. The degree of investigation required immediately after a ship has been hit depends upon many factors, including the following:

- a. Size and type of missile causing the damage
- b. Where the missile hit
- c. Whether it exploded inside or outside the hull.

079-40.1.2 PRELIMINARY INFORMATION/REPORTS OF DAMAGE. Certain information defining the extent of a casualty will be available almost immediately. Heavy shock and whipping of the hull structure may indicate a major underwater explosion, although intense vibration will not always occur from such casualties on large ships. A decided or progressive change in trim or list, as indicated by clinometers, will divulge information. Combat systems, ship control stations and roving patrols near the scene of the casualty will also provide information. For example, combat systems may report that a weapons system is entirely without power; the bridge may report that steering control has been lost; and a repair station may report that water is coming through a certain bulkhead.

079-40.1.3 OBVIOUS DAMAGE. Although preliminary information is not conclusive, when combined with reports from lookouts and other topside personnel, or from the main engine watch, it will locate the damage and

give a general picture of the extent of the casualty. There may also be a few obvious signs of damage, i.e., a minor loss of power, a wisp of smoke, a dropping pressure gauge, excessive warmth on a bulkhead or a slight weeping at a seam. All of these indications shall be investigated thoroughly. They are symptoms of a dangerous condition and prompt remedial action shall be taken if the ship is to survive.

079-40.2 INVESTIGATORS

079-40.2.1 QUALIFICATIONS. Repair party investigators are to be PQS-qualified, physically-fit and well trained in their duties to investigate, assess and report damage. Because their reports validate sensor data, investigators have an important bearing on the actions taken to localize and control damage.

079-40.2.2 INVESTIGATORS' ACTIONS. Investigators shall work in pairs. It may be necessary to have a helper standing by in case one gets fouled in wreckage, falls through a ruptured deck, to hold a flashlight or have a plug or a tool handy if urgently needed. If any casualty is detected while investigating, the following actions should be taken:

1. In case of fire, one investigator notes vital information to include compartment number, frame numbers and nature of the casualty.
2. The investigator then reports this information by hand or by installed interior communications to the repair station and, when possible, to the on-scene leader.
3. The other investigator remains at the scene, and initiates firefighting efforts when practical. This can include using portable fire extinguishers or using the fire hose from the nearest fireplug.
3. The results of the investigation shall be clearly and quickly reported, and
4. The investigation shall be repeated.

079-40.3.2 REPAIR PARTIES MAKEUP. Repair parties shall be organized and trained in the investigative phases of damage control. In large ships it is customary to have subgroups or a repair party detailed to investigate specific items. For example, electrician's mates look for damaged electric circuits. Another group must be trained and equipped to look for fires (commencing firefighting operations at once) and still other groups will be detailed to examine bulkheads and frames, making rapid estimates of their remaining strength and integrity. When making the required investigation:

- a. Know the ship
- b. Investigate thoroughly
- c. Investigate cautiously
- d. Report findings
- e. Repeat investigation
- f. Never lose control of a watertight fitting
- g. Re-secure compartments after leaving them
- h. Look for hidden damage.

079-40.3.3 THOROUGH INSPECTIONS. When an underwater explosion occurs alongside or close aboard, all voids, tanks and lower compartments on the ship shall be investigated. Rivets or plating may be torn loose, plating may be cracked; seams may be parted; bulkheads and shell plating may be penetrated. Damage can occur a considerable distance from the principal point of damage. Furthermore, internal flooding may spread over a large area through watertight fittings damaged by shock or through neglected watertight fittings. Not all of these secondary casualties will be apparent during a preliminary investigation. If water is on the opposite side of a bulkhead containing cracks or defective stuffing tubes, damage can be readily detected. If flooding has not yet reached the area, however, damage may not be visible, and it may not be noticed until a degree of progressive flooding has occurred. Under these circumstances, a secured boiler room could be flooded, for example.

079-40.3.4 RESECURE COMPARTMENTS. The ship should be in the maximum condition of material readiness when damage occurs. Should it not be in this condition, immediate action must be taken to prevent disastrous progressive flooding and fires. Only a minimum number of compartments may be open at any one time for the purpose of investigation and repairing damage.

079-40.3.4.1 It is essential that all personnel be trained to understand the importance of re-securing compartments and all other spaces in the ship that have been entered or subjected to other inspection. Passage through watertight boundaries must be held to a minimum (even to the selection of the smallest closure whenever such a selection exists).

079-40.3.4.2 Investigators and other personnel must exercise care to prevent open doors, hatches and scuttles from being fouled in any manner that would prevent or delay their exit or ability to re-secure the opening. Should the motion of the ship cause the door or fitting to swing, personnel should be directed to tend the fitting while open and re-secure when it is no longer required to open.

079-40.3.5 REPAIR PARTY SAFETY. Observance of all of the principles of inspection will help ensure the safety of repair party personnel. Members of the repair party can not be permitted to enter any closed or poorly ventilated compartment or area until it has been determined by competent authority that the likelihood of suffocation, poisoning and fire or explosion has been eliminated or reduced to a practicable minimum. **NSTM Chapter 074, Volume 3, Gas Free Engineering**, describes precautions that must be observed by personnel entering compartments, tanks, voids or other areas.

079-40.4 AREAS TO INVESTIGATE

079-40.4.1 USE OF QUALIFIED PERSONNEL. Structural damage is to be investigated by personnel who are capable of assessing the damage and of planning and executing emergency repairs.

079-40.4.1.1 Structural Damage. Investigation of structural damage must cover a considerable area surrounding the immediate scene of damage, not only on the same level but also on decks above and below the principal casualty. Investigators must look for damage such as fragment holes, ruptured pipe lines, warped or fractured frames and stanchions, cracks, open seams, leaky stuffing tubes, bent shafts, improperly closed fittings, and severed electric cables, quickly noting any damaged bulkheads which indicate the need for shoring. Essential information is to be reported at once to the repair party leader.

079-40.4.1.2 Flooding Damage. Flooding usually is the result of structural damage below the waterline. It is vital that progressive flooding be stopped. It is also critical to remove as much of the water as possible in order to restore buoyancy and stability, returning the ship to an even keel.

079-40.4.2 HIDDEN DAMAGE. The complete picture of a damage situation rarely is fully evident. Some damage may not necessarily be within the immediate area. Shock, blast, fragmentation and other forces can cause additional damage, which, because of remoteness from the scene of the prime damage, makes it not immediately apparent. The inspection of the ship for damage, therefore, must not be focused solely on the prime damage area. Investigators must inspect the ship's structure, gauges and meters on piping and cable systems. Open circuit-breakers and failure of operating equipment may indicate hidden damage which, in itself, could be as hazardous to the ship as the primary damage.

079-40.4.2.1 Investigation of Torpedo Hit. Consider the case of a torpedo hit similar to the one shown in [Figure 079-40-1](#). In this case, the major damage forward is obvious. A large number of less apparent casualties will be present, however, and unless they are discovered and controlled, the ship may be lost through fire or progressive flooding. Seams, stuffing tubes and pipe lines will be opened over a considerable area and compartment bulkheads may be severely buckled. On several types of light craft, shell plating on the quarters may be cracked badly - even to such an extent that the after part of the ship will break away. Investigation must, therefore, be thorough and complete.

079-40.4.2.2 Underwater Penetration. Investigations must be thorough because the extent of secondary or minor damage could go undetected. Should the casualty involve penetrations of the underwater hull structure, (as from torpedo hits, bomb hits or near misses or splinters) all compartments, tanks and voids adjacent to the original point of damage must be sounded to determine which have been penetrated and flooded. It is important to extend this investigation to every compartment, any part of which lies within 50 feet of the point of impact. If any compartment on the perimeter of this arc shows the presence of casual water, the investigation must be extended beyond the original estimated limits until an intact watertight boundary is determined.

079-40.4.2.3 Compartment Flooding. Complete flooding of a compartment, or flooding to sea level, generally will indicate that the compartment is open to the sea. Flooding to a lesser height may indicate that the puncture is relatively small and that progressive flooding is occurring. Progressive flooding can be verified by subsequent soundings. Isolated or concealed seawater lines leading through a closed or unmanned compartment may have been ruptured or corroded, flooding the compartment. This condition is more dangerous than penetration of the hull. In time, the pressure within the compartment may increase to a hundred pounds or more, causing undamaged bulkheads to collapse. Regularly scheduled, thorough inspections can prevent this type of casualty. [Figure 079-40-1](#) shows that a shell, bomb or torpedo strikes a ship at A, passing aft and downward, and explodes in compartment B. Investigation must cover all spaces along the path of the projectile and, in addition, must completely cover all systems and structures in every compartment which shows secondary penetration (C) as well as adjacent compartments (D), even to a depth of two or three compartments in all directions. Thus, investigation will determine the extent of primary structural damage and also will discover the peripheral damage caused by shock and splinters and establish gas, flooding and fire boundaries around the hit and explosion areas.

- A - INITIAL PENETRATION
- B - POINT OF EXPLOSION
- C - SECONDARY PENETRATION
- D - POSSIBLE SHOCK DAMAGE

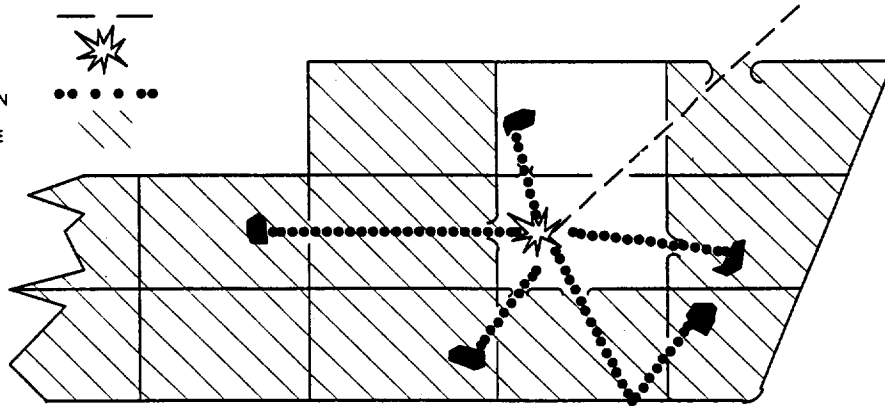


Figure 079-40-1. Possible Peripheral Damage

079-40.4.2.4 Investigation of Adjacent Compartments. Investigators must understand that damage to compartments adjacent to the one in which an explosion occurs is likely due to secondary penetrations and shock. [Figure 079-40-2](#) illustrates the extent to which investigations must reveal and control peripheral damage.

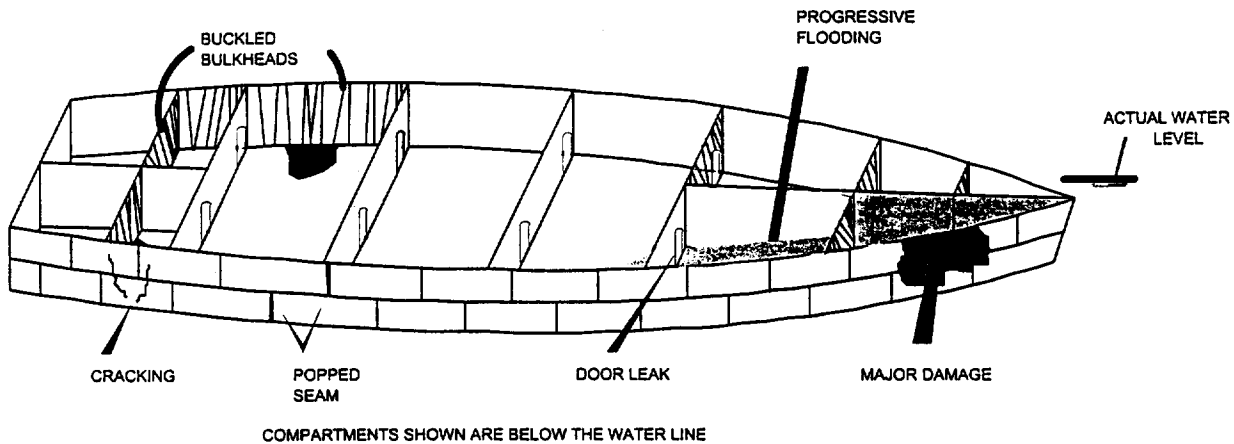


Figure 079-40-2. Areas To Be Examined After Torpedo Hit

079-40.4.2.5 Soundings. Under normal conditions, soundings of voids and tanks are made by the sounding and security watch. During war conditions, a sounding detail is established in each repair party. All personnel should know where and how to sound all compartments in their own and adjacent areas.

CAUTION

Soundings must be taken carefully; they may be deceptive because of foamy oil or the rolling of the ship. Furthermore, caution must be exercised in removing the plug or cap from the upper end of a sounding tube. If the damaged compartment is open to the sea and the outside water level is above the top of the sounding tube, the upward rush of water or oil could prevent recapping and result in flooding the higher compartment.

079-40.4.2.5.1 In preparing for a sounding, slowly back off the plug or cap. If a rush of air escapes around the threads while the cap is still under control, tighten the cap immediately. No soundings are required to further determine that the lower compartment is being flooded; however, permitting more air to escape would permit more water to enter the damaged space.

079-40.4.2.5.2 A trickle of water appearing around the threads of the sounding plug indicates that the compartment below is completely flooded. If either air or water are evident, re-secure the cap and report the situation to the damage control assistant, indicating that the compartment has free-surface water or solid flooding.

079-40.4.2.6 Investigation of Watertight Fittings. Investigation of structural damage by visual examination presents many difficulties and dangers.

WARNING

No watertight door, hatch, airfitting, oil fitting, cap, plug, scuttle or manhole is to be opened until it is definitely known that the compartment on the other side is either completely dry, or flooded to such a small extent that opening the closure will not permit flooding to spread.

079-40.4.2.6.1 To do a thorough damage control investigation, it might be necessary to open one or more watertight doors or hatches. It is not wise to open any such closures below the waterline in the vicinity of damage unless this is preceded by a thorough investigation by means of soundings, and there, only after permission is obtained from higher authority whenever the situation permits. One unsound move and the ship may be lost.

079-40.4.2.6.2 Many compartments are not provided with sounding tubes. This is no obstacle to investigation, however; tapping on a bulkhead with a hammer often will disclose the presence of water on the other side. (The exact height of the water may be judged by variation in the tones produced when the bulkhead is struck at different levels.) Repair party personnel occasionally should tap various bulkheads for practice, to train their ears to the sound of bulkheads around undamaged areas. Tones will vary appreciably with the thickness of the plate.

079-40.4.2.6.3 A dangerous, but often necessary, method of testing a compartment for flooding is to slowly slack off on the hinged side of some of the dogs which hold a hatch or door closed. There is a slight amount of clearance around the hinge pins, and as the dogs are loosened, any water present will begin to seep between the gasket and the knife edge on the side. Control is still maintained by means of the hinges and the opposite dogs. One method of checking quick-acting doors and scuttles is to slightly loosen the door handle or wheel while maintaining pressure on the dogs. This method will show leakage of fluid or air pressure buildup.

079-40.4.2.6.4 Personnel must not loosen the dogs on the edge of the door away from the hinges. Such action could result in having the door buckle or fly open, needlessly flooding another compartment or causing personnel casualties. Secure every fitting after testing.

079-40.4.2.7 Testing Oil and Water. Fuel tanks in the ship should be investigated for damage by taking thief samples of oil and testing each sample for water. Potable and feedwater tanks should be tested for salinity. In some respects these tests give a more positive indication of damage than do soundings, because they will disclose even minor leakage. It is vital to the safety of the ship that the main engine force be made aware of all fuel and water tanks contaminated with seawater; otherwise, they could cut in on a contaminated tank, causing the ship to lose all power.

079-40.5 DAMAGE CONTROL REPORTING

079-40.5.1 Reporting damage and plotting reports on diagrams can be accomplished rapidly and accurately by using a standard system of symbols and abbreviations. [Appendix B-1](#) shows the standard handwritten symbols and abbreviations which must be used for damage control reports. [Appendix B-2](#) shows the standard computer-generated symbology used for electronic casualty plotting.

079-40.6 REPEAT INVESTIGATIONS

079-40.6.1 UNDETECTED DAMAGE. Even though a compartment has been inspected and appears to be free of fires and flooding, it cannot be assumed that damage does not exist. A fire may be ignited or re-ignited from undetected damage to an electric circuit or from a hot fragment buried in a mattress. Flooding may be caused by open or partly opened valves, especially if intervening watertight boundaries fail.

079-40.6.1.1 The first investigation should be considered only as preliminary; additional investigations must be made as soon as time permits. Pipe lines in the damaged area are certain to be ruptured. Valves may be destroyed by splinters or by intense heat. If lines are so badly damaged that they cannot be immediately repaired using soft patches or similar methods, damaged sections must be isolated at the first intact point outside the damaged area. The system then can be connected by jumpers and operated if necessary.

079-40.6.1.2 Air in a damaged area is certain to be fouled with smoke, fumes and gases. Furthermore, a compartment may be so hot that repair personnel cannot remain inside. It may, therefore, be necessary to provide fresh air through the regular air-conditioning system (provided no fire is present), by means of portable blowers or by bleeding from the ship's service lines. Hot compartments can be cooled by spraying them with water and using fog nozzles. Personnel can be cooled by drenching their clothing or by directing streams of water on them from fog nozzles. OBAs are to be available and worn if needed.

079-40.6.1.3 If the compartment is not on fire and it is necessary to employ spark-producing equipment in the area to make repairs, fire extinguishers are to be brought to the scene; the air must be tested before repair work is commenced. Tests for toxic or explosive gases also are to be made by gas free personnel to ensure the working environment is safe.

079-40.6.2 INDICATIONS OF FURTHER DAMAGE. Investigators have several methods for determining (or observing) if the ship has incurred further damage. These methods are described in the following paragraphs.

CAUTION

Suction testing a space when water in the space is below the suction line will remove air from the space.

079-40.6.2.1 Investigating by Pumping. A compartment containing drain lines leading to pumps and eductors often can be tested for flooding by putting a suction on the compartment. If water is present, it will show in the pump discharge; if the compartment is dry, the check valve (if one is installed) will rattle. The investigator must ensure that the drain suction line is not ruptured between the pump and the compartment under investigation. Pumping also may reveal the amount of flooding and the size of the holes causing it. If a single fire and bilge pump is placed in operation in a flooded compartment and the pump loses suction shortly thereafter, the flood-

ing apparently is controllable and the holes relatively small. In every instance, the scene leader shall determine actions for starting and stopping installed dewatering and drainage systems.

079-40.6.2.2 Use of Pressure Gauges. Pressure gauges on steam or water lines often give early information on casualties. If a gauge, for no apparent reason, suddenly indicates a considerable drop in pressure, an observer can assume that the pipeline concerned has been ruptured. Personnel who thoroughly understand a piping system and who know, therefore, which valves are closed for segregating the system, can often make a fairly accurate estimate of the location of the rupture.

079-40.6.2.3 Use of Circuit Breakers. Circuit breakers and electrical measuring instruments mounted on switchboards may also provide information on casualties. When a circuit breaker trips in battle, it can be an indication of shock or of an overload caused by a short circuit or grounding of a damaged cable. The involved circuits can be identified by the numbering system.

079-40.6.2.4 Spreading of Fire. As flooding progresses through damaged or improperly maintained fittings, similarly, fire, gas and smoke can spread. Open flues, such as trunks and ventilation ducts, are potential sources of trouble; the latter are especially dangerous. If they contain flammable dust or are not properly secured, they will carry fire to other parts of the ship. Fire has been known to travel along electrical cables; the heat transferred by metal bulkheads has caused fires in parts of the ship far away from the original conflagration. It is necessary, therefore, to inspect a wide area around the scene of a fire to localize the damage. The overheating of magazines and ready-service ammunition lockers must be avoided.

079-40.6.3 REMEDIAL ACTION BY REPAIR PARTIES. Most major damage is evident within a few minutes, and a well-indoctrinated damage control organization will require only a few personnel to perform the necessary investigations. All other personnel are to take immediate action to control the damage.

079-40.6.3.1 Controlling Damage. After the original investigator has made a report, action must be taken to localize and control the obvious damage and to investigate for latent casualties. Repair personnel must equip themselves with protective equipment, lighting, ventilation facilities and such tools as will be required.

079-40.6.3.2 Controlling Fire. If fire is present, the firefighting party must begin operations immediately. The ship is in grave danger and no repair operations can be started until the fire is extinguished. Personnel generally have to wear OBAs or SCBAs while fighting fires.

079-40.6.3.3 Securing Circuits. Electric circuits in the damaged area must be isolated (killed) by having switchboard circuit breakers secured in main engine control, or by securing switches, if available, in a compartment more closely situated to the scene of the damage. If such action is not taken, short circuits may cause combustible gases to ignite. Power can be restored as soon as circuits are repaired or are tested and found to be intact.

079-40.6.3.4 Inspecting the Ship. After a casualty, adjacent repair parties shall collaborate to inspect the ship. Personnel of the main engines' force should investigate the compartments in which they are working, looking for structural damage as well as damage to machinery. Main engines' force should look particularly for areas penetrated by main shafting, where whipping of the shafts may have caused serious leaks.

079-40.7 MITIGATING THE CASUALTY

079-40.7.1. BENEFITS OF INVESTIGATION. The first two steps in handling a casualty are to put out fires and to control flooding. However, without adequate investigation, no one will know what types and quantities of materials must be provided at the scene, which electric circuits and pipe lines must be isolated and which partially flooded compartments can be made watertight then pumped dry. Working in a haphazard manner, without information or a plan, may waste the repair party's valuable time, i.e., attempting an impossible repair on one leak while six other compartments flood through holes which could be stopped in a few minutes.

079-40.7.2 PRINCIPLES OF INVESTIGATION

- a. Know your ship.
- b. Investigate cautiously, watching for hidden dangers.
- c. Investigate thoroughly.
- d. Always protect yourself
- e. Use breathing apparatus to its fullest capabilities.
- f. Never consider damage lightly. When in doubt, have more experienced personnel investigate.
- g. Report what you find.
- h. Report any unusual noises.
- i. Never lose control of a watertight fitting.
- j. Isolate pipe ruptures and leaks.
- k. De-energize damaged electrical circuits.
- l. Contain smoke spread.
- m. Be alert for progressive flooding or spreading of fire and smoke.
- n. Be sure compartments are re-secured after investigating.
- o. Repeat your investigation.

079-40.7.3 WHAT TO INVESTIGATE

- a. Fire - class of, cause and possibility of spreading
- b. Flooding - cause, primary and secondary boundaries
- c. Smoke - cause, type, how to contain
- d. Communication derangements
- e. Firemain damage
- f. Piping system damage
- g. Hull structure, doors, hatches and scuttles
- h. Ventilation systems damage
- i. Machinery derangements

- j. Power and lighting cables damage.

079-40.7.4 INDICATIONS OF POSSIBLE DAMAGE

- a. Smoke or toxic gases
- b. Loss of light or power
- c. Loss of communications
- d. Gauges indicating pressure drop or alarms
- e. Loose rivets or seams
- f. Warm, warped, panting or buckled bulkhead
- g. Change in list or trim
- h. Vibration
- i. Change in draft
- j. Increase in tank soundings
- k. Unusual machinery noises or odors
- l. Excessive heating, charring or sparking of electric cables
- m. Any unusual noises
- n. Any unusual silences.

SECTION 41.

SHIPBOARD FIREFIGHTING

079-41.1 REFERENCES

079-41.1.1 FIREFIGHTING PRINCIPLES. *NSTM 555, Firefighting, Volumes 1 and 2* contain greater detail regarding the methods, equipment and application of firefighting principles, including hazards inherent in having highly flammable materials in ships.

079-41.1.2 FIRE HAZARDS REDUCTION. Information regarding how to reduce fire hazards aboard Navy ships can be found in *NSTM 555, Firefighting, Volumes 1 and 2*.

SECTION 42.

HULL AND PIPE DAMAGE

079-42.1 OVERVIEW

079-42.1.1 This section describes how damage control equipment can be used to minimize the effects of damage, to confine it, to restore buoyancy and stability and to restore such services as firemain, electric power and light, air pressure where required, suction on drainage lines and other ship systems. Special tools are not always necessary. Many casualties can be corrected by using readily-available materials and common sense.

079-42.2

DIVERSITY OF BATTLE DAMAGE

079-42.2.1 When planning and preparing for control of damage, it is important to understand that no two incidents have identical characteristics, effects or require the same methods for repairing damage although the causes of damage, types of fires, sections of the ship involved or basic principles for the control of damage can be similar. [Appendix D](#) provides decision flowcharts to assist damage control personnel at the scene, helping them take immediate action. The following paragraphs describe basic principles which are to be applied for control of damage.

079-42.3

BATTLE DAMAGE CLASSIFICATION

079-42.3.1 In general, battle damage may be classified as follows:

- a. Large holes in the underwater hull
- b. Small holes and cracks in the underwater hull
- c. Holes in the hull above water
- d. Punctured, weakened, buckled or distorted bulkheads
- e. Flooded machinery compartments or other vital spaces
- f. Warped or sprung doors and hatches
- g. Weakened or ruptured beams, supports and other strength members
- h. Ruptured or weakened decks
- i. Wreckage which interferes with function
- j. Ruptured or cracked pipe lines
- k. Severed electric cables
- l. Broken or distorted foundations under machinery
- m. Broken or pierced machinery units
- n. Fire, with its attendant heat, smoke and other damage.

079-42.4 UNDERWATER EXPLOSIONS

079-42.4.1 **DAMAGE IMPLICATIONS.** Damage from an underwater explosion impairs the strength of a ship in the following two ways:

- a. Structural strength members are damaged by being ruptured or buckled.
- b. Flooding of compartments takes place, thus increasing the load on the already damaged ship girder.

079-42.4.1.1 An underwater explosion frequently opens a larger hole in the shell of a large ship than it does in a small one. The large ship is better able to afford the destruction and loss of structure because a smaller proportion of main structural members is damaged. A large ship's main structural shapes and plates are considerably heavier and more numerous than in a small ship. Therefore, there is less chance of structural failure in a large ship.

079-42.4.1.2 On cruisers, destroyers, auxiliaries and similar-sized ships, underwater explosions in the midship region have ruptured large portions of principal strength members. In ships of this type, after extensive damage to major strength members, the ship can break up unless the strength of fractured members can be replaced before the ship is further subjected to heavy seas. Partial restoration of main strength members can be accomplished only when the ship is at reduced speeds, with a calm sea, and when the destination is not too distant. Such repairs may not be practical underway, but frequently can be accomplished at advanced bases.

079-42.4.2 EXPLOSION AT ENDS OF SHIPS. An underwater explosion at either the bow or stern of a small ship (i.e., destroyer, frigate or auxiliary), usually causes considerable local destruction. One effect of such an explosion is to shake the ship like a whip. Waves of flexural vibration pass through the length of the hull, producing stresses similar to those experienced by hogging and sagging, of shorter duration but greater in intensity.

079-42.4.2.1 The result usually is not apparent, but can be serious. Damage consists mainly of compression failures in the midships region, evidenced by wrinkled deck plating, wrinkled shell plating, buckled longitudinal girders, laying over of flanges and wrinkling or other failure of any of the waist members that contribute to the ship's longitudinal strength. Such failures may be hidden below the waterline, under boilers, behind stores and equipment or beneath the surface of subsequent flooding water.

079-42.4.2.2 Compression members that once are buckled can never again recover their original strength. Attempts to straighten them are of little value; the only practical action is to shore immediately, then later replace the buckled compression members.

079-42.4.3 PROMPT ACTION. After the ship has sustained a hit, damage must be investigated following the guidance provided in [Section 40](#). With accurate reports from ship's investigators, the damage control officer can assess the extent of the damage and determine the action(s) required to localize and overcome the casualty.

079-42.4.3.1 A severe explosion or a well-placed shell may cause more damage than the repair party in the affected area can expeditiously handle, even assuming none of the repair party has been injured or killed. After a hit has been sustained, each repair station should send at least one person to the affected area to learn the extent of the damage, ascertain if help is needed and notify their respective repair station officers of the situation. Each repair station will then be ready to begin work immediately if so directed.

079-42.4.3.2 When a ship is so severely damaged that bow or stern is likely to break off, the correction of trim by incorrect methods (such as counterflooding a peak tank at the high end to correct the trim on a hogging ship) may hasten this loss. If there is imminent danger of breaking up, the proper procedure is to beach the ship (on a friendly shore if possible). Care must be taken not to drive the ship in a seaway.

079-42.5.3.2 Stiffening a Flat Plate. Compression stresses require more cross-sectional area, to be provided in the form of either shapes or plates, with stiffeners properly located to prevent buckling. Stiffeners on plating should run parallel to and be tied into other intact stiffeners in the vicinity. When placing stiffeners on plating, space them not more than 100 times the plating thickness or stiffener thickness, whichever is smaller. (When

possible, this distance should be reduced to about 60 times the smaller thickness.) One of several satisfactory methods of stiffening a flat plate in compression is shown in [Figure 079-42-1](#).

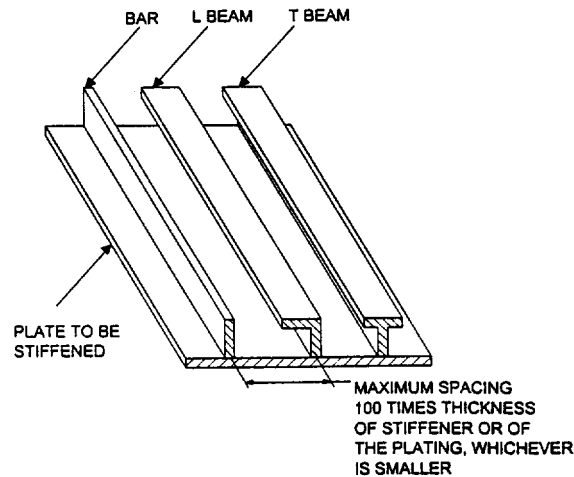


Figure 079-42-1. Stiffening Flat Plate in Compression

079-42.5.3.3 Action After Failure. A ship that has suffered compression failures amidships is in as precarious a condition as if the main strength members had been carried away. The actions that must be taken in such a case are as follows:

1. Reduce speed.
2. Change course to minimize hogging, sagging and pitching.
3. Make an immediate, careful inspection of the damage, locating evidence of wrinkled deck plating, buckled or failed longitudinals and buckled or stanchions or bulkheads that brace the hull girders. Look for hidden damage behind machinery or under stores. Use shallow-water diving equipment, if there is any flooding amidships. Examine fuel tanks for evidence of contamination.
4. Proceed immediately to the nearest safe anchorage if the tactical situation permits.
5. Commence repairs en route if at all practical.
6. Consider beaching the ship if damage is severe, or heavy weather is imminent.

079-42.6 FLOODING LOAD

079-42.6.1 INCREASE IN STRESSES. The load on the ship's girder is increased by the presence of flooding water. The increase in stress depends on both the amount and location of the following:

079-42.6.1.1 Sagging. Damage and consequent flooding in the middle length increases sagging stresses, which, in turn increase the tension at the bottom and compression at the top of the hull girder. Actions to correct trim caused by damage in the middle length must be aimed at reducing sagging stresses. This may be accomplished by any one or all three of the following methods:

1. Pump the liquid overboard in the amidships region. This would include either flooding water or the liquid in intact tanks. Consider stability before pumping low weights overboard.
2. Transfer liquids from amidships region to ends.
3. Counterflood high end (assuming good freeboard).

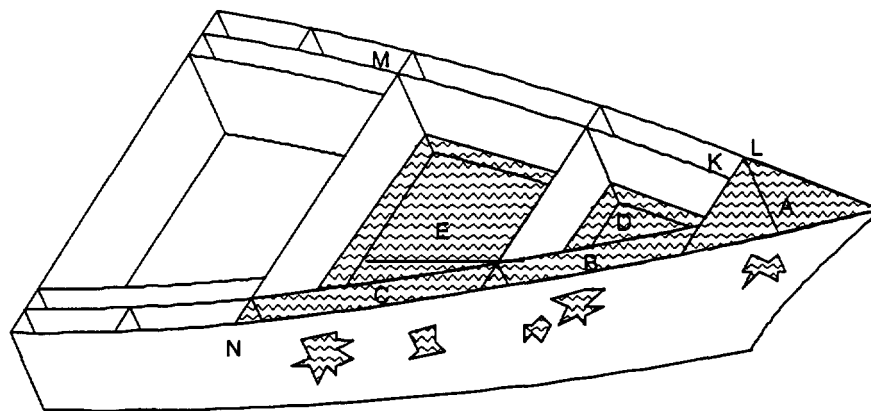
079-42.6.1.2 Hogging. Flooding at the ends after damage increases hogging stresses, which, in turn, increases the tension at the top and compression at the bottom. In this condition, action for the correction of trim must be to reduce hogging stresses. Such action shall be as follows:

1. Transfer liquids toward amidships.
2. Pump liquid near damage overboard. As when correcting sagging stresses, such liquid includes flooding water or liquid in intact tanks. Consider stability before pumping low weights overboard.
3. Flood amidships tanks (assuming good freeboard).

079-42.7 FLOODING BOUNDARIES

079-42.7.1 ESTABLISHING BOUNDARIES. A flooding boundary is established by first locating the bulkheads and decks which are dry and likely to remain dry. The next action is to advance the flooding boundary toward the original point of damage by preventing further flooding of dry or partially-flooded compartments. It is important to close in on the damage from all sides.

079-42.7.2 DEPICTION OF FLOODING DIAGRAM. Figure 079-42-2 represents a ship that has received severe underwater damage. Compartments A, B and C have been badly ruptured and are completely flooded. There is little or nothing that can be done about them. Compartments D and E are only partly flooded. Their out-board bulkheads contain small holes, cracks, loose rivets, broken seams and splinter holes. Progressive flooding is taking place. If no action is taken to close these holes, the ship will take on more water, with a subsequent loss of buoyancy, and the list will increase several more degrees to starboard. Compartments A, B, C, D and E constitute the damaged or flooded area. The bulkheads and decks surrounding that area form the flooding boundary. If D and E become completely flooded, the flooding boundary may not hold. There may be hidden cracks or leaky stuffing tubes or the bulkheads may fail from the additional pressure upon them.



A-B-C = BADLY HOLED AND COMPLETELY FLOODED
 D-E = PARTLY FLOODED THROUGH SMALL HOLES AND CRACKS
 K-L-M-N = FLOODING BOUNDARY

Figure 079-42-2. Establishing Flooding Boundaries

079-42.7.3 ADVANCING BOUNDARIES. Even though a flooding boundary has been established, there is no indication that the boundary will remain safe. Action must be taken by the repair party to advance that flooding

back toward the point where the torpedo or bomb exploded. If it is possible to patch the outboard bulkhead of compartments D and E and get the flooding in those compartments under control, this will accomplish the following advantages:

1. To ensure that the original flooding boundary indicated by K, L, M and N will not be lost
2. To prevent more flooding water from entering the ship
3. To prevent the continuing loss of buoyancy and stability.

079-42.7.4 ADVANTAGES OF EFFECTIVE PATCHING. Should those bulkheads be so well patched that they are able to keep compartments D and E relatively dry, the additional advantages will be as follows:

1. To eliminate a large amount of flooding water, thus reducing the list and trim
2. To eliminate free-surface water in those compartments, thus contributing to the stability of the ship
3. To reduce impairment of the fighting qualities of the damaged ship.

079-42.8 PROGRESSIVE FLOODING AND BURNING

079-42.8.1 HISTORIC OVERVIEW. Few Navy ships sink as a direct result of initial damage; however, many went down hours later as a result of progressive flooding, fire, collapsing bulkheads, increased free-surface and human error. Many ships would have survived had flooding, fire and smoke boundaries been established and maintained. Ship compartmentation allows large areas to sustain damage so long as the damage can be boxed and confined.

079-42.8.2 PRIORITIZE WORK EFFORTS. "Hold what you have" should be the slogan of the repair party. Do everything possible to prevent progressive flooding and burning. It is human nature to attack obvious damage while ignoring hidden damage (that could sink the ship). Hours are often wasted by repair parties trying to patch large or multiple holes in compartments which are already flooded or have large free-surface areas. Smaller holes through interior bulkheads or other holes that allow progressive flooding and more free-surface often are overlooked. In most cases, it is prudent to plug interior holes first.

079-42.9 HOLES IN SHIPS

079-42.9.1 GENERAL. When a ship is struck by a projectile with a force sufficient to pierce a watertight boundary, a hole is created. It is imperative that holes be plugged promptly to stop, or appreciably slow flooding effects.

079-42.9.2 TYPES OF HOLES. Holes through watertight boundaries can be of almost any size or shape. Shell holes frequently are several times as large as the projectile causing them. Projectiles and bombs rarely make circular holes; more often, they strike the ship at an angle, creating elongated holes (sometimes up to six or eight feet long). Ricochets create a keyhole-shaped opening. Splinters and fragments create unusual patterns, ranging from fuzzy circular holes burned through aluminum plating to odd-shaped rectangles through steel plates.

079-42.9.2.1 Jagged Protrusions. In almost every case, the projectile punches out part of the metal completely and bends the rest of it inward, forming jagged protrusions. Ragged edges or torn rumpled plating can project both inward and outward in the same hole (because a shell may have exploded while passing through the plate). Spidery cracks or cuts may radiate from the hole. Protruding edges of torn plating can be removed or reduced by

oxyacetylene torches or by pounding them with mauls. Lightweight iron plates can often be flattened fairly well by pounding but this is not true of the heavier special-treatment steel plates found on combatant ships. Caution must be exercised in the use of oxyacetylene torches, which can result in fires or explosions.

079-42.9.2.2 Blast Effects. Holes produced by shock differ in size and shape. Bulkheads may be split wide open, have small cracks or torn seams. Distortion of plating is common. Watertight doors and hatches may be bent away from their knife edges, especially if the fittings were not properly secured. Rivets can be pulled through plating, welding around pipe lines passing through bulkheads may crack, shafts passing through bulkheads may whip severely, dislocating glands and packing and ripping adjacent bulkheads. Cracks in sea chests, ruptures in piping or holes left by careless workers can also contribute to flooding; each will have to be repaired if the ship is to survive.

079-42.9.3 LARGE HOLES IN UNDERWATER HULL. Torpedoes, contact mines and some near-miss bombs can, upon explosion, create large holes in the underwater hull and cause large sections of hull plating to be destroyed. This type of damage causes complete and extensive flooding and a great amount of wreckage. Such damage, which cannot be repaired by the ship's force, must be repaired in drydock.

079-42.9.4 SMALL HOLES IN UNDERWATER HULL Bulkheads with small holes, cracked plates or seams, warped hatches, leaky stuffing tubes or holes made by blast or by fragments, must be acted upon in the same manner as small holes in the underwater hull. Small holes in the underwater hull often result from near-miss bombs or from violent explosions at some other part of the ship. A torpedo explosion forward may corrugate and crack shell plating on the quarters. Cracks also may result from stresses produced by steaming at high speeds or by the working of the plates in heavy seas. It is possible to localize flooding and preserve buoyancy by plugging such holes. And when water has been removed from damaged compartments, further action can be taken to minimize damage.

079-42.9.4.1 Water Pressure. Water pressure must be considered when it becomes necessary to make repairs to underwater holes. A hole submerged on one side only is subjected to an inward pressure of 0.444 pounds per square inch for every foot of submerged depth. A hole seven feet below the waterline will be subjected to a pressure of three pounds per square inch. A circular hole five inches in diameter and nine feet below the waterline will be subjected to a total pressure of 78.5 pounds. These pressures are not excessive, and they are further reduced when the hole is submerged on both sides.

079-42.9.4.2 Accessibility. The lack of accessibility is often the greatest difficulty in repairing underwater holes. If the inboard compartment is flooded, it may be dangerous to attempt repairs. Opening a hatch or a door may permit flooding in another compartment. It may be necessary, instead, to send a person wearing shallow-water diving apparatus down into a compartment to repair a submerged hole. Note that such repairs can be hampered by hidden or tangled wreckage, darkness or water and by the difficulty of working underwater with wooden shoring and other buoyant repair materials.

079-42.9.5 HOLES AT WATERLINE. Holes in the hull at or just above the waterline may not appear to be of immediate consequence. However, such holes destroy reserve buoyancy and, should the ship roll in a heavy sea or lose buoyancy, can become submerged and admit flooding water above the center of gravity. This situation is dangerous because such a condition reduces stability and the flooding water invariably presents a large free-surface. Therefore, holes at or near the waterline must be plugged at once, with priority given to holes at the waterline on the low side.

079-42.9.5.1 Interior Sheathing Damage. Interior sheathing damage near the waterline can be hazardous. Sheathing damage of this type must be cut away before holes in the exterior hull can be plugged. Sheathing can be removed by taking out the screws (a slow process), by cutting the screws with a cold chisel and hammer, with a pneumatic chisel or with an axe. (The best tool is a pneumatic shear, provided air pressure is still available.) A linoleum knife is effective on light aluminum sheathing.

079-42.9.5.2 Interior Lighting Exposure. Holes above the waterline can be hazardous in another way: such above-water holes permit interior lighting to be exposed at night, perhaps revealing the ship's position to an enemy. Sheathing can complicate the ability to locate hull penetrations above the flooding level.

079-42.9.6 FLOW OF WATER THROUGH HOLES. The amount of water that can enter through a hole in the ship's hull can be calculated only on a moment-in-time basis, because, as water is received into the hull, the ship will settle and the hole will be further submerged. As the depth of the hole increases, the pressure of the water increases, causing a greater amount of water to enter the ship until the level of the water in the flooded compartment reaches the level of the hole. Thereafter, the pressure will decrease.

079-42.9.6.1 To compute the amount of water that could enter a ship through a hole in the side, the following formula is useful:

$$Q = 3600 A \sqrt{H}$$

Q = Quantity of water per minute in gallons

A = Area of hole in square feet

H = Height of water in feet (depth of hole)

The formula is derived from $Q = AV = A \sqrt{2gH}$

where $Q = \text{ft}^3/\text{sec}$, $V = \text{ft}/\text{sec}$, $g = 32 \text{ ft}/\text{sec}^2$.

NOTE

No coefficient is used for friction. Therefore, actual flow rates will be less than that obtained from the formula. For purposes of rough calculations, use an H corresponding to the depth of the hole below the initial external waterline.

079-42.9.6.2 The amount of water flowing laterally through a hole in a bulkhead can be computed in a similar manner. Under the same conditions, ingress of water can be reduced by either of the following actions:

- a. Careening the ship to raise the level of the hole (impractical but not impossible)
- b. Reducing the area of the hole (very practicable and effective in most cases).

079-42.9.6.3 [Table 079-42-1](#) can be used to determine flow of water through holes. First, look down the left-hand column (hole diameter in inches) to the approximate hole size. Then, proceed to the right along that row until the intersection with the known head of water, in feet, is reached. The number at the intersection is the flow in gallons per minute. No coefficient for friction is used in this chart; therefore, the actual flow rates will be less than that obtained from this chart.

Table 079-42-1 FLOW OF WATER THROUGH HOLES

HOLE DIA IN INCHES	HEAD OF WATER IN FEET												
	2	4	6	8	10	12	14	16	18	20	24	28	32
1	28	40	49	56	63	69	74	79	84	89	97	105	112
2	111	157	192	222	248	272	294	314	333	351	384	415	444
3	250	354	433	500	559	612	661	707	750	790	866	935	1000
4	445	629	770	889	994	1089	1176	1257	1333	1405	1540	1663	1778
5	695	982	1203	1389	1553	1701	1837	1964	2083	2196	2406	2598	2778
6	1000	1414	1732	2000	2236	2449	2646	2828	3000	3162	3464	3741	4000
7	1361	1925	2357	2722	3043	3333	3601	3849	4083	4303	4714	5092	5444
8	1777	2514	3078	3555	3974	4354	4702	5027	5332	5620	6157	6650	7109
9	2249	3181	3896	4499	5030	5510	5951	6362	6748	7113	7792	8416	8997
10	2777	3927	4809	5553	6209	6802	7347	7854	8330	8781	9619	10390	11107
11	3360	4752	5820	6720	7514	8231	8890	9504	10080	10626	11640	12573	13441
12	4000	5655	6926	7997	8941	9795	10579	11310	11996	12645	13852	14961	15995
13	4693	6637	8129	9386	10494	11496	12417	13274	14079	14841	16257	17560	18772
14	5443	7697	9426	10885	12170	13331	14400	15394	16327	17210	18853	20364	21770
15	6246	8834	10820	12494	13969	15302	16528	17667	18740	19754	21640	23374	24988
16	7106	10051	12310	14214	15892	17409	18804	20102	21322	22475	24620	26593	28429
17	8024	11347	13897	16047	17942	19654	21229	22694	24071	25373	27795	30022	32095
18	8996	12722	15582	17992	20116	22035	23802	25445	26988	28448	31164	33660	35985
19	10024	14177	17363	20049	22416	24555	26523	28354	30073	31700	34726	37408	40098
20	11110	15710	19241	22218	24840	27211	29392	31421	33326	35129	38483	41566	44436
21	12244	17316	21208	24488	27379	29992	32396	34632	36732	38719	42416	45814	48977
22	13439	19008	23280	26881	30054	32923	35561	38016	40322	42503	46560	50290	53763
23	14688	20772	25441	29376	32844	35978	38861	41544	44064	46447	50881	54958	58753
24	15995	22622	27707	31993	35769	39183	42323	45245	47989	50585	55414	59853	63986
25	17356	24545	30061	34711	38809	42513	45920	49090	52067	54883	60122	64939	69424
26	18770	26546	32513	37542	41974	45980	49664	53093	56313	59359	65025	70235	75085
27	20242	28627	35061	40485	45264	49584	53557	57254	60727	64012	70122	75740	80971
28	21770	30787	37707	43539	48679	53325	57598	61574	65309	68842	75413	81455	87080
29	23353	33026	40449	46706	52220	57203	61787	66053	70059	73849	80898	87380	93414
30	24992	35345	43289	49985	55885	61219	66125	70690	74977	79033	86577	93514	99971
31	26683	37735	46216	53365	59665	65359	70597	75470	80048	84378	92432	99838	106732
32	28434	40212	49250	56868	63581	69649	75231	80424	85302	89916	98499	106391	113738

079-42.10 METHODS OF REPAIRING HOLES

079-42.10.1 GENERAL. There are two general methods of repairing a hole; either put something into it or put something over it. In either case, the objective is to reduce the area through which water can enter the ship or through which it can pass from one compartment to another.

079-42.10.1.1 The following suggestions for plugging and patching holes are designed for battle use. They are temporary repairs that ship's force can do in action to keep the ship afloat and fighting. In most cases, they do not require elaborate tools or equipment. Repairs can be effected using either prefabricated patches or materials that may be adrift and which can be used effectively by a trained ship's force.

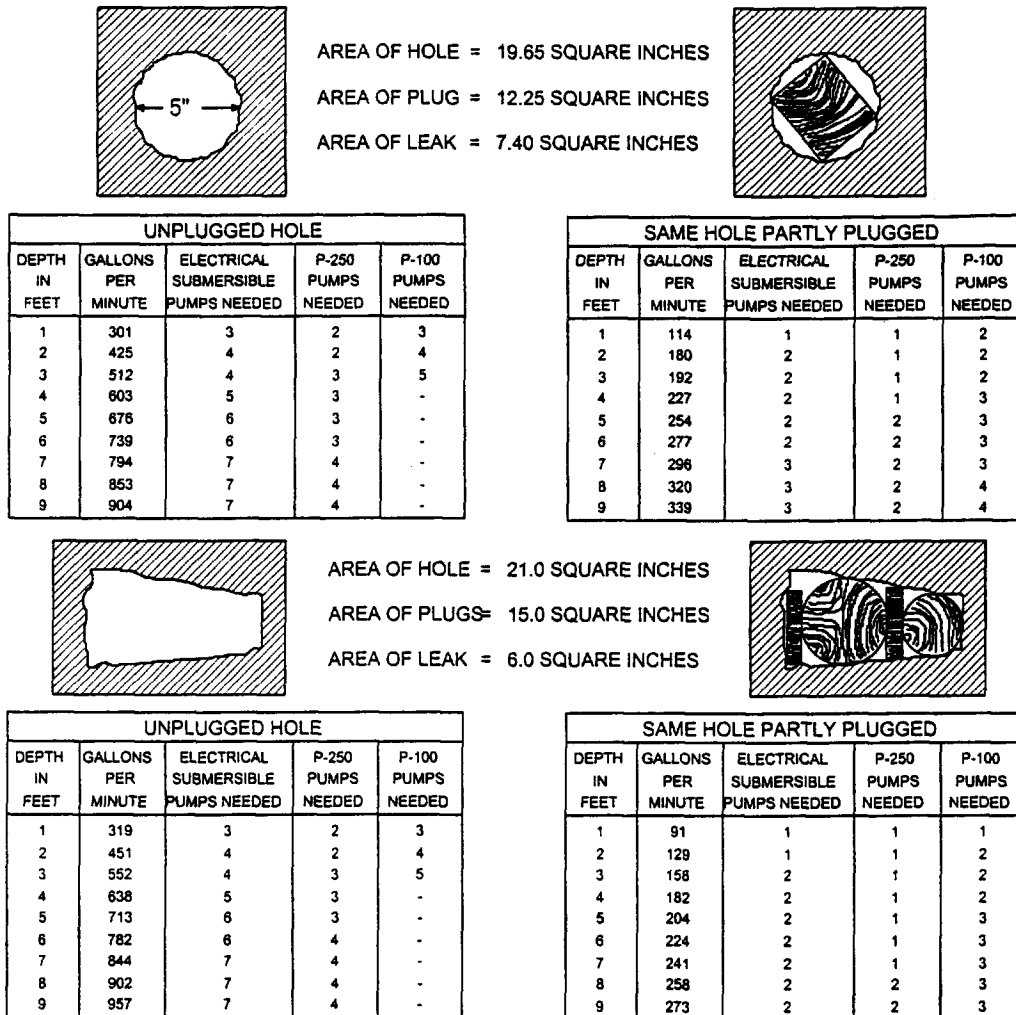
NOTE

No temporary patch will be perfectly watertight, but if it can reduce the ingress of water by as much as 50 percent, it may be possible to control the flooding with the pumps.

079-42.10.1.2 All of the patches discussed in the following paragraphs and all of the principles behind them have been proven in battle. They have helped to bring ships and personnel home safely. Some of them have enabled ships to remain in combat and at sea for months after the original damage was received.

079-42.10.1.3 There is no one patch that can be suggested for all types of leaks. The choice, construction and application of any patch must be made accurately and promptly. [Figure 079-42-3](#) shows the flooding effect of unplugged holes, and of the same holes after the insertion of the most simple type of plugs. The volumes of flooding water are given in gallons and also in terms of the number of portable electric submersible and portable pumps required to handle the flooding. The pump capacities used are considerably under the rated capacities, but if the strainers are clogged with debris, actual capacities may be much less. The numbers in this figure are obtained by using a coefficient of 0.6 to account for friction losses, etc.

THE AMOUNT OF WATER ENTERING A SHIP THROUGH A HOLE VARIES DIRECTLY WITH THE AREA OF THE HOLE AND THE SQUARE ROOT OF ITS DEPTH BELOW THE WATERLINE



NOTE: AVERAGE EFFECTIVE FLOODING AREAS SHOWN WITHIN WHITE LINES. THESE FIGURES SHOW HOW IMPORTANT IT IS TO PUT SOME KIND OF PLUG INTO ANY HOLE RIGHT AWAY.

Figure 079-42-3. Flooding Effect Comparison

079-42.10.2 WOODEN PLUGS AND WEDGES. The most simple method to repair small holes is to use wooden plugs. Plugs made of soft wood are effective, especially in holes not over 3 x 2 inches. (They have held up well in even much larger holes.) Every ship has an assortment of conical, square-ended and wedge-shaped wooden plugs at each repair station. Plugs should be stowed in canvas bags for various damage control kits. Plugs should not be painted; unpainted soft wood absorbs more water and grips better. Combinations of conical, square-ended and wedge-shaped plugs may be used, if needed, to get better conformation with the shape of the hole. It is best to wrap plugs with lightweight cloth, prior to insertion. The cloth will help plugs grip better (see [Figure 079-42-4](#)), and also will fill some of the gaps between plugs. Wooden plugs will not always create a watertight fit, but by caulking the remaining leaky area with rags, oakum and smaller wedges, the ingress of water can be greatly reduced. Note that square-ended plugs hold better than conical plugs in holes in plating one-fourth inch or less in thickness. Also, when wedges do not fit tightly, use a hatchet to quickly split the wedge into smaller pieces. The smaller sized wedges can be applied quickly into the smaller hole.

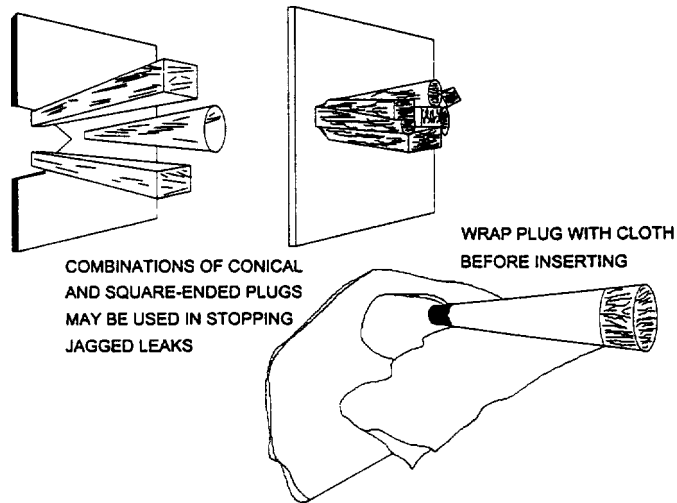


Figure 079-42-4. Use of Wooden Plugs to Fill Holes

079-42.10.2.1 Most wooden plugs are inserted from inside the ship; plugs driven in from outside may not have as much interference (from inward-protruding metal, for example), but outside plugs that cannot be readily tended, are often knocked out by the action of the sea and do not hold up as well over extended periods of time. The choice of whether to insert a plug from inside the ship, or from the outside, will depend upon several factors: access, amount of flooding and degree of wreckage.

079-42.10.2.2 [Figure 079-42-5](#) illustrates the use of a line to secure a plug from the outside. The line is secured to the inboard end of a plug with a screw eye and the other end is made fast to a stanchion.

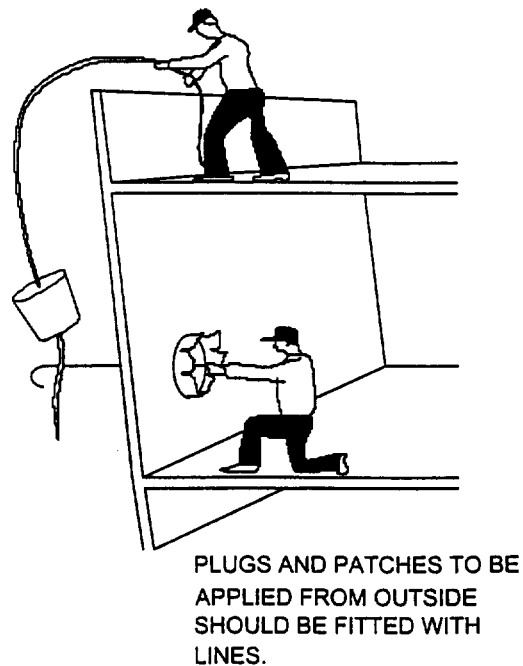


Figure 079-42-5. Use of Line to Secure Plug

079-42.10.3 MATTRESSES. Mattresses, which can be used to patch large holes, are placed on inside-the-ship holes. Sometimes it is desirable to place the patch inside the ship, not only for accessibility but to reduce the danger of having the patch knocked away by sea action. For inside patches, innerspring mattresses are preferred

principally because they hold their shape better while being placed, are thicker and adjust better to protruding edges. It would be good to use at least one thickness of blanket as a facing for an innerspring mattress. The thickness of two crew mattresses will generally be more effective than a single mattress. The mattresses should be backed with joiner doors, steel plates or wooden plates made of cleated planks, shored stoutly in place. Holes or cracks into which the mattress cannot be pushed can be stuffed with rags, oakum and wedges. Such patches have not always been satisfactory but they have given good results over many shell holes and in replacing damaged watertight doors. Another effective mattress-plugging method is to roll the mattress(es) around a wooden plug or a timber to increase their size and to provide rigidity. Wrapping them in a blanket sometimes helps. Such plugs must be frequently checked since they have a tendency to back out of the holes as a result of the action of the sea. Figure 079-42-6 illustrates two methods for using mattresses to patch or plug holes.

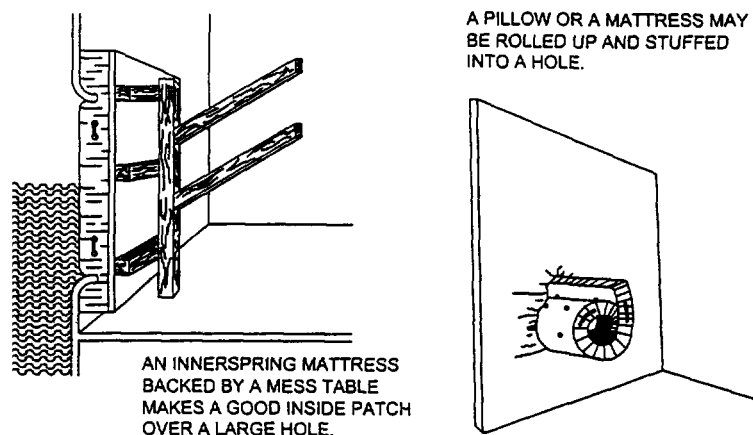


Figure 079-42-6. Plugging with Mattresses

079-42.10.4 PLATE PATCHES. Plate patches have, in the past, proven to be of great value. (One small ship returned from an action with 84 of them in use.) Plate patches are easily made; every ship should have several on hand before departing for a combat zone. Figure 079-42-7 shows how prefabricated patches can be made with a square piece of 10-pound (quarter-inch) steel plate. On one side is a thick gasket placed near the edges. A thick tube of canvas stuffed with oakum or cloth makes an effective gasket; somewhat less effective is the use of strips of old rubber tires. The gasket can be secured to the plate with machine screws, washers and nuts, but the holes through the plate must be reamed so the screws will not hold the plate away from the ship. The gasket can also be held in place with retainer strips. At the center of the inner side weld is a ring or eyebolt to secure a line which holds the patch close to the skin of the ship.

079-42.10.4.1 Another method often used to secure a plate patch is accomplished by drilling a hole through the center of the plate, then inserting a wire or manila line through the hole, with the outboard end knotted. (Wire is stronger and it does not give easily. When coated with fuel oil, however, wire is very slippery. Manila line is preferable.) Plate patches are made in various sizes up to five feet square. The larger sizes are very heavy; it is necessary to weld an eye at the top center of the plate to secure a handling line, which can also act as the vertical support when the patch is in place. Similar eyes can be welded in place at the forward and after ends for securing guys. The plate patch is lowered over the side by the handling and supporting line. A person inside the ship reaches out through the shell hole, grabs the center line and pulls the patch tight against the ship's side; the center line then is made fast to a stanchion.

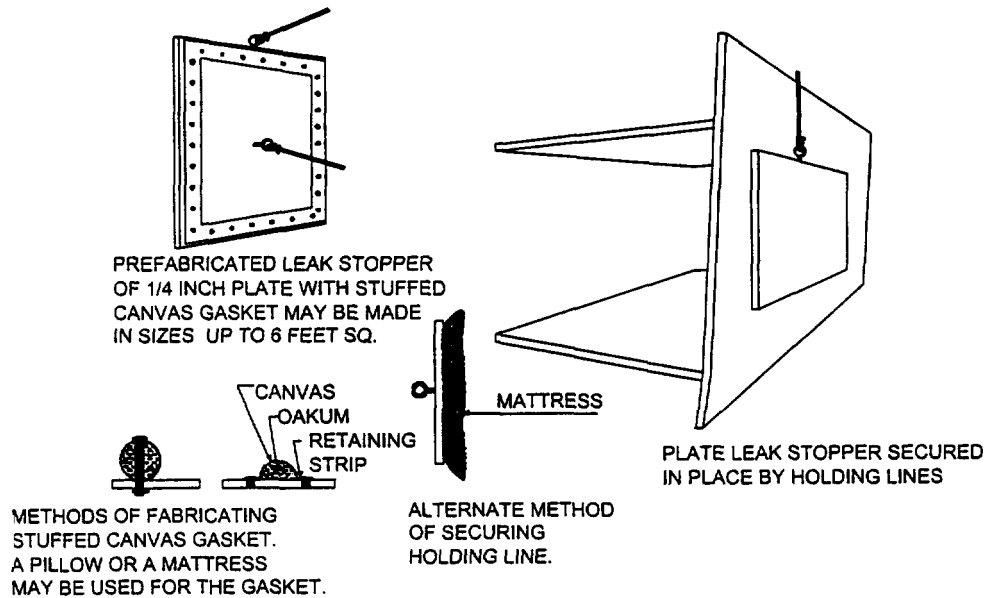


Figure 079-42-7. Application of a Plate Patch

079-42.10.4.2 Every ship carries a large amount of material from which almost all patches can be improvised: mattresses, pillows, blankets, mess tables, joiner doors, planks, floorplates and gratings, for example.

079-42.10.4.3 The patch in [Figure 079-42-8](#) has been made by placing a crew mattress over the shell hole outside the ship, backing it with a mess table (when available), and holding it in place with two lines passed through two holes drilled through the patch. The inboard ends of the lines are secured to a stanchion, and tightened by using sticks to make Spanish windlasses. Fore and aft guys are used to keep the patch in place against sea action. Another ship made a similar patch, using a floorplate, a mattress and a manila line. In this case an eyebolt was welded to the plate to secure the line.

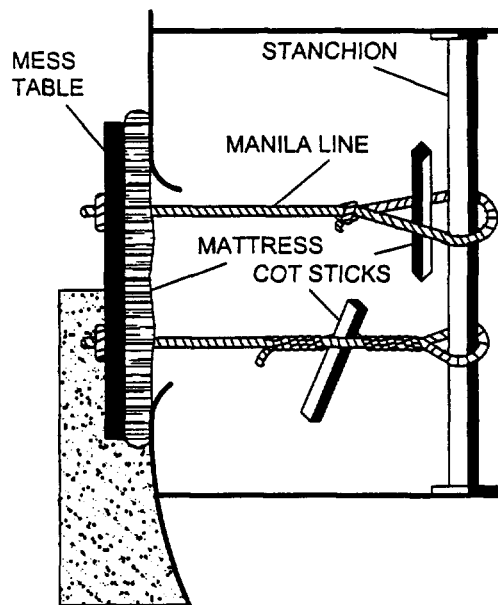


Figure 079-42-8. Outside Patch Made of Mattress and Mess Table

079-42.10.4.4 Repair parties are to survey their areas to ascertain where materials can be found from which extra patches can be fabricated. This survey should be made during training exercises.

079-42.10.5 HINGED PLATE PATCH. [Figure 079-42-9](#), a variation on the plate patch, shows a circular plate, 18 inches or less in diameter, cut in two and so hinged that it may be folded and pushed through a hole from inside the ship. The plate is fitted with a gasket, and also a line for securing it to the ship. With this design, personnel in a shallow-water diving outfit can apply a patch over a submerged hole without going outside the ship. This patch is designed only for use over a relatively small hole, since it has no vertical support to hold it in place.

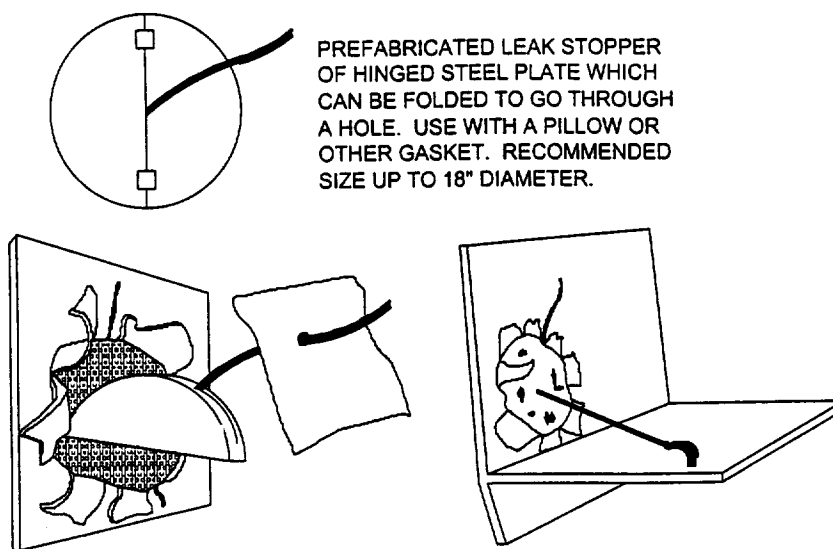


Figure 079-42-9. Application of a Hinged Plate Patch

079-42.10.6 FLEXIBLE PLATE PATCH. A flexible variety of the plate patch can be used over curved surfaces (such as the turn of the bilge). The plate is made of lightweight sheet metal, reinforced parallel strips of light angle iron, welded in place, about six or eight inches apart. The plate has four eyes for securing lines, and it should have some kind of soft gasket on the facing surface. It is, in effect, a stiff, metal collision mat.

079-42.10.7 PILLOWS, BLANKETS AND KAPOK LIFE JACKETS. Feather pillows do not make effective patches or gaskets. When the feathers get wet, they will collect in a lump at one end of the ticking cover, collapsing the patch. Furthermore, if the casing rips, feathers come out and clog pump strainers. Kapok life jackets are more effective. Folded blankets can be used in place of pillows.

079-42.10.8 BOX PATCH. When jagged edges protrude inward, a suitable patch is a steel box running in sizes up to 18 inches square and six inches deep. The box is open at one end and has a gasket running along the facing edges. The gaskets may be made of rubber or of canvas stuffed with oakum. The box is put over a shell hole from inside the ship and is held in place with shoring. When the compartment is pumped dry, the box may be secured by welding angle clips between the box and the hull plating, after which the timbers can be removed for use elsewhere. The box cannot readily be fitted to uneven surfaces, so variations will have to be made in its use. One variation is to stuff the box with pillows, or to lay pillows over the hole before applying the box. Another variation is to stuff rags and wedges into holes between the box and the rumpled hull. In the absence of ready-made steel boxes, similar patches can be made of planks. The advantage of a wooden box is that its edges can be shaped with a hatchet to fit closer to corrugations in plating. It is suggested that large ships make and carry box patches in sizes up to four feet square and one foot deep. [Figure 079-42-10](#) shows three views of box patches illustrating a steel box leak stopper shored in place or welded in place with angle clips.

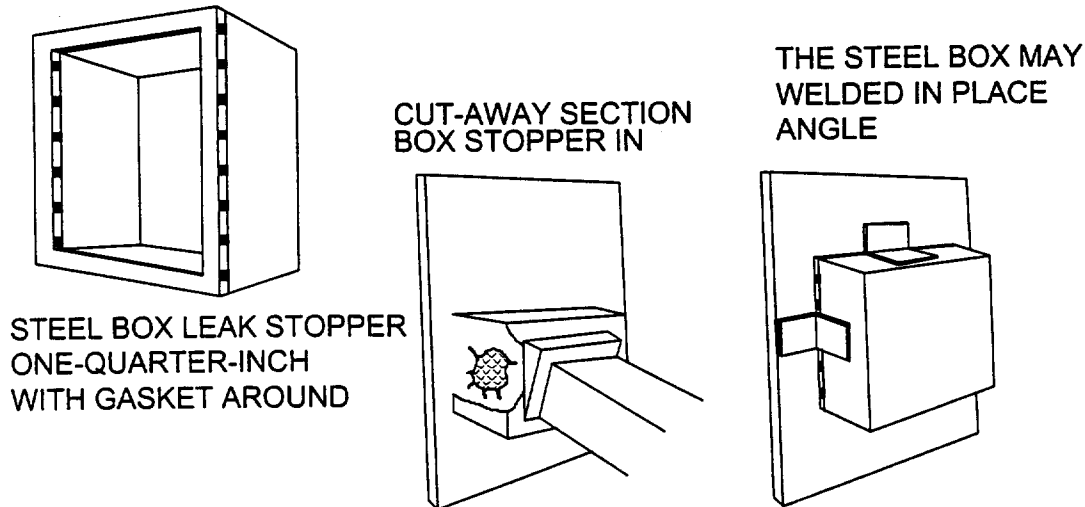


Figure 079-42-10. Box Patch

079-42.10.9 BUCKET PATCH. An ordinary galvanized bucket can be used in a variety of ways to stop leaks. It can be pushed into a hole, bottom first, to form a metal plug, or it can be stuffed with rags and put over a hole like the box patch previously described. It can be held in place by shoring or by using a hook-bolt.

079-42.10.10 HOOK BOLTS. A hook bolt is a long bolt having the head end so shaped that the bolt can be hooked to plating through which it has been inserted. Common types of hook bolts are the T, the J and the L, as illustrated in [Figure 079-42-11](#); so-called because they resemble those letters. The long shanks are threaded and provided with nuts and washers. Steel or wooden strongbacks are used with hook bolts, which have no regular head.

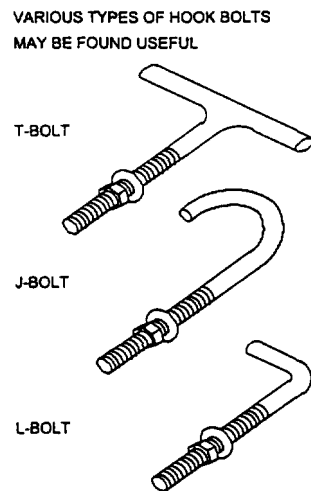


Figure 079-42-11. Types of Hook Bolts

079-42.10.10.1 The head end of the bolt is inserted through a hole and the bolt is rotated or adjusted until it cannot be pulled back through the hole. A pad or gasket, backed by a plank or a strongback, is then slid over the bolt, and the patch is secured in place by tightening the nut.

079-42.10.10.2 Generally it is necessary to use these bolts in pairs, as illustrated in [Figure 079-42-12](#). Hook bolts can be used in combination with many of the patches previously mentioned, especially the folding plate, the box and the bucket.

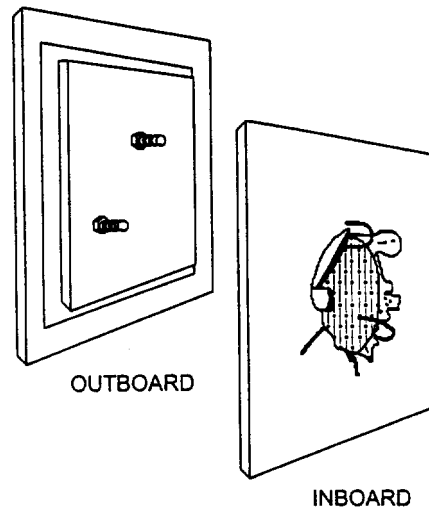


Figure 079-42-12. Securing Patch with J-Bolt

079-42.10.11 FOLDING T. A variation of the hook bolt is the folding T. It resembles the T-bolt, but it has a hinge where the shank joins the crosspiece so it is much like the tumble toggle bolt. This bolt may be folded and inserted through a small hole; when pulled back, the crosspiece catches on the hull plating. Using the folding T, a person standing inside the ship can put a patch either inside or outside the ship. By means of a retaining line on the bolt, a strongback and a pillow can be threaded over the line and the entire patch folded and tossed out through the hole. When the line is hauled in, the patch hugs the ship where it can be readjusted to give a tighter fit; or the pillow and plate can be pushed over the shank inside the ship, which will give an inside patch. Nuts and washers are provided for holding and tightening the patch, preferably using large wings on the nuts. [Figure 079-42-13](#) illustrates the installation of a folding T-patch.

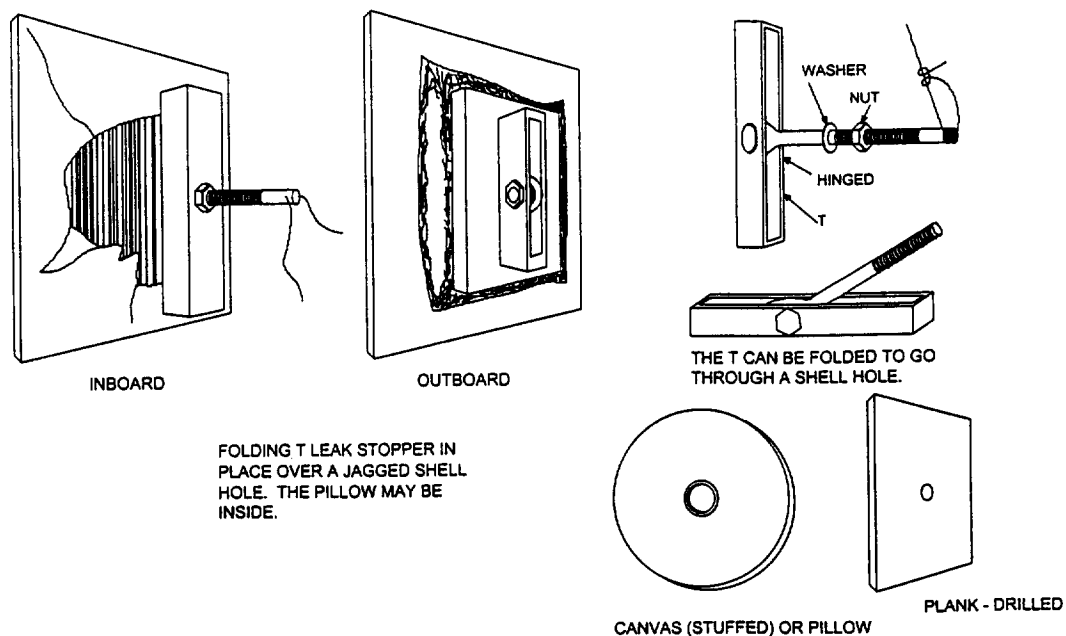


Figure 079-42-13. Installing Folding T-Patch

079-42.10.12 WELDED PATCHES. It is possible to repair large holes in decks and bulkheads by welding steel plates onto the ship's surface, covering the hole. (It may be necessary to make a temporary patch (previously

described) while preparing to weld steel plates in place.) Before welding a flat steel plate in place, all protruding edges around the edges of the hole must be cut away, using an oxyacetylene torch or a pneumatic chisel.

CAUTION

Before using any flame- or spark-producing repair equipment, always test the air for the presence of explosive fumes, have a CO₂ extinguisher at hand, and lead out a fire hose with personnel ready to operate.

079-42.10.12.1 A patch should be applied to the side on which the projectile entered. Thus, if a bomb penetrates a deck, put the patch on the upper, not the lower, side. This reduces the time and labor necessary to clear a hole for repairs.

079-42.10.12.2 The immediate application of welded patches generally is confined to those which can be made on decks and interior bulkheads; others are made when the ship has withdrawn from action or is dead in the water.

079-42.10.12.3 A steel plate can be held lightly in place by tack welding, after which the welder should go around the plate with a solid bead to hold it securely in place and to stop all cracks. If the plate is large, it must be reinforced with shoring and welded stiffeners on the back to prevent excessive motion. If this precaution is not observed, the welding may crack causing the patch to open wide and act as a scoop.

079-42.11 SEALING LEAKS AND CRACKS

079-42.11.1 GENERAL. Quick action when sealing leaks and cracks can prevent further flooding or even advance the flooding boundary back to the area of damage. The following paragraphs describe methods for sealing leaks and cracks.

079-42.11.2 CRACKS IN STEEL PLATES. A common type of leak is caused by a crack in a steel plate. When the leak is in a flat surface away from frames and other interference, it can generally be stopped by scraping the surface smooth and applying a patch of sheet packing, backed by a shole held in place with shoring as illustrated in [Figure 079-42-14](#). A crack around a welded port insert is an example of damage which could be stopped using the sheet packing patch.

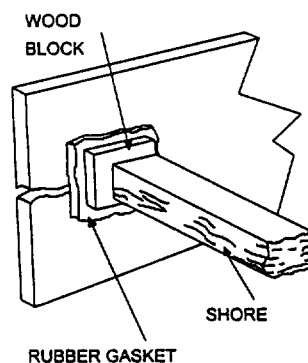
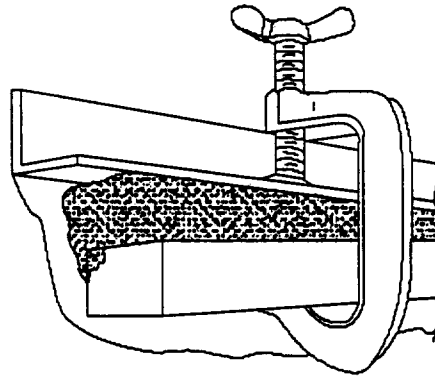


Figure 079-42-14. Patching Crack Leaks with Sheet Packing, Sholes, and Shoring

079-42.11.3 CRACKS ADJACENT TO FRAME. When the crack is adjacent to a frame, it may be necessary to use oakum as a stopper, held in place by the corner of a timber and clamps, as illustrated in [Figure 079-42-15](#).



C-CLAMPS MAY BE USED TO
HOLD PADS TO A LEAK
ALONG A FRAME.

Figure 079-42-15. Sealing Crack Adjacent to Frame

079-42.11.4 TORN PLATING. To prevent continued cracking, drill quarter-inch holes at the extreme ends of the crack, plug the holes and, time permitting, weld a plate over the crack. This technique is illustrated in [Figure 079-42-16](#).

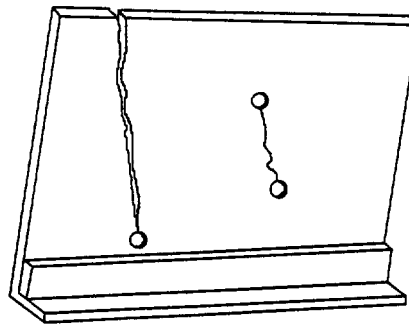


Figure 079-42-16. Controlling Cracks

079-42.11.5 CAULKING THIN PLATING. Wedges tend to open cracks; therefore, it is not advisable to drive wedges into cracks in thin plating (especially hardwood wedges). Marline, oakum and rags can often be used as effective caulking materials. Two methods of handling these caulking materials are illustrated in [Figure 079-42-17](#).

079-42.11.6 CAULKING TORN SEAMS. Among the most difficult holes to plug are torn seams or loose bounding boards where deck and bulkhead plates are joined. It is not advisable to weld leaky riveted seams because the intense heat will cause adjacent rivets to leak. Rags, oakum, marline, soft wood wedges, shingles, lead strips, lead wool, metal caulking and various plastics have been used to plug such leaks. These materials are applied on the unflooded side; however, the working of the plates (causing the cracks to open and close) permits plugging materials to be washed out. Temporary measures can be taken, i.e., wedging packed oakum into place with the method illustrated in [Figure 079-42-18](#).

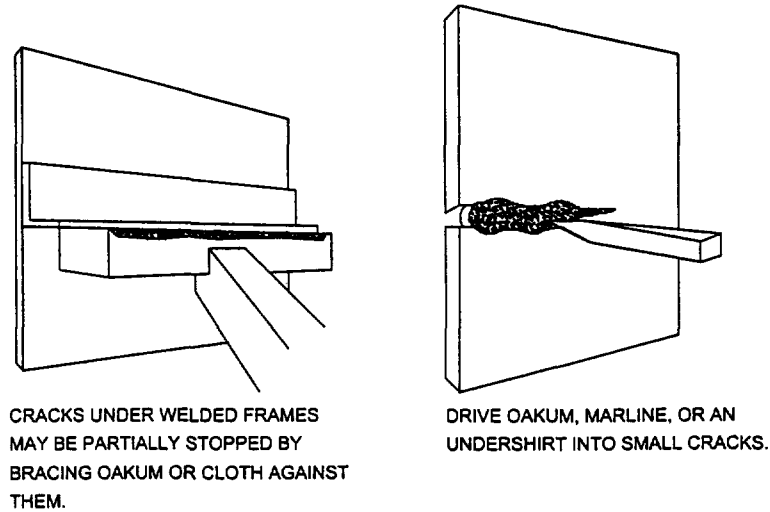


Figure 079-42-17. Caulking Thin Plating

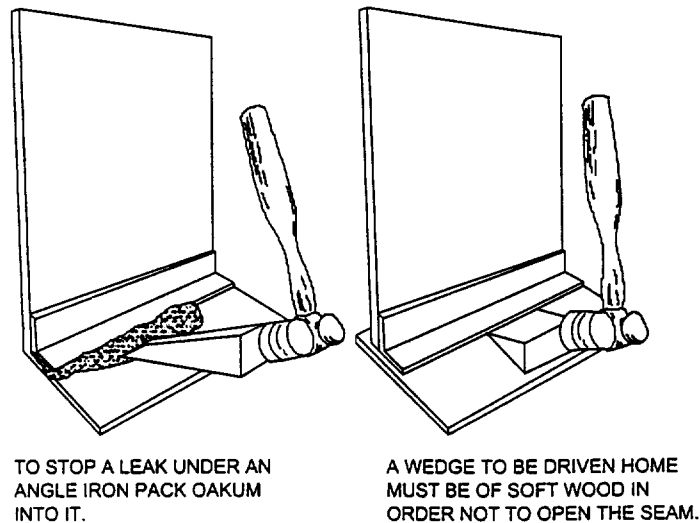


Figure 079-42-18. Caulking Torn Seams

079-42.11.7 DOORS AND HATCHES SPRUNG BY BLAST. Doors and hatches are often sprung by blast, especially if not properly secured. Frequently, the closure can be made tight with shoring. Small spaces between the closure and the knife edge can be treated as cracks. In some cases the damage is so bad that it is better to remove the closure entirely and to replace it with a mattress backed by a shored plate. Armored hatches present a peculiar problem, especially when the surrounding decks are warped. In some cases the best remedy is to cut the hinges, allowing the hatch to fall back into its proper place.

079-42.11.8 LEAKY STUFFING TUBES, SHAFT GLANDS AND RIVETS. Stuffing tubes around electric cables and reach rods frequently leak because they were not properly packed or because the packing has hardened with age. Sometimes it will suffice to tighten the packing nut. Marline, oakum and very small wedges have been used effectively. Action must be taken to ensure that they are properly packed at all times and checked with periodic air tests.

079-42.11.8.1 Some leaky shaft glands may be repaired by tightening the nuts. In others, the studs have been broken so it is necessary to shore the whole gland back in place, preferably with welded braces. In one case, the

leak was so bad that the ship had to make a type of box patch in two sections, secure it around the shaft and weld it over the gland. In effect, the ship made a new gland.

079-42.11.8.2 Leaky rivets are difficult to repair. Frequently, they have been pulled through plating but not far enough to insert wooden plugs. Slugs cut from sheet lead, lead wires, marline, red lead and caulking are effective repair materials.

079-42.11.9 COFFERDAMS. A cofferdam is an additional bulkhead built around a large damaged area. The steel box previously described in [paragraph 42.11.8.1](#) is a cofferdam of limited size. Cofferdams are installed inside the ship during and immediately after damage. Outside cofferdams are often used in salvage operations. A cofferdam may be built of steel plates or heavy planks, either directly supported by frames and stanchions or held securely in place by shores. When constructed, they may be partly or completely flooded.

CAUTION

When using a cofferdam as an access between flooded and unflooded areas, the cofferdam must be strongly built and firmly secured; otherwise, it could slip or collapse, compromising the safety of the ship to the point of losing it.

079-42.11.9.1 Construction of Cofferdams for Holes in Side Walls. The most practical method of repairing a hole is to build a strong retaining bulkhead around it, leaving it open at the top so stuffing materials (mattresses, clothing, bales of rags) can be dropped in. These materials need to be weighted to prevent floating; when the pen (box) is full, iron bars or shores should be added to hold the material in place. If the hole is so large that the stuffing materials will fall through, it is important to install a grating of cross pipes, timbers or angle irons before stuffing.

079-42.11.9.2 Construction of Cofferdams if Flooding is Below. Cofferdams can be fabricated to cover holes in either vertical or horizontal plating, as well as to cover hatches, trunks, scuttles and doors creating a transit between dry compartments and flooded compartments.. To prevent the spread of flooding and permit safe opening, a cofferdam must be built completely around a hatch or scuttle, extending two feet higher than the outside water level. Personnel in a shallow-water diving outfit may then enter the flooded area below to operate valves or plug small leaks.

CAUTION

Never open a hatch or scuttle if the compartment below is completely flooded and the outside water level is two or more feet above the deck from which entry is desired. Such an action may cause severe flooding, even causing the ship to sink.

079-42.11.9.3 Construction of Cofferdams if Flooding is Above. The same type of cofferdam may be built if flooding is in the upper deck and entry below is desired. The cofferdam must extend above the water line (to an upper deck, if necessary) and escape scuttles can be cut with an acetylene torch. When it is possible to weld a steel plate to the deck, it is important to make sure it is securely welded at the corners and to the deck. Cracks can be caulked with oakum if a tight weld is not possible. Cross bracing or shoring is necessary if the water level is high in or around the cofferdam.

079-42.11.9.4 Wooden Cofferdams. When constructing a wooden cofferdam, cut tongue-and-groove planks. Cleats should be installed across the boards of each side and cross-nailing or metal strips should be employed to lock the corners securely. The cofferdam should be pressed down tightly to the deck with adequate shores from

above. All cracks and seams should be caulked with oakum or cloth; a portable pump suction may be necessary to remove leakage inside. The cofferdam must be strongly built and firmly secured to prevent slipping or collapsing.

079-42.12 STRENGTHENING BEAMS AND FRAMES

079-42.12.1 RUPTURED OR WEAKENED FRAMES. Beams, frames and decks, and some bulkheads are strength members of the hull structure. If they break or become weakened, the hull may collapse, causing the ship to break in two and sink. A small ship may not have the necessary equipment to weld on heavy rails or angle irons for additional support, but some help can be obtained by shifting weights (to reduce the strain) and by shoring. Beams and frames can be patched or strengthened by bolting or welding doubling plates or bars along the webs. Figure 079-42-19 shows how beams and frames can be ruptured or weakened and illustrates methods for strengthening these vital structural parts of the ship.

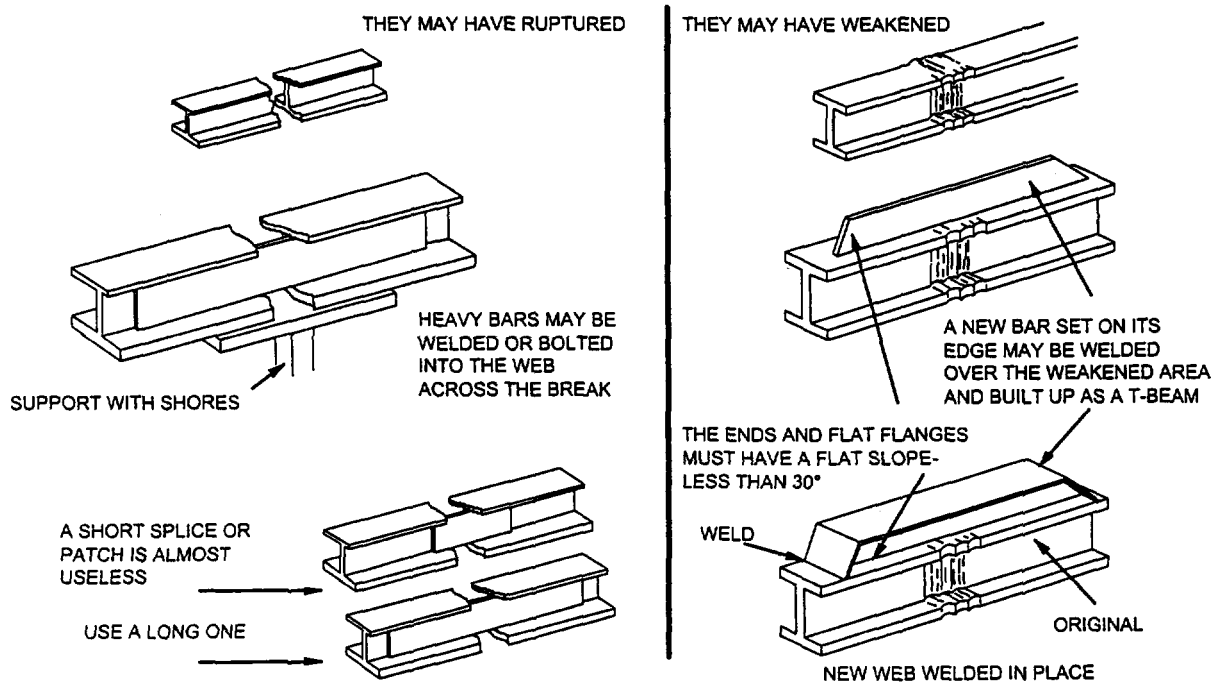


Figure 079-42-19. Strengthening Beams and Frames

079-42.12.2 HEAVY EQUIPMENT SUPPORTS. Supports for heavy equipment can be pushed back into place with screw jacks and shoring and later secured with stanchions made of heavy pipe welded in place. Chainfalls and heavy wires, possibly fitted with turnbuckles, may be useful to pull plating and equipment back to their original positions. Supports needed under dislocated machinery and guns must often be carried down several decks because a single deck may not have the strength to support all the weight. It may also be necessary to make successive supports down to the bottom frames.

079-42.13 STRENGTHENING CRACKED MACHINERY SUPPORTS

079-42.13.1 Strength can be restored to cracked, fractured or weakened supports under machinery by welding on side plates or angle irons as illustrated in Figure 079-42-20.

079-42.14 REPAIRING PIPE LINES

079-42.14.1 PREPARATIONS PRIOR TO REPAIR. Before starting to repair any pipe line, it may be necessary to remove pressure from the line and provide an auxiliary service.

079-42.14.2 RESHAPING DENTED COPPER PIPING. Copper piping sections that have been dented, flattened or distorted can be brought back to normal roundness and shape by the following methods:

1. Anneal (heat) the whole section or, if preferred, only the damaged section.
2. Place section under a hydrostatic pressure not exceeding the test pressure of the system.
3. While under pressure, hammer the piping, beginning with the high spots, and it will round up to shape.

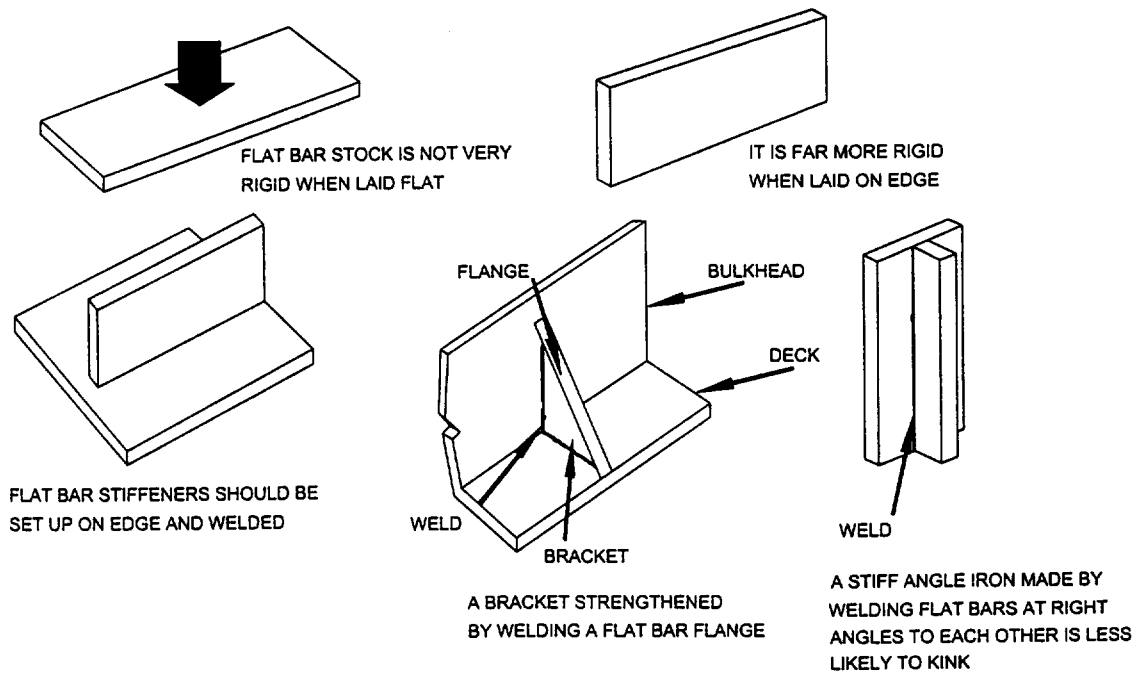


Figure 079-42-20. Strengthening Machinery Supports

079-42.14.3 RUPTURES. Several types of pipe ruptures are illustrated in [Figure 079-42-21](#). Definitions for the various types of ruptures that could occur to piping systems are as follows:

- a. Simple - a rupture with no protruding edges, located on a straight section of pipe.
- b. Elbow - a rupture with no protruding edges, located on a curved section of pipe.
- c. Severed - a section of pipe that has been completely separated.
- d. Compound - a rupture having protruding edges, ruptures in fittings, mangled pipes, and similar piping damage.

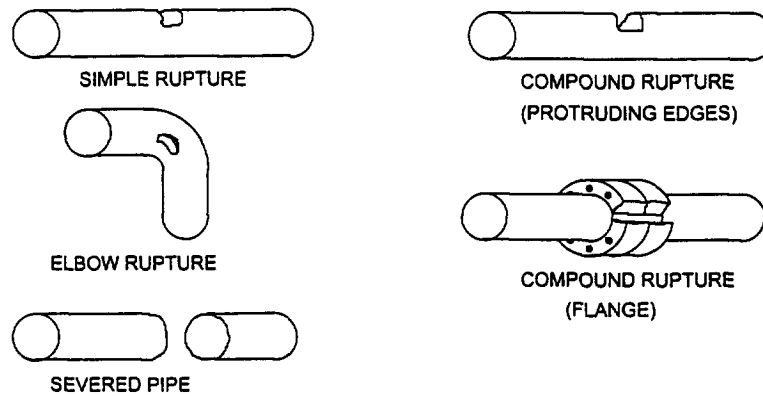


Figure 079-42-21. Types of Pipe Ruptures

079-42.14.4 JUBILEE PIPE PATCHES. The jubilee pipe patch is a modification of a commercial hose clamp. Examples of the application of the jubilee pipe patch can be found in *NAVSEA SS-100-AG-MAN-010, The Damage Control/Firefighting Equipment Layout Booklet*. This patch consists of a piece of sheet metal which is rolled into a cylinder and so shaped at the gap that the two ends are really flanges. These flanges can be reinforced by welding on strips of scrap iron, after which the two flanges are drilled to take from three to five bolts. It is advisable to weld small braces from the flange to the back of the patch to keep the flange faces more or less parallel under pressure.

079-42.14.4.1 The sheet metal in the body of the patch must be as heavy and strong as possible, but it should be capable of being sprung or bent so the gap will go over the pipe to be repaired. A sheet of packing is first put over the hole, extending well on either side of it. The jubilee clamp is then sprung open and clamped over the packing. When the bolts are tightened, this patch will easily hold upward of 100 pounds pressure.

079-42.14.4.2 Every damage control repair station shall contain several of these homemade patches, in assorted sizes, as each patch fits only one size pipe.

079-42.14.5 SOFT PATCHES. Small holes or cracks in low pressure (150 psi) piping often can be repaired by soft patches. Examples of the application of soft patches on a low pressure pipe line can be found in *NAVSEA SS-100-AG-MAN-010, The Damage Control/Firefighting Equipment Layout Booklet*.

079-42.14.5.1 When possible, reduce the area of the hole using the following steps:

1. Drive softwood wedges into the hole.
2. Mark a line on the wedges along the pipe and remove from the hole.
3. Cut wedge ends off one-half inch below the marked line (so fluid flow in the pipe is not impeded) and wrap wedges with cloth or oakum.
4. Insert wrapped wedges into pipe and trim wedges flush with the outside of the pipe.
5. Measure and cut a piece of sheet rubber packing so that it extends two inches on either side of the damaged area and will wrap around the pipe, leaving a one-quarter-inch gap between ends.
6. Place sheet rubber on pipe and cover with a piece of canvas that also extends two inches on either side of the damaged area but wraps completely around the pipe.
7. Hold in place tightly wrapping with two layers of marline or wire.

079-42.14.5.2 The soft patch can be modified or improved to suit immediate conditions. Often it is advisable to have a curved plate of lightweight sheet metal between the packing and binding. Based on the individual situa-

tion, a small hole can be drilled at each end of the rupture. This can prevent the rupture or crack from expanding when wedges are driven in. Small solid rubber balls can also be used to patch holes in pipes by placing them over the hole and securing by banding, wiring, shoring or wedging.

079-42.14.5.3 Marline and oakum have been used successfully as caulking material in cracks. In many cases, such as on sharp curves, it is not possible to use sheet packing, but combinations of wedges, marline and various plastics will often make effective patches.

079-42.14.6 THUMB CLAMPS AND C-CLAMPS. C-clamps and thumb clamps can be used to hold plugs or patches in place. For example, a block of soft wood (the pad) may be rough-shaped to fit over a damaged area in a pipe; the pad can then be held in place tightly with two thumb clamps. Care must be taken to reinspect patches held in place by clamps, because they have a tendency to work loose under shock or vibration.

079-42.14.7 CAULKING WITH HAMMER AND CHISEL. Light caulking applied with hammer and chisel has sometimes been used to close small crack leaks, especially adjacent to flanges. This method requires special care because there is always a danger of opening the crack even wider.

079-42.14.8 WELDING AND BRAZING. Welding, brazing and silver soldering can be used to repair leaks, especially at the joint between pipe and flanges. Such methods are slow and not reliable in the hands of unskilled personnel because they can lead to fires and explosions; therefore, their use in combat is limited.

079-42.14.9 STEAM LINES. Soft patches are not recommended for high pressure steam lines - they are satisfactory only for low pressure steam lines. Rubber packing will melt and create an offensive odor but it will vulcanize and make a tight patch. It is far safer to isolate the damaged area and make repairs while in port.

079-42.14.10 GASOLINE OR OTHER FLAMMABLE FLUID LINES. Soft patches are not recommended for gasoline or other flammable fluid lines because the slightest leak would create a tremendous fire hazard. It is far safer to replace the damaged section. The plastic patch can be used as an emergency repair.

079-42.14.11 REPLACING PIPING. If the pipe has been badly holed or ruptured, patching may not suffice and it may be necessary to replace a section. It is advisable to carry spare sections of smaller sizes of important pipe. In an emergency, it may be possible to remove a section from an unimportant system and install it where the need is urgent. If the ruptured pipe was fitted with screw flanges, the procedure is to remove the entire damaged section, cut screw threads on the new piece, screw the flanges onto the new piece and install it. The flanges are then bolted together.

079-42.14.11.1 Damaged Pipe. To replace only the damaged part of a small pipe:

1. Cut out the damaged area with hacksaws.
2. Cut a piece of pipe almost the same length as the gap.
3. Cut screw threads on all exposed ends of pipe and make up the joints by using pipe unions and couplings.
4. Cut the filler piece short enough to permit inserting the pipe fittings.
5. Use white lead on screw threads to seal the joint.

079-42.14.11.2 Pipe Unions. Unions may be improvised similarly to the soft patches previously described. If the joints are not held together, they could be pushed apart by pressure reaction. It is advisable to force the joints together by means of lines, shores or wedges.

079-42.14.11.3 Pipe Jumper Hose System (PJHC). This system provides a means to make temporary emergency cold pipe repairs in minutes, so piping gets back in service quickly. The system is ideal to quickly repair

hydraulic lines, chilled water lines, fuel lines, fire protection systems, the firemain and compressed air systems. Permanent repairs can then be made at a more convenient time and place. Features include:

1. Installs with simple hand tools.
2. Operates at pressures to 4,000 psi (275 bar).
3. Operates at temperatures from 0-200°F (-17 to 93°C).
4. Allows pipe jumpering up to 40 feet (12 m).
5. Available in kitted stowage for easy accessibility.
6. Repairs standard pipe sizes from 1/4-inch to 2 1/2-inch IPS/NS.
7. Provides a cold repair solution; no welding required.

079-42.14.12 SPECIAL TOOLS. All ships are provided with special tools with specific uses to repair the piping system. They are described in NAVSEA SS-100-AG-MAN-010, *Damage Control/Firefighting Equipment Layout Booklet*.

079-42.14.12.1 Hand-Clamping Device. All large ships have been provided with a hand-clamping tool, together with the necessary metal straps, clamps and complete directions for its use in securing soft patches and in securing hoses to couplings and pipe. Every ship is to have spare bands and clamps so that personnel can train by actually using the equipment. Jubilee clamps and couplings are easy to install, involve no pipe threads and generally make tight joints. Each clamp generally fits only one size of pipe.

079-42.14.12.2 Metal Clamping Tool. The metal clamping tool, usually referred to as the band-it clamp, has many uses in the repair of piping. It is comparatively simple to operate and produces a very effective repair when applied. The metal clamping tool is supplied in a kit which consists of the following items: (See also the NAVSEA SS-100-AG-MAN-010 *Damage Control/Firefighting Equipment Layout Booklet*, for more information.)

- a. Steel bands
- b. The metal clamping tool which tightens and cuts the steel bands
- c. Steel buckles

079-42.14.12.3 Blanking Lines. Ruptured pipe lines are often a menace because they cannot be readily isolated and continue to perform a vital function within the piping system. In the case of firemain, the choice may lie between flooding a compartment or extinguishing a fire. Frequently, in the case of oil lines, important and undamaged machinery must be secured. Such problems have been solved by blanking off part of the pipe line. Low pressure pipe lines can often be blanked by driving wooden plugs, covered with cloth. Unsupported, these plugs have a tendency to back out. Adequate support can generally be provided by using shores or jacks, or by drilling a hole through the pipe and pinning the plug in place. For frayed ends of pipe cut by fragments, combinations of plugs may be desirable. When damaged pipe is joined by screw fittings, it is a simple matter to unscrew the damaged part and to stop the flow of fluid by means of a pipe cap or pipe plug.

079-42.14.13 JOINING ODD-SIZED FLANGES. For each size of pipe in the Navy, flanges and threads are standard. However, a case could arise when it is desirable to connect flanges of different sizes of pipe and threads. The flanges cannot be bolted together because the bolt holes do not line up. This difficulty may be overcome by inserting a gasket and holding the flanges together with heavy C-clamps. At least four such clamps are required for each connection.

079-42.14.14 VACUUM LEAKS. Vacuum leaks occur mainly in the engineering compartments. They are often inaccessible or obstructed in such a way that ordinary patches cannot be applied. Fireproof plastics and putties, however, can be applied. Duct tape also has been used effectively. Vacuum leaks should never exceed approximately 15 psi.

079-42.15 PLASTICS AND PLASTIC PATCHING

079-42.15.1 PLASTIC PIPE PATCHING KIT. All water, fuel and gas lines can be repaired, with service restored to the affected system, using the plastic pipe patch kit. See AEL 2-880044271 for kit contents. The use of certain plastic materials in Naval construction and repair has become of real importance in damage control, and limited use has become standard practice aboard most ships. Basically, the plastics so employed can be identified by their chemical and physical properties, described in more detail below.

079-42.15.2 TYPES OF PLASTIC. Physically, plastics may be divided into two basic types: thermosetting and thermoplastic.

079-42.15.2.1 Thermosetting plastics are made from fluid materials which are fed into a mold and become rigid when heated. The finished plastic has no melting point, so if it is reheated to a high enough temperature, it will char and degrade.

079-42.15.2.2 Thermoplastic plastics are solid materials initially, which are melted for feeding to the mold and solidify on cooling. On reheating they will again soften and flow.

079-42.15.2.3 To illustrate, thermosetting plastics are similar to concrete which cannot be reformed once it has set, whereas thermoplastic plastics behave more like metal in that when reheated, will soften and may be reformed.

079-42.15.2.4 The plastic used in pipe repair kits is a synthetic epoxy resin. Epoxys are thermosetting plastic materials. Special chemical formulations are used to give the material some flexibility. Normal expansion of piping systems in ships will have little, if any, effect on the plastic repair. These materials should not be used on areas having a great amount of expansion or contraction in a short period of time, such as may occur with expansion joints.

079-42.15.3 PLASTIC PATCH ADVANTAGES. The principal advantages of the plastic patch in damage control are as follows:

- a. Versatility
- b. Simplicity
- c. Effectiveness
- d. Speed of application
- e. Durability.

079-42.15.3.1 The plastic patch is versatile because it can be applied successfully to piping systems, fittings, bulkheads and decks. In paste mixtures, plastic can be used as a filler for cracks and small (1-inch) holes, where the pressures are under 300 psi and the temperature does not exceed 200°F. The patch has excellent adhesive

qualities when applied to ferrous and cuprous metals and can be employed for emergency repairs to a variety of damaged structures having smooth or jagged, protruding edges. Plastic patches can be applied under conditions which delay repairs by other methods, and in many cases require permanent repairs or replacements before service can be restored to the damaged system.

079-42.15.3.2 The preparation and application of the plastic patch can be accomplished with basic knowledge and training. The application of the pipe or surface patch is comparable to that of a battle dressing in first aid. Use of the paste is as simple as applying putty.

079-42.15.3.3 Plastic patches are completely effective when properly applied. In instances when defects occur, the leakage may be found at the extremities of the patch, between the patch and the metal surface. Such leaks are generally less than one percent and are generally attributed to faulty preparation or application.

079-42.15.3.4 It can be assumed that the speed of application of a plastic patch is basically determined by the size and type of rupture and the local working conditions. A simple patch can be applied to a four-inch pipe in less than ten minutes. Once the patch is properly in place, the type and size of the rupture or the size and shape of the structure have little effect on the installation time involved.

079-42.15.3.5 The maximum patch life has not been determined, but all indications are that a properly applied patch will last until such time as a permanent repair or replacement can be made. However, it must be understood that the patch is an emergency expedient and is not intended, nor should it be considered, a substitute for a permanent repair. The patch is relatively inert, being adversely affected only by excessive (200°F) heat and concentrated acids.

079-42.15.4 **STRENGTH AND ADHESION.** The success of a properly applied patch is dependent upon two factors: strength and adhesion. With these two factors present, the patch will be completely effective. During the process of curing, the patch will have the tendency to adhere well to metal and other surfaces. The process of applying the plastic patch actually reinforces the activated resin with fibrous glass material. The reinforcement of the resin greatly increases the strength when the patch is cured. Should fibrous glass materials not be available, reinforcing can be accomplished by the use of cloth such as a blanket, or some other material which will absorb the resin. In most cases reinforcing with such material will not provide the equivalent strength obtained through the use of fibrous glass materials. Although substitute materials are effective to a high degree, they should be used only in extreme emergencies.

079-42.16 PATCHES FOR PIPES AND BULKHEADS

079-42.16.1 **GENERAL.** Several types of patches are available to repair pipes and bulkheads in diverse locations and with diverse uses. They are described in the following paragraphs.

079-42.16.2 **PIPE PATCH.** The components of the repair kit normally used for repairing a pipe in the piping system are the liquid resin and liquid hardener mixture, together with the prescribed fibrous glass materials. This mixture is approved for patching piping systems at a maximum pressure of 300 psi and a maximum temperature of 200°F. This mixture is approved for patching the following piping systems:

- a. Fresh water
- b. Salt water

- c. Fuel oil, lubricating oil, fog oil, HEAF, diesel oil
- d. Gasoline and JP-5
- e. Refrigeration

079-42.16.3 FLAT PATCH. This patch is the metallic and nonmetallic surface repair patch. It is approved for patching surfaces at a maximum pressure of 300 psi and a maximum temperature of 200°F. The flat patch utilizes the same components as the pipe patch. The flat patch is approved for patching the following metallic and non-metallic surfaces:

- a. Metal bulkheads and decks
- b. Tanks, voids, and cofferdams
- c. Wood surfaces.

NOTE

Flat patching material must not be used to repair steam boilers.

079-42.16.4 PASTE PATCH. The paste patch is also a metallic and nonmetallic surface repair patch. The material normally used for patching small holes, cracks, and fillers is the paste resin and paste hardener mixture. The paste mixture was developed primarily for small holes and cracks under one inch in diameter. In many respects, the paste mixture has the same general characteristics as the liquid mixture. It is approved for patching surfaces at a maximum pressure of 300 psi and a maximum temperature of 200°F. The paste mixture is approved for patching the following:

- a. Sea chests
- b. Valve bodies
- c. Pump casings
- d. Cooling water jackets
- e. Condenser heads
- f. Flanges
- g. Caulking for leaking seams and rivets
- h. Porous castings
- i. Threaded joints

NOTE

This material must not be used to repair steam boilers.

079-42.17 BASIC MATERIALS

079-42.17.1 GENERAL. Basic materials used in patching are described in the following paragraphs.

079-42.17.2 RESINS AND HARDENERS. Liquid and paste resins are of the epoxy type. Liquid and paste hardeners are chemical compounds used to harden the resins. These ingredients are packaged in prescribed amounts. When hardeners and resins are mixed, a chemical reaction occurs which causes the mixture to harden. The liquid mixture sets in approximately 12 minutes; the paste mixture in approximately 17 minutes.

CAUTION

Do not mix hardener with resin until all preparations have been completed and do not intermix liquid resin and paste hardener, or paste resin and liquid hardener. Do not mix resin or hardener from any other source with those supplied in this kit.

079-42.17.3 VOID COVER. The void cover is resin-treated glass cloth that can be cut and formed to cover and support the patching materials over a damaged area.

079-42.17.4 WOVEN ROVING CLOTH. Woven roving cloth is made of a short staple, glass fiber woven into a thick fluffy cloth. During the application of a plastic patch, this cloth is coated with resin hardener mixture and wrapped around or placed over the damaged section. This cloth provides the principal strength of the patch and provides a method of applying the resin hardener mixture.

079-42.17.5 FILM (PVC). The film is a thin, transparent, polyvinyl chloride material used as a separating film for a flat patch to prevent the patch from adhering to the backup plate or supports. In pipe patching, it is used to cover the entire patch and retain the activated resin around the patch. When used in such an application, it is described as a retaining cover.

079-42.18 PATCH APPLICATION SEQUENCE

079-42.18.1 As different patching materials are applied to patch an area (i.e., void covering, woven roving, retainer cover), the area covered gets progressively larger. [Figure 079-42-22](#) illustrates the position of patching materials relative to each other.

079-42.18.2 The build-up in patch length or width during applications must be considered when making the initial determination of the length of patch to be applied. Where practical, the patch should extend four to five inches on each side of the rupture, and should wrap around the pipe.

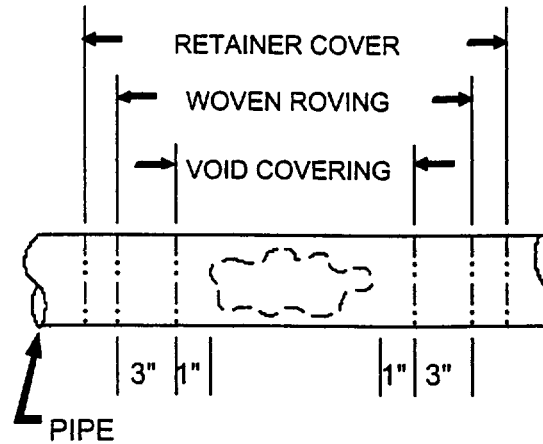


Figure 079-42-22. Sequence of Applied Patch Materials

079-42.19 FLAT PATCH (LIQUID)**CAUTION**

Flat patches must not be used on steam boilers.

079-42.19.1 APPLICATION PARAMETERS. The simple flat patch is approved for making plastic repairs to ruptures in metallic and nonmetallic surfaces as described in [paragraph 079-42.14](#). Ruptures up to and including 12 inches in diameter (or square) can be successfully repaired using procedures similar to those employed when making pipe repairs. When ruptures exceed 12 inches, it is important to consider using additional patching materials, i.e., pillows, box patches, mattresses or boiler plates. When ruptures exceed six inches in diameter, increase the patch overlap one inch for each inch of increased diameter. The greater the overlap, the larger the area to which the patch will adhere and thus increase the total strength of the patch. [Figure 079-42-23](#) illustrates a patch over a 12-inch hole.

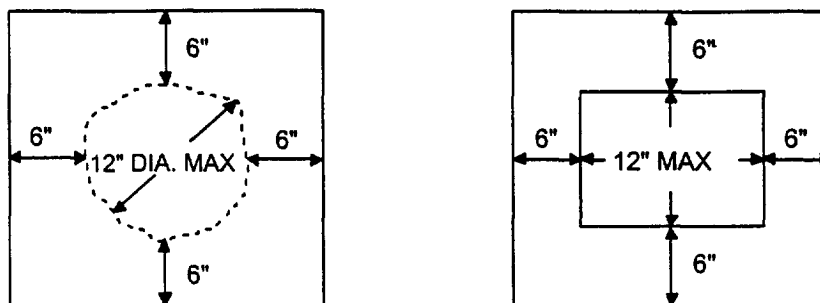


Figure 079-42-23. Patch Size for 12-Inch Hole

079-42.19.2 APPLICATION TO VERTICAL SURFACE. The steps to apply a simple flat patch to a vertical flat surface shall be as follows:

1. Follow all preparation instructions carefully. Use goggles and gloves provided with repair kit.

2. Lay the first ply of woven roving cloth on a flat surface. Starting at one end, pour the resin-hardener mixture, spreading evenly with a spatula over the entire area. Work toward the opposite end. Take care to ensure that the edges are well impregnated.
3. Coat the surface to be patched by rubbing with impregnated cloth.
4. Center the impregnated cloth over the damaged area.

NOTE

Center the next ply over the preceding one and use the spatula to work out air bubbles and wrinkles.

5. Position the PVC covering over the plastic patch and press firmly.
6. Position the back-up plate over the plastic patch and press firmly.
7. Position the necessary strongback and shoring to hold the back-up plate in place.

NOTE

When the temperature around the patch is below 50°F, the careful application of heat from infrared lamps will speed up the curing of the patch. Excessive heat may make the patch porous. Use caution.

079-42.19.3 APPLICATION TO OVERHEAD OR HORIZONTAL SURFACE. When applying a flat patch to the overhead or the underside of horizontal flat surfaces, prepare vertical flat surfaces, taking care to support the weight of the patching materials as they are being applied. Because of weight, the successive layers of impregnated (liquid resin-hardener) woven roving cloth will have a tendency to pull away from the area to be patched. For this reason, a minimum of two personnel should be employed during these operations. [Figure 079-42-24](#) illustrates the overhead or horizontal flat surface patch.

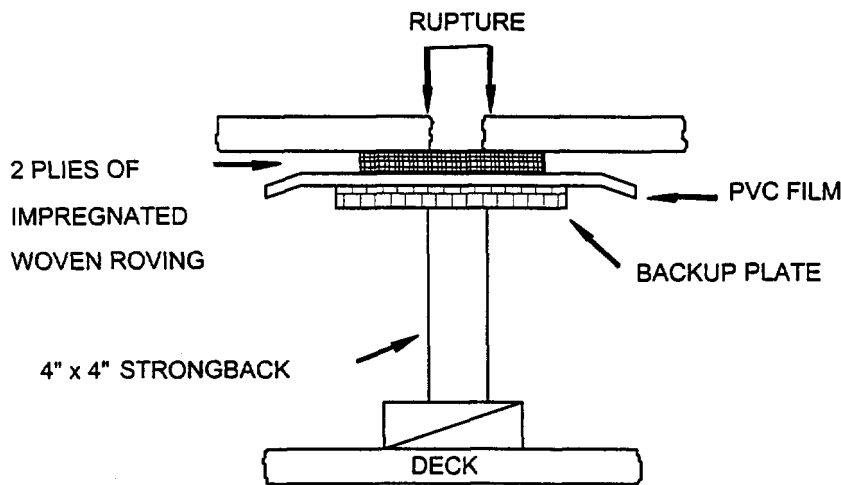


Figure 079-42-24. Overhead or Horizontal Flat Surface Patch

079-42.19.3.1 The steps to apply an overhead or horizontal flat surface patch are as follows:

1. Proceed as stated in [paragraph 079-42.20.3](#).
2. The first person puts the patch in place.
3. The second person positions the back-up plate and assists in positioning the supporting structure.

079-42.19.3.2 As an alternate method, take all preparatory actions described above; then assemble the materials on a suitable working surface in reverse sequence, as follows:

1. Back-up plate, PVC cover, impregnated layers of woven roving, and so forth.
2. Pick up entire assembly and press firmly over the center of the rupture.
3. Position the supporting structure.

079-42.20 PASTE PATCH

079-42.20.1 GENERAL. The paste resin-paste hardener mixture can be used to repair cavities, cracks and small holes. It is also suitable for repairs to small bulkhead holes, such as those resulting from the removal of electric cables, small fuel oil tank ruptures, small piping system ruptures and cracked water end casing or reciprocating fire and bilge pumps. The paste patch is recommended for such emergency repairs as eroded or ruptured centrifugal pump casings. It should not be used for holes larger than one-inch in diameter because the uncured resin may sag, fall through or pull away. When cured, the paste mixture is less shock-resistant than the liquid resin used with glass reinforcement. In general, for maximum strength, repair the damaged area with the glass reinforced liquid-hardener system.

079-42.20.2 PREPARATION. The following preparations must be made prior to the application of the plastic patch:

1. Clean the area adjacent to the rupture, making sure it is free of oil, grease, dirt, paint and other foreign matter. If grease or oil is present, use an approved cleaning solution. If neither of these solvents is available, scrape the area to be patched and wipe free of all dirt and residue. When a clean surface is obtained, the surface may be further abraded using the abrasive cloth furnished with the kit, for better adhesion.

NOTE

The surface to be cleaned should extend approximately one inch beyond the entire periphery of the rupture.

2. Make sure that the rupture surface is dry.
3. Determine the amount of paste resin and paste hardener that will be required. For example, one can of paste resin (300 grams) mixed with one can of paste hardener (75 grams) is sufficient to fill a ruptured area one-inch thick by four-inches square. (16 cubic-inch volume).

079-42.20.3 APPLICATION. The simple paste patch is applied in the following sequence to vertical, overhead or underside of horizontal surfaces.

1. Follow carefully all preparation instructions (using face shields, goggles and gloves provided with kit).
2. Open paste resin can; open paste hardener can.
3. The paste resin and paste hardener are to be removed from the containers and mixed on a flat surface, using only an amount sufficient to make each repair.
4. Apply paste mixture to the rupture, applying sufficient pressure to force the mixture into and through the entire thickness of the ruptured material (extruding slightly as shown in [Figure 079-42-25](#)), leaving a convex working surface extending approximately one inch beyond the entire periphery of the rupture.

5. Place the PVC film over the paste mixture and smooth over lightly. The PVC can be removed after the mixture is cured.

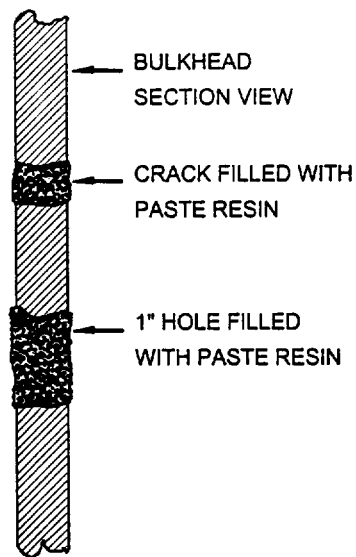


Figure 079-42-25. Bulkhead Repair

079-42.20.3.1 The paste mixture, in addition to the areas previously described, can be used as filler in places where equipment has been subjected to excessive erosion or corrosion and shipyard repair facilities are not immediately available.

079-42.20.3.2 Eroded piping, internal pump casings, condenser heads and tube sheets can be repaired temporarily with the paste mixture. The application of the paste mixture (with modifications suitable to the individual repair) is substantially the same regardless of the type of small crack or cavity involved. For all such minor repairs, after proper preparation has been made, the application consists principally of troweling, squeezing or molding the paste mixture to conform to the defective area.

079-42.21 LIQUID-PASTE COMBINATION PATCH

079-42.21.1 Situations may develop where it is desirable to use the liquid resin-hardener mixture, reinforced with roving cloth, in combination with the paste resin-hardener mixture. The woven cloth can be applied to either side of the paste resin-hardener mixture used to fill the cavity (as illustrated in [Figure 079-42-26](#)). Using one ply of impregnated woven roving on one side of the surface being repaired is sufficient. When it is desirable to present a finished side, the paste should be applied to that side, because it can be sanded or ground to conform to surface contours after it has hardened. Where practical, it is best to apply woven roving on the pressure (impact) side of the hole.

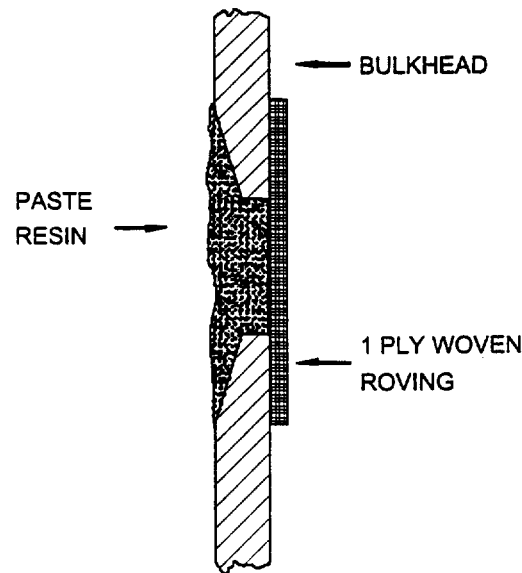


Figure 079-42-26. Combination Patch Repairs to Metal or Wooden Bulkheads

079-42.21.2 A combination patch can be employed in the following cases:

- a. When insufficient quantity of material for either single type patch (liquid or paste) is available
- b. When an individual patch has been applied with unsuccessful results. (Either type patch may be used as a supplementary repair.)

079-42.21.3 The paste mixture, prior to curing, acts as a temporary seal, after which the liquid-impregnated cloth can be applied as a permanent repair. This technique can be used when a ruptured area cannot be isolated and is based on the premise that the paste mixture will not wash away as readily as the liquid.

079-42.21.4 The paste can be used as a filler to form a flat surface in a compound rupture. The woven roving can then be applied to form a flat patch.

079-42.22 SUGGESTIONS FOR USING PLASTIC REPAIRS

079-42.22.1 Both paste and liquid resins with their associated hardeners are always mixed in the same proportions: four parts of resin and one part of hardener. The resin and hardener are packaged in their proper ratio. Add the hardener to resin and mix thoroughly until a uniform gray color is observed. When mixing paste resin and hardener, it is advisable to remove both from the can and mix them on a dry clean board so the uniform color of the mix can be more easily observed.

079-42.22.2 One large can of liquid resin (400 grams), when mixed with 100 grams of liquid hardener, will give a total of 500 grams of activated resin, which is sufficient to thoroughly impregnate one strip of 6-inch by 40-inch woven roving. Two grams of resin hardener mixture will impregnate one square inch of woven roving cloth. Determine the quantity of resin hardener mixture required to impregnate the amount of woven roving to be used. Do not mix resin and hardener until all other preparations have been accomplished.

CAUTION

When making any repairs involving the use of plastic resins, wear provided gloves to protect hands, and face shields to protect the eyes. In the event resins come into contact with any part of the body, wash the affected area with hot water and soap.

079-42.22.3 Patches should not be subjected to any pressure until the temperature of the patch has dropped below 150°F. Do not make repairs on systems carrying pressures exceeding 300 psi or temperatures exceeding 200°F.

079-42.23 PATCHING SAFETY PRECAUTIONS

079-42.23.1 LIST OF PRECAUTIONS. It is extremely important to provide forced-air supply and exhaust ventilation during the entire time plastic patching materials are being applied. (Proper ventilation is most important during the time that heat and the resultant fumes are given off.) Following are additional safety precautions:

1. Prior to using plastic, don gloves and goggles.
2. Avoid spilling plastic materials.
3. Keep resin and hardener off skin areas, whenever possible.
4. Keep resin and hardener out of eyes. If contaminated, immediately rinse with water and obtain medical treatment.

CAUTION

Resin and hardeners available on most ships can be incompatible with those provided in patching repair kits. Do not mix resin or hardener from any other source with those supplied in the repair kit. There is a probability that a violent reaction will occur if resins and hardeners are interchanged.

079-42.24 ELECTRIC WIRING CASUALTIES

079-42.24.1 DAMAGE TO WIRING. Explosions or projectiles will cause extensive damage to electric wiring. Wires may be cut, grounded, shorted or completely destroyed, resulting in the loss of power in many important lighting, fire control, communication, ship control and power circuits. Whenever there is any casualty involving damage to electrical cable and equipment, electrical circuits can become a hazard if they remain energized. In the event of serious damage, it may be necessary to remove electrical power from all cables in the damaged area to prevent the ignition of combustible liquids and gases. Continued operations, however, may require the reestablishment of power to undamaged circuits, particularly those which extend through the damaged area. The facility with which this can be accomplished will depend upon familiarity with, and knowledge of, the ship's electric plant.

079-42.24.1.1 All personnel should be made familiar with the purpose and use of electrical damage control equipment. This is particularly true with respect to the casualty power system. However, only qualified person-

nel are to make cable connections, except in extreme emergencies. During casualty power drills, it is, for the sake of realistic training, desirable to interrupt normal power, then re-energize equipment by means of the casualty power system. Any equipment that would be damaged by a power interruption is to be carefully de-energized prior to the casualty power drill and transferred to a source of power not involved in the drill. Any interruption is to be limited to portions of the power system not involving susceptible equipment; otherwise the drill must be simulated only. Similar precautions are to be taken if interruption of systems or ship operations being conducted might result in a hazardous situation, such as could occur on a carrier during air operations.

079-42.24.1.2 Fire results in practically every case where electrical cable or electrical equipment is damaged. Instructions for combating electrical fires, are found in *NSTM Chapter 555, Firefighting, Volumes I and II*.

079-42.24.2 JUMPERS. Breaks in wiring and cables are frequently repaired by inserting short pieces of new cable, called jumpers. Most ships carry assorted jumpers up to 10 feet long at each repair station (or reels of cable from which jumpers may be cut). Jumpers are not to be confused with casualty power cables. When damage to a cable is extensive, it may be necessary to replace a complete section between junction boxes, or between distribution boards and boxes. Such replacement is accomplished by pulling the cable out through stuffing tubes, then installing a new cable. It is important to plug the tubes temporarily to preserve watertight integrity. In emergencies, new cable is run by the most rapid means available, which may involve running it through doors and hatches. Every precaution must be taken to avoid breaking watertight integrity more than is absolutely necessary. Installation of all jumpers should be under the direction of an experienced electrician's mate familiar with the electric circuits. Repair personnel must know that each cable is identified by a number on a metal tag at the point where the cable is secured in a junction box and also by metal tags where the cable passes through a deck or a bulkhead.

CAUTION

Before beginning repairs on any damaged electric circuit, it must be de-energized. This is not only to protect personnel from shock but also to prevent fires and explosions. This is accomplished by following proper tag-out procedures.

079-42.24.3 SMALL CONDUCTORS. When small single conductors are cut, the damage can be repaired by skinning back the insulation on both the jumper and the original conductor, then splicing a jumper across the break. Wires should be scraped with a knife blade, since fuel and grease from human hands will insulate the wires from each other and reduce the effectiveness of the repair. After cleaning the wires, solder or twist and lock them together in such a manner that they cannot be pulled apart, making sure to have good metal-to-metal contact. Then wrap the exposed metal joint tightly with insulating tape. This technique is illustrated in [Figure 079-42-27](#).

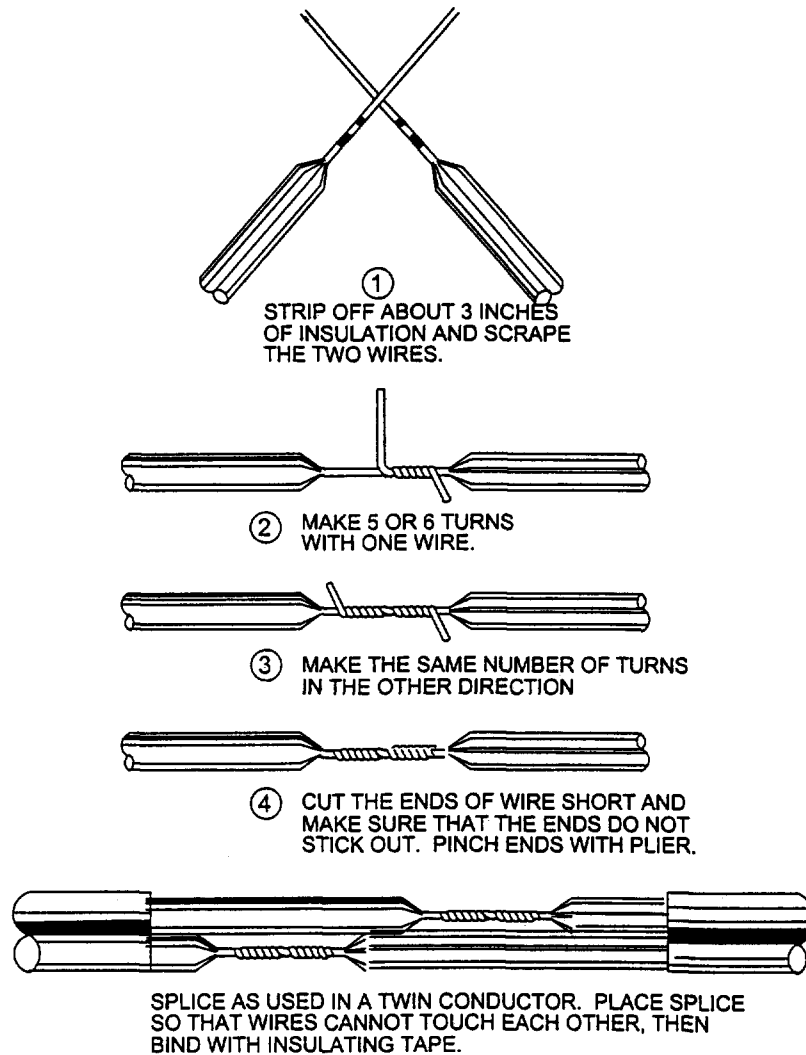


Figure 079-42-27. Repair of Small Conductors

079-42.24.4 LARGE CONDUCTORS. The procedure for inserting jumpers in large conductors is much the same as for small conductors, except that the larger sizes of wire require the use of different methods for securing the conductors to each other. Use the power-actuated cable press, if available. (In an emergency, almost any type of cable clamp will suffice.) All joints must be carefully bound with insulating tape.

079-42.24.5 IDENTIFICATION OF MULTIPLE CONDUCTOR CABLES. Each conductor is covered with an insulating fabric of a different color combination or with the name of a color printed on the insulation of each conductor. Color combinations can be used to identify conductors so wires can be joined correctly. An example, when there are twenty conductors in a cable and it becomes necessary to bridge a gap in ten of them to restore power to a gyrocompass, color combinations become very important. Should the wires be connected at random, chaos would be produced. When connecting red to red, black to black, and so on, however, the circuits will be restored correctly and all equipment will work properly.

079-42.24.6 RINGING THROUGH. Should it become impossible to identify the color markings on conductors because of burning or discoloration, it will be necessary to cut back the outside armor and insulation until the undamaged color markings are exposed or resort to a method of identification used before the current system or marking was adopted. This is called ringing through.

079-42.24.6.1 Personnel with sound-powered telephones should station themselves at each end of the damaged cable. They should ground one end of their phones to the ship's structure, or to the metal armor around the cable, and one person should secure the other end of the telephone to the first conductor to be repaired. The second person should use a second wire to locate the proper conductor. By touching each conductor in turn, one can soon locate those cables which must be repaired.

079-42.24.6.2 The sound-powered telephone circuit also can be used for exchange of information and orders.

079-42.24.7 INSULATION. Every individual joint made by joining conductors must be insulated with tape. When several such unions are made in a cable repair, the whole area must be securely wrapped with waterproof tape to avoid contact with salt water or the ship's structure. Do not permit cables to lay on deck; if necessary, tie them up to the overhead.

079-42.24.8 HOT CIRCUITS. Hot circuits are those carrying electric current. Only the most experienced personnel are permitted to work on hot circuits, and then only when workers have been insulated adequately. It is always safer if damaged circuits are isolated before beginning repairs.

079-42.24.9 TRAINING FOR ELECTRICAL REPAIR. It is not sufficient for personnel to read about how to make repairs or study pictures of equipment and discuss methods. Nor is it enough that they have all the tools authorized by the ship's hull allowance list, or that they make all the prefabricated patches and tools as has been suggested. All damage control personnel must know how to apply the principles and use materials in the most effective way. Such knowledge can be gained only by a combination of education, training and practice. A thorough knowledge of the ship is of prime importance. Repair party personnel must know their own area. They also must know the areas of other repair parties in case they have to make repairs or assist them in their areas. It is recommended, therefore, to rotate personnel between repair parties from time to time to achieve this knowledge.

079-42.25 EMERGENCY LIGHTING

079-42.25.1 High-intensity yellow chemical lights are plastic tubes containing a non-toxic chemical mixture, in which a smaller glass tube containing another chemical mixture floats. To activate a light wand, the plastic tube is bent, causing the inner glass tube to fracture, thereby allowing the chemicals to mix. Immediately, a bright yellow light is emitted and the chemical light wand is ready to use.

079-42.25.2 The high-intensity yellow chemical light is the color most suitable for emergency illumination. Yellow lights can be used to mark accesses, identify hazards and mark personnel casualties. Several chemical lights used simultaneously will provide sufficient light for non-complex tasks. The maximum efficiency of the high-intensity chemical light is approximately 30 minutes. After 30 minutes, the brilliance gradually dims but the lights will continue to glow for approximately 8-12 hours, during which time they are still useful as markers. Shelf life varies 2-4 years for various colors of chemical lights. The shelf life is 4 years for the high-intensity yellow chemical light. To prevent premature expiration of the shelf life, ensure that foil packages are kept intact until the lights are actually used. If a shelf life is indicated on the package, expend the chemical lights in training exercises prior to the expiration date. If no expiration date is indicated, periodically test one out of each box of 10 chemical lights to ensure that they are good.

SECTION 43.

SHORING

079-43.1 INTRODUCTION

079-43.1.1 SHORING DEFINITION. Shoring is the process of placing supports against the side of, beneath or above a structure to prevent metal fatigue, sagging and bulging. Shoring is the best way to temporarily support structure until more permanent measures are possible.

079-43.1.2 OBJECTIVES OF SHORING. The objectives of shoring are:

- a. To reinforce straining bulkheads, doors and hatches against abnormal pressures
- b. To support damaged and weakened structure and fittings.

Both objectives are achieved by distributing the stresses exerted on straining or weakened members to sound parts of the structure. Main watertight bulkheads are built to withstand stresses which occur when compartments are flooded statically (compartments are tested during building to ensure this). To conserve timber and avoid wasting valuable time, shoring should not be carried out on an otherwise sound structure merely because the compartment is flooded. Extensive damage in the vicinity, however, may weaken the structure significantly enough that it becomes incapable of standing up to its designed stress point. Shoring is then necessary.

079-43.1.3 SYMPTOMS OF STRAIN ON STRUCTURES. The primary purpose of shoring is to support weakened structures, which can result from battle damage, heavy seas, collision or excessive weight. Straining of structure is usually readily apparent and can be recognized by any of the following:

- a. Panting - the alternate bulging and contraction of plating (caused by uneven pressure or locked up stresses) resulting in metal fatigue and often accompanied by a groaning or pinging noise
- b. Buckling of deck beams or bulkhead stiffeners
- c. Bulging of bulkhead or deck plating
- d. Fracture or splitting of plating, especially alongside stiffeners or where bulkheads or decks abut hull plating.

NOTE

It is often difficult to detect cracks since they can be hidden under paint, oil or fittings.

079-43.1.4 SYMPTOMS OF STRAIN ON SHORING. When choosing shores, the principal concern is with stresses exerted on the shoring under the following two conditions:

- 1. When the shore is in direct compression; that is, when the pressure acting on the shore is parallel to its axis.
- 2. When the shore is subject to pressure acting perpendicularly to its axis.

079-43.1.4.1 Shores will support far greater weight in direct compression than they will in a cross-axial direction. It makes no difference whether the shores are placed horizontally or vertically; it does make a great deal of difference how the pressure is applied in relation to the axis.

079-43.1.4.2 When designing a shoring structure, it is important to have as few shores as possible under cross-axial stress and as many as possible under direct compression. The simplest and strongest shoring structure is illustrated in [Figure 079-43-1](#), where the shore, in direct compression, is anchored against a solid structure and holds the strongback against the bulkhead.

NOTE

If a deck or bulkhead has been distorted, use shoring only to hold the new position (not to force the damaged area back to its original shape).

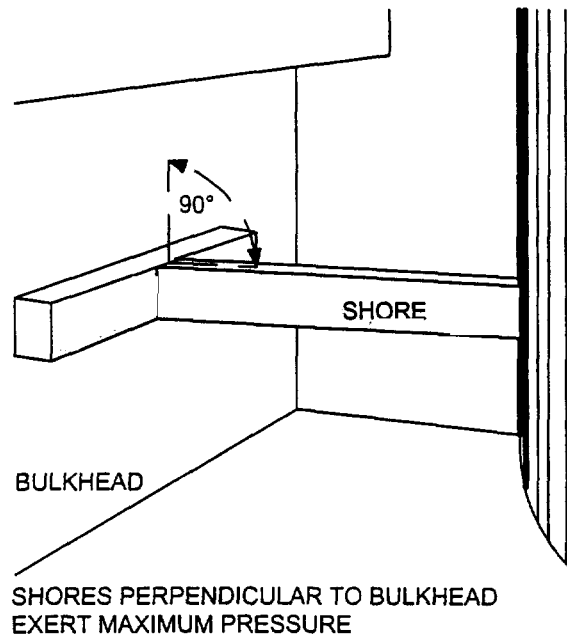


Figure 079-43-1. Simplest and Strongest Shoring Structure

079-43.2 PRINCIPLES OF SHORING

079-43.2.1 ESSENTIAL ELEMENTS. The essential elements of effective shoring are as follows:

- Strong and rigid anchor points for the shores
- A reasonably complete network of reinforcement
- Distribution of the load over as large an area as possible with a good layout of strongbacks or a shole
- Observation of length limitations - 30 times minimum thickness
- Use of shores for support only - not to restore structure to original shape.

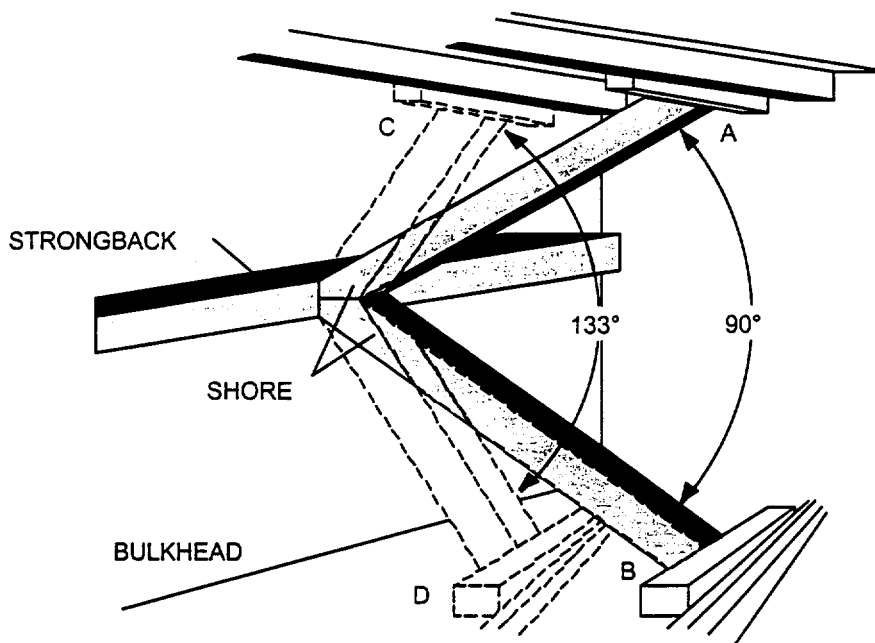
079-43.2.2 DECISION AIDS. The aim should be to shore to the nearest strong point. If the nearest structure is not strong enough, the shoring must be continued back, through other compartments if necessary, to end at members of sufficient strength. The shoring assembly must always be kept under observation because if it becomes strained it will, itself, require support. [Chart 4](#), Flowchart on Shoring, [Appendix D](#), provides a decision path to aid in making shoring decisions.

079-43.2.3 APPLICATION OF SHORING PRINCIPLES. Chosing when to shore requires good judgement. For example, deep water in a compartment, with consequent pressure, is not, of itself, a criterion for application of shores. A low-level bulkhead will have more pressure exerted upon it, but it will be able to withstand that greater pressure because of its heavier construction. The force of an explosion may loosen foundations, crack beams, shear plates or part seams, damaging the bulkhead, with subsequent loss of strength. Deep bulges in plat-

ing, bowed frames and stanchions, loose rivets, cracked seams and panting of bulkheads are indications of the need for shoring. Panting is a dangerous condition since it causes metal fatigue which, in time, will result in cracking and splitting. In most cases, the need for shoring patches and loose machinery is obvious. However, weakened supports under guns and machinery units may not be readily noticed, so a careful inspection should be made of this equipment whenever damage is sustained in the vicinity; such weakened supports should be shored whenever necessary so further operation will not cause greater damage. Remember, too, the most basic principle of shoring: When in doubt, shore.

079-43.2.4 CHARACTERISTICS OF SHORED BULKHEADS. A bulkhead and its supporting frames make up a sort of spring on which varying pressures are exerted. The bulkhead will bulge and pant as pressure varies, and it will weave as the ship itself changes shape while working in a seaway. Hence, the pressure on shoring will increase and decrease, and the bulkhead will tend to move away from the shores. No shoring job can be considered complete, therefore, until all slack has been taken up. Then a continuous watch must be posted, whose duty it is to tighten the wedges as they start to work loose. Shoring is intended to support warped bulkheads; it is not intended to push warped bulkheads back to their original positions or shapes. Note that excessive shoring pressure may cause a bulkhead to collapse or rupture, especially at boundaries.

079-43.2.4.1 Bulkhead Shoring Angles. Shores must form a considerable angle with the bulkhead they are supporting. Correct shoring angles are illustrated in [Figure 079-43-2](#).



WHEN THE ANGLE OF THE TWO SHORES IS GREATER THAN 90°, THE EFFECTIVENESS OF THE SHORES IS LESSENER. THEREFORE, IT IS BETTER TO ANCHOR SHORES AT A AND B THAN AT C AND D.

Figure 079-43-2. Correct Shoring Angles

079-43.2.4.2 Plans for Shoring Major Bulkheads. It is advisable to have a plan for shoring each major bulkhead. The plan should include consideration for such obstructions as machinery, pumps, pipe lines, lockers, stores and sheathing. This plan should also include the locations of shoring supplies and how to move them to the desired point with the least interruption of watertight integrity.

079-43.2.5 GENERAL RULES FOR SHORING. There are certain general rules applicable to all types of shoring - whether for bulkheads, decks, hatches or doors. These rules are:

- a. The scene leader will inform the shoring team what needs to be shored when they arrive on scene.
- b. The length of a shore should never be more than 30 times its minimum thickness.
- c. Remember that the shorter a wooden or steel shore in relation to its minimum thickness, the more weight it will support. Figure 074-43-3 illustrates this point.

Length of Shore in Relation to Its Strength

SIZE	STRENGTH	STRENGTH (at maximum extension)
3-5 feet	20,000 pounds	12,000 pounds
6-11 feet	20,000 pounds	6,000 pounds

- d. Shores should not be cut to length in anticipation of damage, since any distortion of the structure would make them useless.
- e. For stowage purposes, it is recommended that shores be in 16-foot to 18-foot lengths so, when needed, they can be cut to proper size with minimum waste.
- f. Shores should never be placed in position before damage occurs since they would transmit the shock of an explosion, extending the damage.
- g. Wedges should generally be used in opposing pairs. They should either be driven simultaneously or a heavy weight should be held against one while the other is driven.
- h. Strongbacks, sole pieces or pad pieces should be used to distribute pressure over a large area to prevent the shore from rupturing plating.
- i. A careful shoring watch should be maintained on any system of shoring, to attend to any loosening immediately.

079-43.2.6 PRESSURE CALCULATIONS. While it is not expected that repair parties will stop to make many calculations after the ship is hit, emphasis should be placed on the following important points:

- a. The total pressure on a bulkhead of a flooded compartment is tremendous.
- b. The pressure is greatest along the deck and least along the overhead.
- c. Pressure depends upon the height of the water over a given point.
- d. Pressure also depends upon the roll and pitch of the ship.
- e. Pressure may depend on the motion (speed forward or backward) of the ship.

Since c, d, and e in the preceding paragraph are variable, it is important to understand that those pressures and stresses also will be variable. When undertaking any shoring operation, the maximum stress (with an ample factor of safety) must be allowed.

079-43.2.7 VOLUME SUPPORTED BY SHORING. The load which a store can safely support depends upon the following factors:

- a. The material of which the shore is made - the stronger the material, the greater the load.
- b. The length between supports - the greater the length, the less the load.

- c. The minimum thickness of the shore - the greater the thickness, the greater the load.
- d. The direction in which the pressure is applied in relation to the axis or grain of the shore.

Items a and c in the preceding paragraph are determined by NAVSEA, whereas items b and d must be determined by the damage control assistant. In explanation of item c, it is recognized that the cross-section area has some bearing on the strength of a shore; however, the minimum thickness is far more important. A two-inch by four-inch plank is much stronger than a one-inch by eight-inch plank of the same length.

079-43.2.8 INSTRUCTION AND TRAINING. Repair personnel and other key members of the ship's force must be trained and given practice in the details of shoring operations. Models of compartments and miniature shores can be used to train personnel; applying simulated shores to bulkheads in repetitive situations under ideal conditions is also an effective teaching method. After a group has mastered several types of structures, they can then be drilled in actual shoring problems. They should study complications (such as interference from bunks, pipe lines and other immovable obstructions) and difficulties inherent in locating strong supports.

079-43.3 WOODEN SHORING

079-43.3.1 COMPONENTS OF WOOD SHORES. There are four major components used to accomplish wooden shoring operations:

- a. Shore - a portable beam for reinforcing or adding strength to a bulkhead or deck.
- b. Shole - a flat plate that can be placed under the end of a shore to distribute weight or pressure.
- c. Strongback - a bar or beam, often shorter than a shore, used to distribute pressure or to serve as an anchor for a patch over a hole.
- d. Wedge - a block, triangular on the sides and rectangular on the butt end.

079-43.3.2 WOODEN SHORES. Most shores - portable beams for reinforcing or adding strength to a bulkhead or deck - are made from wood which can be readily cut, shaped and trimmed to meet varying needs of repair parties. Softwood (pine or fir) is generally used, since such wood can be easily handled, cut and fastened; softwood will also absorb water, swell and help to tighten shores.

079-43.3.2.1 Types of Wood. The best woods available for shores are douglas fir and yellow pine. (Hemlock and spruce may be used but they are not as strong and are less satisfactory for handling.) Any wood chosen should be straight-grained and relatively free of knots and cracks. Keep in mind that green timbers have less strength than cured timbers; it is also important to note that if it becomes necessary to use weaker woods or those containing defects, more or heavier shores will have to be used to support the same weight.

NOTE

Although hardwood shores are stronger than softwood shores, they are difficult to cut, less absorbent and harder to nail, the combination of which makes them unsatisfactory for Navy use.

079-43.3.2.2 Sizes of Wooden Shores. Shoring is supplied in square sizes: four-inches by four-inches (large deck ships may have six-inches by six-inches). Wood for pad pieces is supplied in lengths of nine-inches by three-inches and twelve-inches by two-inches, both of which can also be used as shores if necessary. Shores

should be cut to the longest length possible, while maintaining portability and not exceeding stowage height aboard ship. (sixteen-foot to eighteen-foot lengths are typical.) Actual quantities allowed per ship are contained in the ship's allowance equipage list. Following in [Figure 079-43-4](#) is a definition of maximum shoring lengths, given the thickness of the shore.

Maximum Shoring Length

Thickness of Shore	Length of Shore
2 inches	5 feet
4 inches	10 feet
6 inches	15 feet
8 inches	20 feet

079-43.3.3 SHOLES. As noted above, a shole is a flat plate used under the end of a shore to distribute weight or pressure. Sholes should be made of douglas fir or yellow pine planks, one inch or more in thickness, and from eight to twelve inches wide. Wider sholes can be made by nailing cleats across two or more widths of planking. Even single planks may have to be cleated at the ends to prevent splitting. It is neither necessary nor desirable to prefabricate sholes.

079-43.3.4 STRONGBACKS. A strongback - a bar or beam used to distribute pressure or to serve as an anchor for a patch - can be all or part of a shore (and should be as thick as the shore). Scraps of wood obtained when cutting shores should be retained for use as strongbacks and short shores. Heavy planks as well as steel bars, angle irons and pipe, are often used as strongbacks, although their tendency to spring back and forth under variable loads must be considered. The same materials used as strongbacks can also be used for making semi-permanent repairs, when time is available.

079-43.3.5 WEDGES. A wedge is a block, triangular on the sides and rectangular on the butt end, primarily made of wood, which can be shaped as needed to support shoring. Soft woods (douglas fir and yellow pine) are preferred; however, a few hardwood wedges should be kept on hand because they have good resistance to crushing. (One drawback to using hardwood wedges is that they have a tendency to work loose.) All wedges should be cut with a coarse saw and left unpainted so that they will absorb water and better grip the area into which they are wedged. Wedges should be approximately as wide as the shores with which they are to be used. They can be made with various angles at the leading edge, but since blunt edges do not hold well, sharp wedges are preferable. A good wedge has a length of about six times its butt thickness. Thus a wedge for use with a four-inch by four-inch shore, four inches wide and two inches thick, should be twelve inches long.

NOTE

Steel wedges can be used in conjunction with wooden wedges to take some of the wear and pressure off the latter. Steel wedges can also be welded in place when making semi-permanent repairs.

079-43.4 METAL SHORING

079-43.4.1 COMPONENTS OF METAL SHORES. In general, the rules for using wooden shores apply also to metal shores. Only the methods of applying the shores differ. Adjustable steel shores consist of two telescopic, tubular steel sections, fitted with head and base plates and a screw jack, with a drop handle for fine adjustments. Damage control automatic adjustable telescoping steel shores are available in the following models:

- a. Model 3-5 - Adjustable from a minimum of three feet, plus or minus three inches to a maximum of five feet, plus or minus three inches. Model 3-5 will carry a vertical load when closed (but extended one inch on screw jack) of 20,000 pounds, but only 12,000 pounds when extended to its maximum.
- b. Model 6-11 - Adjustable from a minimum of six feet, plus or minus three inches to a maximum of eleven feet, plus or minus three inches. Model 6-10 will carry a vertical load when closed (but extended one inch on screw jack) of 20,000 pounds, but only 6,000 pounds when extended to maximum.

079-43.4.2. METAL SHORES. Steel shores must be maintained in operable condition at all times following the guidance listed here:

- a. Heave each telescope action of both tubes.
- b. Keep swivel joints free, clean and greased.
- c. Keep screw jack free of painted threads; keep clean and greased.
- d. Do not dent or hit metal shores (any distortion to the outer cases may prevent the inner part from sliding freely, thus making adjustments difficult or impossible).
- e. When metal shores are stowed after use, lightly oil all moving parts.

079-43.4.3 ADVANTAGES OF METAL SHORES. Aboard Navy ships, the use of metal shores has been limited. However, steel shoring has the following advantages:

- a. Fireproof
- b. Prefabricated and adjustable
- c. Much stronger than wood - the strength of metal shores is along the length and not across the sections, which makes them suitable for use as vertical or breast shores.
- d. Saves space, because a less complicated shoring structure is required.
- e. Welded members will not slide or jump out of position.
- f. Repairs can be semi-permanent in nature, thus permitting the ship to continue in operation when the use of wooden shores would not permit further action.
- g. Welded steel permits a greater number of types of repairs than wood.

NOTE

The disadvantage to using steel shoring is that it can be spark-producing when welded or scraped against other metal.

WARNING

The danger of using any spark-or flame-producing equipment when making repairs cannot be overemphasized, especially when there is a possibility of the presence of explosive gases.

079-43.4.4 EXAMPLE OF METAL SHORES. In addition to the use of steel shores to plug holes in the side of the ship, steel shores also are used to support overhead decks or loads. [Figure 079-43-5](#) illustrates a steel shore as described in [paragraph 079-43.4](#).

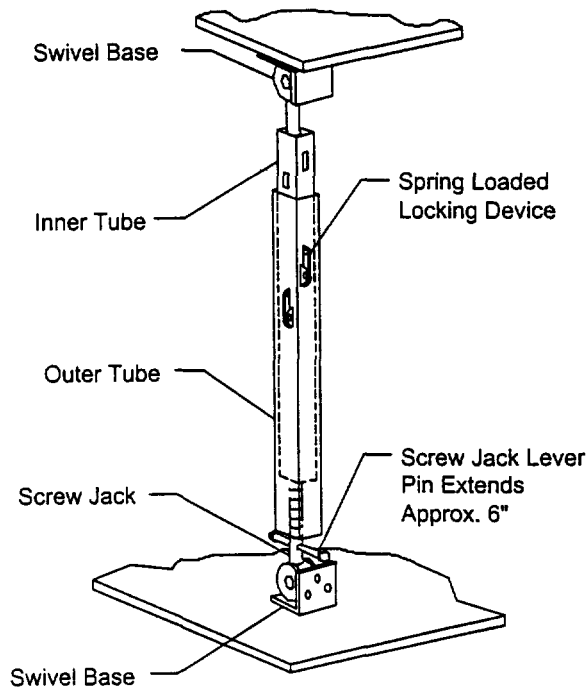


Figure 079-43-5. Steel Shoring

079-43.4.5 STEEL SHAPES USED IN SHORING. Metal shapes generally used for shoring and repair operations include: flat plate, bar stock, pipe, various types of angle irons, wedges, and sliding (telescopic) shores. The thickness of steel plate can be identified by its weight per square foot; that is, five-pound plate is 1/8-inch thick and ten-pound plate, 1/4-inch in thickness. Metal shapes can be cut with hacksaws, pneumatic chisels, electric welding tools and by oxyacetylene torches. Some of the more common steel shapes are illustrated in [Figure 079-43-6](#).

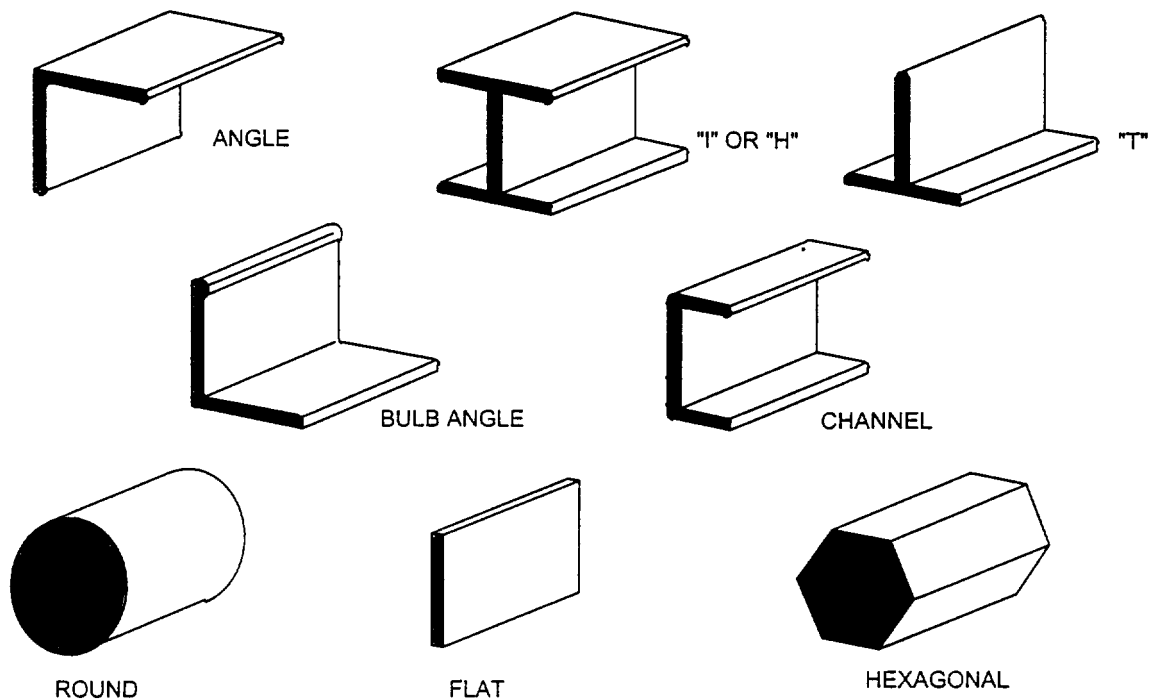


Figure 079-43-6. Steel Shapes Used for Shoring

079-43.4.6 PIPE SHORES. Pipe is either ordinary (light walled) or heavy-duty (thick walled). When used for shoring, it can be made more resistant to kinking and collapsing by filling it with sand. Pipe shores are stronger than wooden shores and can be welded in place, eliminating additional bracing. Two types of pipe shores are illustrated in [Figure 079-43-7](#) and a welded pipe shore is shown in [Figure 079-43-8](#).

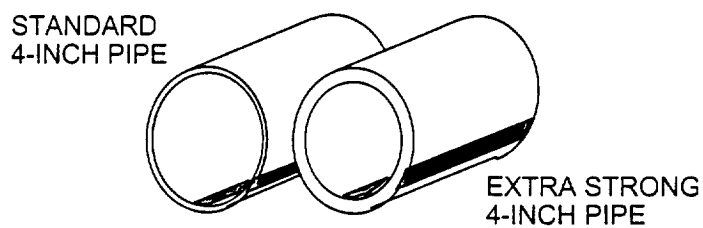


Figure 079-43-7. Types of Pipe Shores

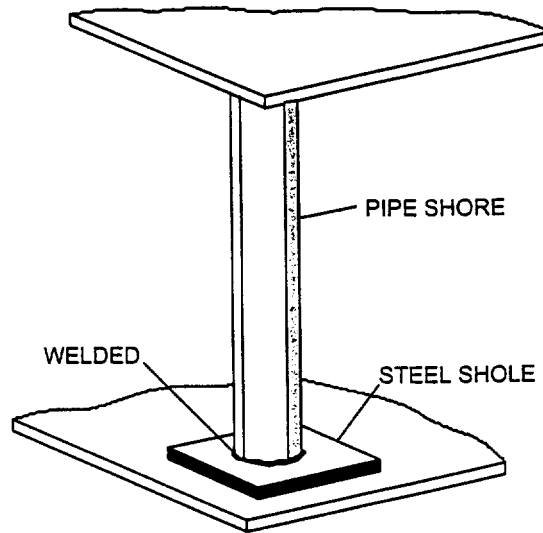


Figure 079-43-8. Welded Pipe Shore

079-43.5 OTHER SHORING EQUIPMENT

079-43.5.1 ALLOWANCE EQUIPAGE LISTS (AELs). NAVSEA Allowance Equipage Lists indicate the quantity and type of gear a ship is required to have and also the quantity of shores a ship is allowed. Small shoring items are stowed in kit bags to reduce their danger as splinter hazards. The bags are to be stenciled and contain a statement of their contents. To ensure that a full kit is available, allowance materials are to be inspected regularly and preserved to prevent rusting and deterioration.

079-43.5.2 TOOLS FOR SHORING. The essential tools for shoring are mauls, handsaws, cross-cut saws, heavy hand hammers, axes and heavy wood chisels. These tools are included on the shoring kit AELs and stowed in the damage control repair stations. Additionally, sliding measuring battens are also required. These normally consist of two pieces of wood about one-inch by one and one-half inches and approximately five feet long, connected with clips in such a way as to permit one batten to slide in line with the other. Finally, a carpenter's square is used to measure angles and cuts on wooden shores.

079-43.5.3 HANDS-ON TRAINING. It is difficult to explain and teach the fine points of pressure vectors unless personnel are actually on the job where they can use tools to measure, cut and trim shores and secure them in place. Instructions should begin with the use of hand tools such as hammers, hatchets, saws and mauls.

079-43.5.3.1 Cutting Shores. Using a piece of shoring timber, ask trainees to cut off shore lengths. Some will press down on the saw blade and cause it to bind. It is helpful to point out that in instances where such binding delays the job one-half minute at each cut, a complicated shoring job can be delayed thirty minutes or more, with possibly disastrous results.

079-43.5.3.2. Driving Wedges. Instructors should rig a shore between a deck and a beam and have trainees practice driving wedges. Let them see why they must drive two wedges simultaneously from opposite sides to keep the shore from tilting and why they must use a block buffer to prevent splitting the wedges. On an oily deck, wedges and shores will probably slip, causing the shoring installation to fail. To alleviate such an occurrence, teach trainees how to use sand and non-skid strips to reduce slipping of shoring.

079-43.5.3.3 Using Tools. Personnel should be taught how to use battens, squares, rulers and tapes when measuring lengths of shores required for various jobs. They must also be taught how to measure the angles to which the timbers must be trimmed in order to produce a stout structure. When trainees have mastered these details, the following principles of spreading pressure should be demonstrated:

- a. How timbers are strong in direct compression and weak across the grain
- b. Why strong anchors are necessary.

079-43.5.4 OFTEN-USED SHIPBOARD EQUIPMENT. In addition to the previously described equipment, the following items are often used in connection with shoring:

- a. Mattresses and pillows
- b. Electric welding machines
- c. Table tops
- d. Sheet packing
- e. C - clamps
- f. Turnbuckles
- g. Chainfalls
- h. Screw jacks
- i. Hydraulic jacks
- j. PHARS kit
- k. Bolts, nuts and washers
- l. General workshop material
- m. Ship furniture.

079-43.5.5 STOWAGE. When stowing shores, distribute them well over the ship in accessible compartments above the waterline. Pockets between frames and girders are excellent for stowing shores. Secure them with lines or metal clips so they cannot break loose but can easily be removed when required. The damage control deck, particularly, must be well stocked. The majority of wood and metal shoring is spread throughout the DC deck in each DCRS area of responsibility.

NOTE

Wooden wedges should be made up into compact blocks, stowed with shoring kits.

079-43.6 LAYING OUT SHORING

079-43.6.1 "I" TYPE SHORING. Basic "I" type shoring consists of a single beam between an anchor point and a strongback. (Strongbacks are set up to distribute pressure on plate patches, box patches, ship's structure, doors, hatches and scuttles; they are arranged on watertight fittings to put as many points of pressure on the closure as

it has dogs.) "I" type shoring does not require centerlines or angles. Distance is measured from the area to be shored to the anchor point; then the thickness of any patches, shole plates or strongbacks is subtracted to obtain the corrected length of the "I" shore.

NOTE

Subtract an additional one-half inch from any shore length that will receive wedges.

079-43.6.2 "K" TYPE SHORING. There are two methods used to lay out "K" type shoring: the measuring batten method, illustrated in [Figure 079-43-9](#), and the framing square method. A description of each method follows:

079-43.6.2.1 Measuring Batten Method. "K" type shoring can be laid out with a measuring batten (used to expedite the process) in the following manner:

1. Place one end of the batten against the bulkhead next to the area to be shored and the other end against the anchor point. This will give the correct length of the shore.
2. Next, subtract the thickness of any patches, shole plates or strongbacks to obtain the corrected length.
3. Subtract an additional one-half inch from any length that will receive wedges.
4. Prepare the shore by marking the center line (by placing the heel of the square on the shore's edge and any even number on the opposite edge). Make sure to have calculated the correct length before starting this step.
5. Repeat this in several locations along the shore.
6. Draw a line the entire length of the shore.

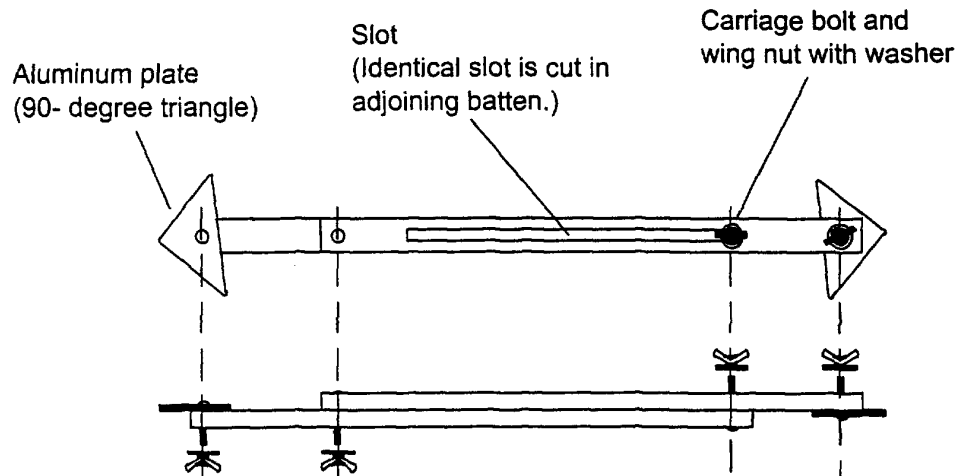
079-43.6.2.2 Framing Square Method. "K" type shoring can also be laid out with a framing square. The square used on ships is divided into 12^{ths} on one side and 16^{ths} on the other. The side of the square that is divided into 12^{ths} is used to measure shoring; therefore, it is important to hold the square with the tongue (short end) in the left hand and stay on one side of the shore while transferring measurements and angles. The following steps should be used to obtain the correct measurements:

1. Obtain the rise by measuring from the center of the damage to the deck.
2. Obtain the uncorrected run by measuring from bulkhead to the anchor point.
3. Obtain the corrected run by subtracting the thickness from any of the patches, shole plates or strongbacks.
4. Subtract an additional one-half inch from any shore length that will receive wedges.
5. Mark the rise on the tongue (short end) and the run on the body (long end) of the square.
6. Place the marks found in step # 5 on the centerline of the shore and mark the shore at these two points.
7. Measure the distance between these two points and convert it into feet and inches, then mark that length on the shore and square it off at both ends, in pencil.
8. Mark the angles by placing the square on the centerline of the shore.
9. Place the rise measurement on the intersection of the centerline and squared-off line.
10. Place the run measurement on the centerline at the opposite end.

11. Draw a line across the width of the shore along the edge of the square's tongue.
12. Turn the square 90° to the left and place the heel (outer point) of the square on the line intersection and the square's body along the first side of the angle drawn.
13. Draw a line from the centerline to the edge of the shore along the square's tongue.
14. Mark the opposite end of the shore by turning the square 90° back to the right; slide the square down to the other intersecting lines and repeat the process.
15. Place the run measurement (at this end) on the intersection of the centerline and squared off line. (When finished, the angles should be exactly reverse of the opposite end.)

079-43.6.3 MEASURING LENGTHS OF SHORING. When measuring the length to which a shore must be cut (the distance from a bulkhead to a nearby girder) use the folding rule, a steel tape or a wooden batten. (Cotton or manila lines are unsatisfactory because they are too elastic and will give incorrect dimensions.) An efficient measuring batten can be made by securing two eight-foot pieces of one and one-half inch by one and one-half inch lumber with sliding clamps. Each clamp is then secured to one leg only, so that the batten can be extended to a length of about fourteen feet. A locking device, such as a screw, can be used to hold the pieces in place once a measurement has been taken.

079-43.6.3.1 Wooden Batten Measuring. Extend the batten to the desired length and lock it. Lay the batten along a shore, mark and cut the timber to the proper length. (This is more accurate and will take less time than measuring the batten and then measuring that distance on the shore.) In general, shores should be cut one-half inch shorter than the measured length. This half-inch is to allow space for wedges to enter. [Figure 079-43-9](#), shown earlier, illustrates the use of the measuring batten in shoring.



Notes:

- Wood battens should be 1-inch x 2-inch hardwood.
- Hardware should be stainless steel.
- Length of battens and length of slots are builders choice.
- Aluminum plate is 1/4-inch with slightly rounded corners.
- Bolt ends are peened over to keep wing nuts from falling off.

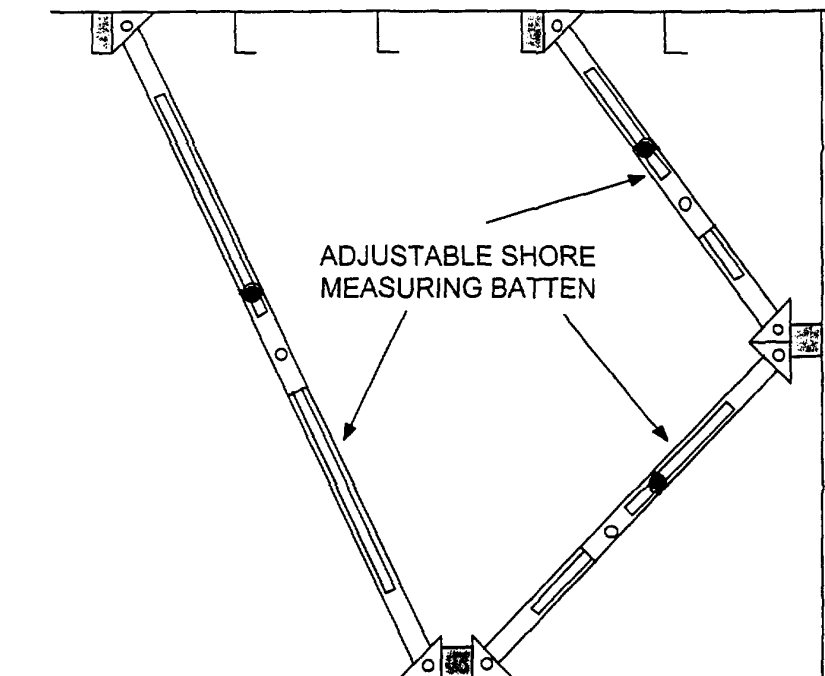


Figure 079-43-9. Use of Measuring Batten in Shoring

079-43.6.3.2 Folding Rule Measuring. Shores can be measured for length by using a folding rule or a twenty-five-foot steel tape and a carpenter's square. The procedure, illustrated in [Figure 079-43-10](#) is as follows:

1. Measure the distance A from the center of the strongback to the deck. Then measure the distance B from the edge of the anchorage to the bulkhead, minus the thickness of the strongback.
2. Lay off on a carpenter's square the measurements A and B, using the ratio one-inch to one-foot.
3. Measure the diagonal distance between A and B. This is the length of the shore in feet.

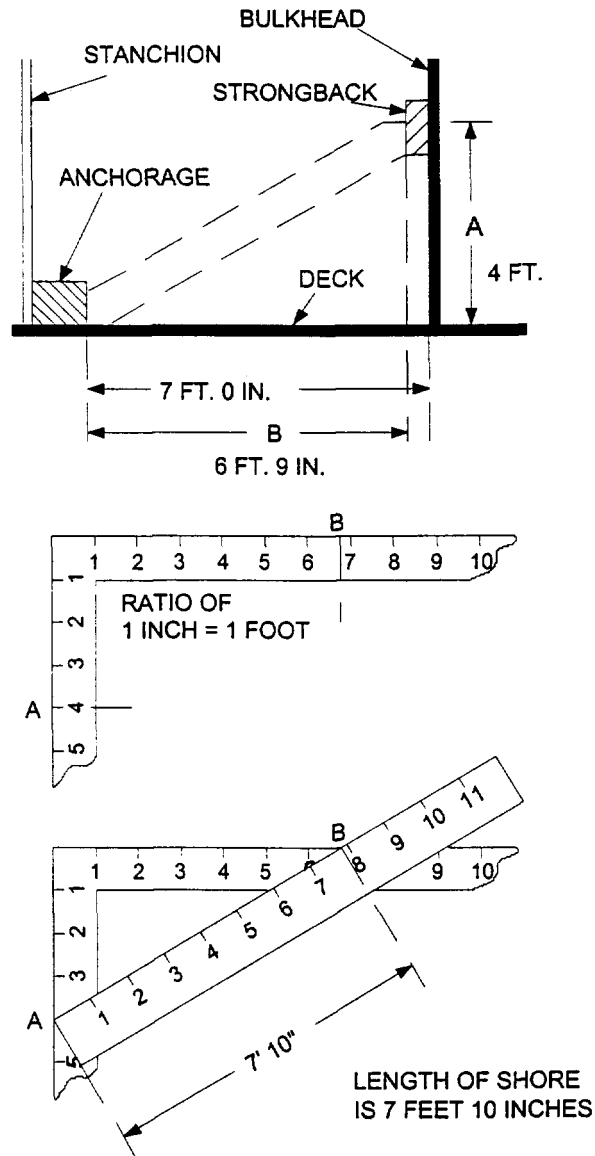


Figure 079-43-10. Folding Rule/Steel Tape Measuring Method

079-43.6.4 CUTTING/SHORING. Proper cutting of shores is important to all shoring operations. Improperly cut shores cause unnecessary delays and waste materials. Improperly fitted shores and wedges may cause an entire shoring effort to fail. Shores are generally cut with portable electric circular saws or by handsaws when necessary. All repair party personnel are to be instructed in the correct use of these tools.

079-43.6.4.1 Angle Cuts. Angle cuts can be made using the measurements indicated in [Figure 079-43-10](#), prior, as a guide. Refer to [Figure 079-43-11](#), Cutting Shoring Angles, for the following step-by-step process:

1. Lay the carpenter's square along the shore as shown in [step 1](#) of [Figure 079-43-11](#), making sure that the measurements, 4 inches and 6-3/4 inches, lay along the same line. Cut shore to this line.
2. Measure the center of the cut and mark a right angle to it for the second cut. Work and saw to the line. One end of the shore is now cut.
3. Along the center of the stock, measure the desired length of the shore (7' 10") and mark off a perpendicular line at the other end of the stock.
4. Slide the carpenter's square to the center point on the perpendicular, keeping the same measurements on the same lines as before. Mark the cutting line on the other side of the square.
5. Mark a right angle from the center point of this cut for the second cut. Make these cuts and the shore will be the proper length with the correct angle cuts.

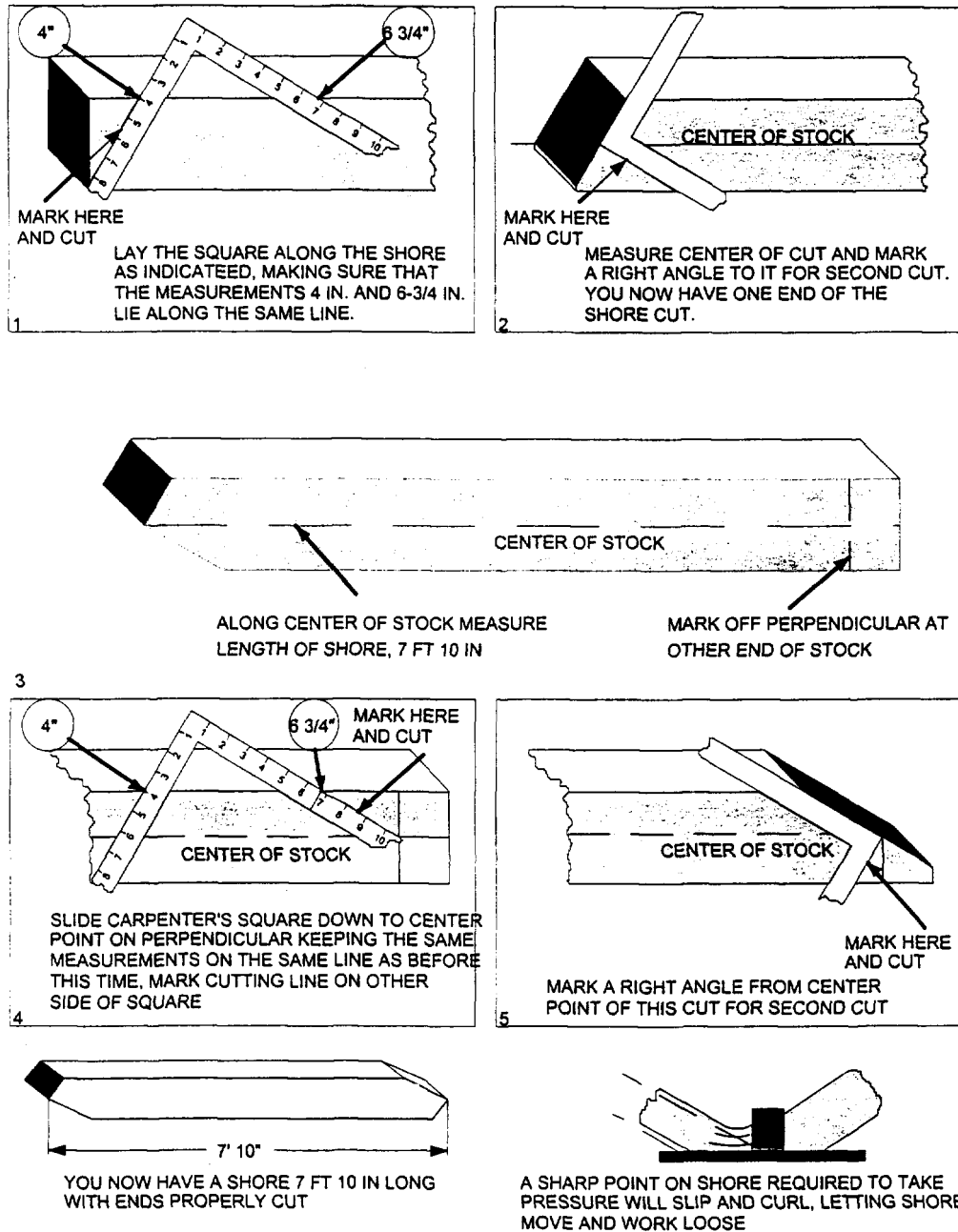


Figure 079-43-11. Cutting Shoring Angles

079-43.6.4.2 Cutting Tips. Wet timbers are difficult to cut unless the proper methods of sawing are used. When cutting heavy six-inch by six-inch and eight-inch by eight-inch shores, a lumberjack crosscut saw will save considerable time. Chisels, axes and hatchets can also be used in cutting and trimming shores. Keep all cutting tools maintained in the best possible condition, i.e., oiled, sharpened and free from corrosion.

079-43.6.5 TRIMMING SHORES. The process of shaping the ends and sides of a shore so they will fit into the shoring structure properly is called "trimming". Certain rules must be observed when trimming to prevent shoring from splitting and chipping (and thus becoming useless). These rules are described in the following paragraphs:

079-43.6.5.1 Square Trim. If shore A is to fit against a plane surface of shore B and take a load in direct compression, the end of A must be cut square and perpendicular to the axis of A. This will spread the pressure over the greatest possible area. This principle is illustrated in [Figure 079-43-12](#).

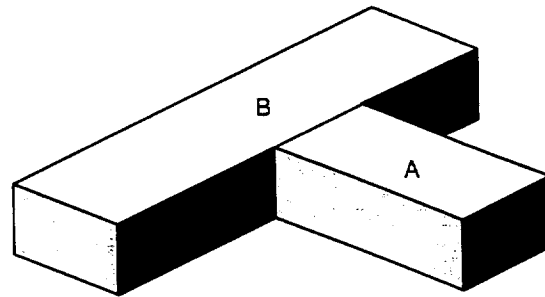


Figure 079-43-12. Fitting Shores Together

079-43.6.5.2 Sharp Point Trimming. A sharp point never should be left on the end of a shore when the shore will be required to take any pressure, because the a point will slip, permitting the shore to move and work loose. The shore must be trimmed in order to present a substantial flat area at each pressure surface. [Figure 079-43-13](#) illustrates the incorrect and the correct method of cutting the end of a shore.

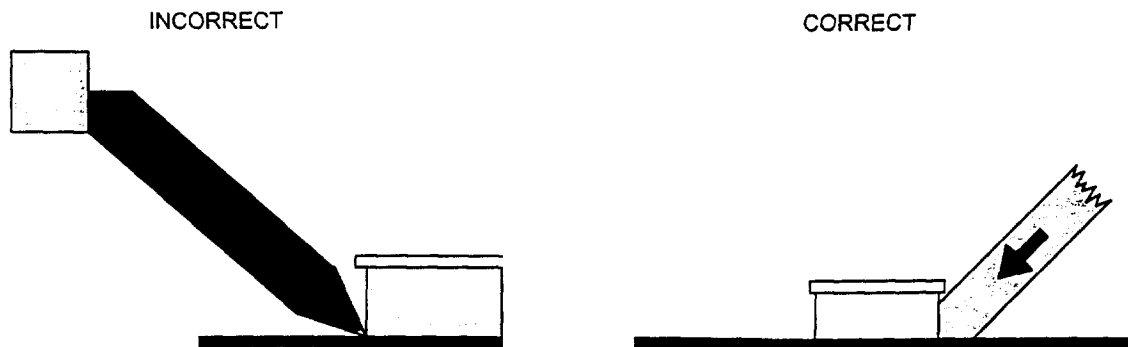


Figure 079-43-13. Cutting the End of a Shore

079-43.6.5.3 Fitting Shores to Deck. [Figure 079-43-14](#) illustrates two shores (A and B) pressing down on the deck. A study of the two illustrations will reveal the weakness inherent in the incorrect fitting.

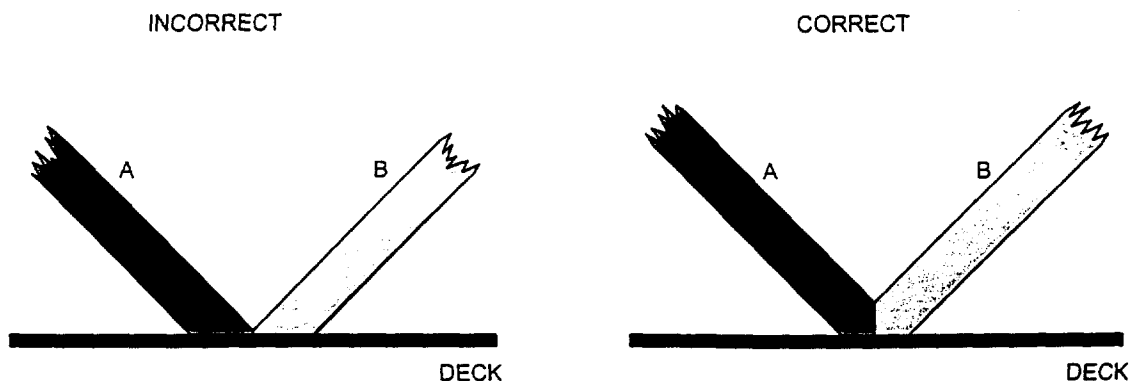


Figure 079-43-14. Fitting Shores Pressing on Deck

079-43.6.5.4 Trimming Two Ends of a Shore. Both ends of a shore must be shaped to avoid weakening any part of the assembly. [Figure 079-43-15](#) illustrates both incorrect and correct methods of shaping shores which need to be trimmed at both ends. The construction shown on the left is not a correct method. If shore B is not

perpendicular to A, B will have a strong tendency to slip out of place. In this case, angle θ is less than 90 degrees and the shore will slip in the direction of T unless block D is nailed on top of C. It would be better to use a wide timber as a strongback, embodying D and C as one piece, because the pressure of B will tend to pry the nailed D away from C. A two-inch by ten-inch plank could be used in place of C and D. In the illustration on the right, shores A and B have been shaped not only to present flat surfaces to girder G and hatch H but also against decks D and E. They are also shaped at their other ends to present flat surfaces to each other and to strongback C at point M. This method makes a strong shoring job. The flat surfaces are necessary where wedges are to be driven.

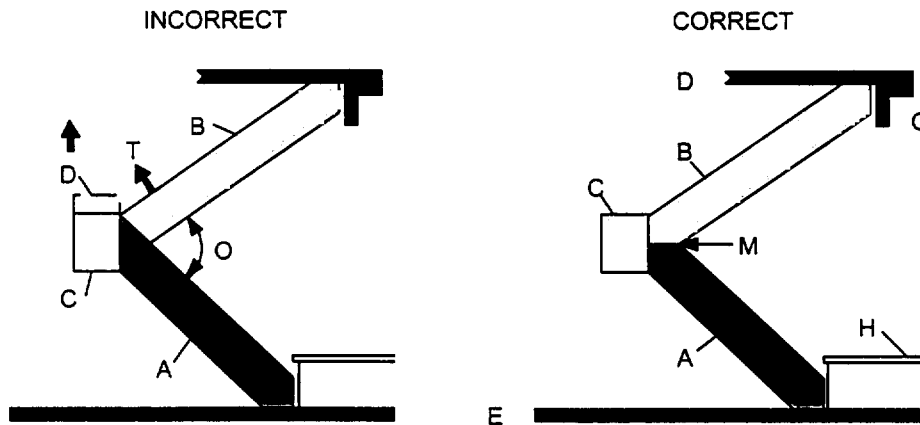


Figure 079-43-15. Shaping Both Ends of Shore

CAUTION

Shores are sometimes notched to fit against other shores. If there is any working of the shoring structure, the notched shore is very likely to split. This method must never be used when any great pressure is expected. A safer and more satisfactory method is to cut a socket in the horizontal shore A into which the butt of the inclined shore B will fit.

079-43.7 APPLYING WEDGES

079-43.7.1 ROUGH-CUTTING WEDGES. Wedges are to be cut in such a manner that they retain a rough finish on all surfaces. Wedges are to be rough-cut to the dimensions as indicated in [Figure 079-43-16](#), and must remain unpainted.

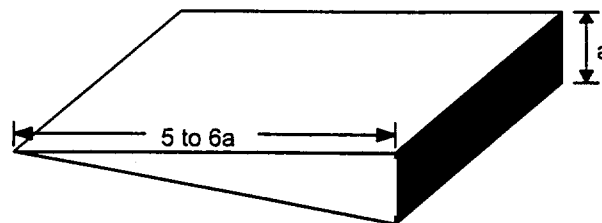


Figure 079-43-16. Wedge Size

079-43.7.2 SAWING WEDGES. Wedges are made by sawing a rectangular block as indicated in [Figure 079-43-17](#). To stow wedges, set them hypotenuse to hypotenuse; that is, so that they form a shape similar to the timber before cutting.

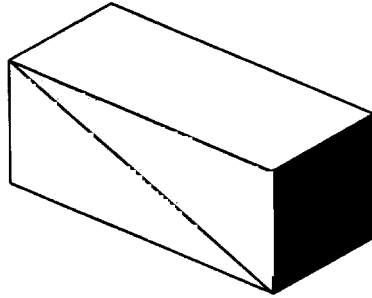


Figure 079-43-17. Cutting Wedges

079-43.7.3 MAKESHIFT WEDGES. [Figure 079-43-18](#) illustrates how to create makeshift wedges by cutting a short piece of shoring with a hatchet. Put wood piece A on block of wood B when chopping, to protect the hatchet.

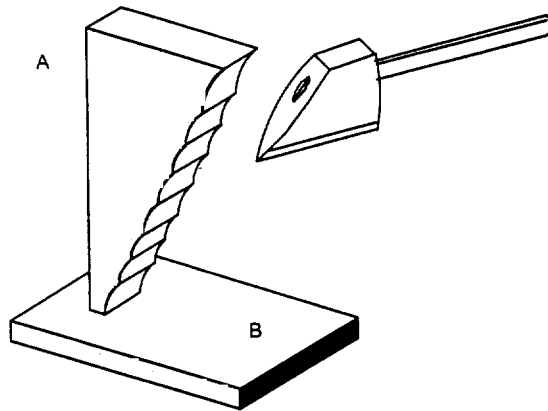


Figure 079-43-18. Cutting Makeshift Wedges

079-43.7.4 DRIVING A WEDGE. To drive a wedge, put a block of wood between the butt of the wedge and the maul, to prevent the wedge from splitting, as illustrated in [Figure 079-43-19](#).

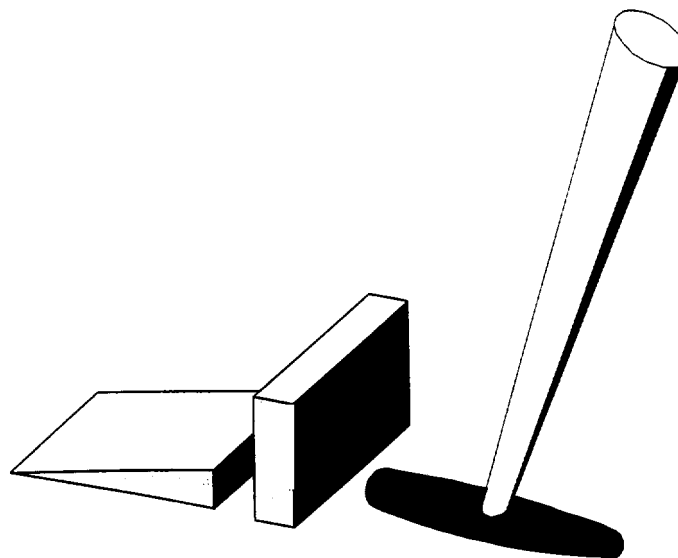


Figure 079-43-19. Driving a Wedge

079-43.7.5 USING TWO WEDGES. When using wedges to support a shore, either horizontally or vertically, always use two wedges driven simultaneously with two five-pound mauls, striking evenly from both sides to prevent tilting the shore. If there is not enough room to swing a second maul, the same effect can be gained by holding a maul against the butt of one wedge and driving the other. If the deck is slippery, throw sand under the wedges to reduce the tendency to slip. It is poor practice to use more than one pair of wedges behind one end of a shore. (Such a rig may easily collapse.) [Figure 079-43-20-A](#) illustrates the procedure for using two wedges to support a shore. As illustrated in [Figure 079-43-20-B](#), if wedges W are not enough to take up all the space between shores A and B, use block C as a filler piece, provided the joint is laid on and supported by a deck. It is considered poor practice to use such filler pieces in vertical shoring because the unsupported joint may collapse when the ship works.

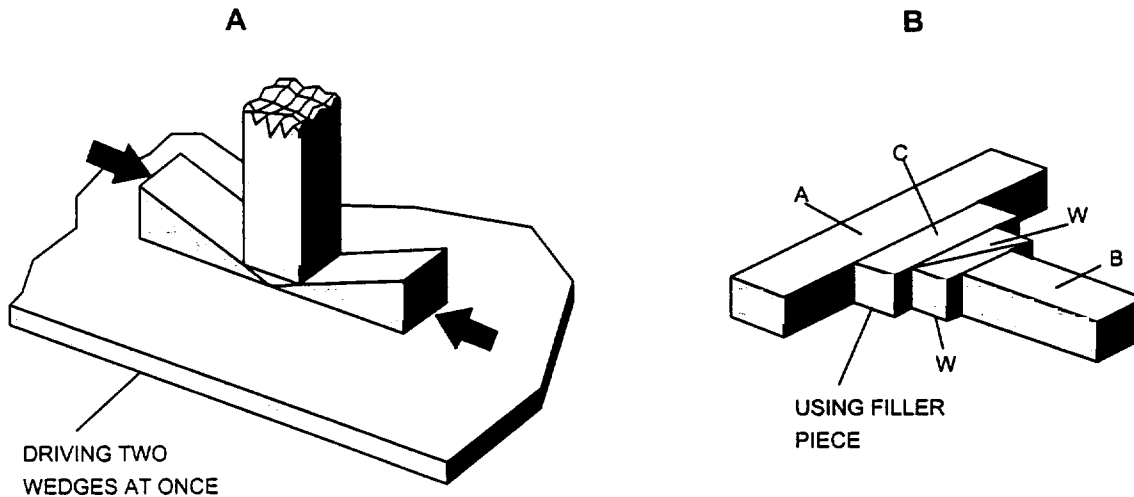


Figure 079-43-20. Effective Wedge Practices

079-43.7.6 LOCKING WEDGES. [Figure 079-43-21](#) illustrates the method to be used to lock wedges in place. After wedges W have been driven home as indicated in Step 1, cut them off along the lines A - A. Then, as indicated in Step 2, cut blocks of two-inch by four-inch shoring (T) to fit the spaces and tap them into place snugly.

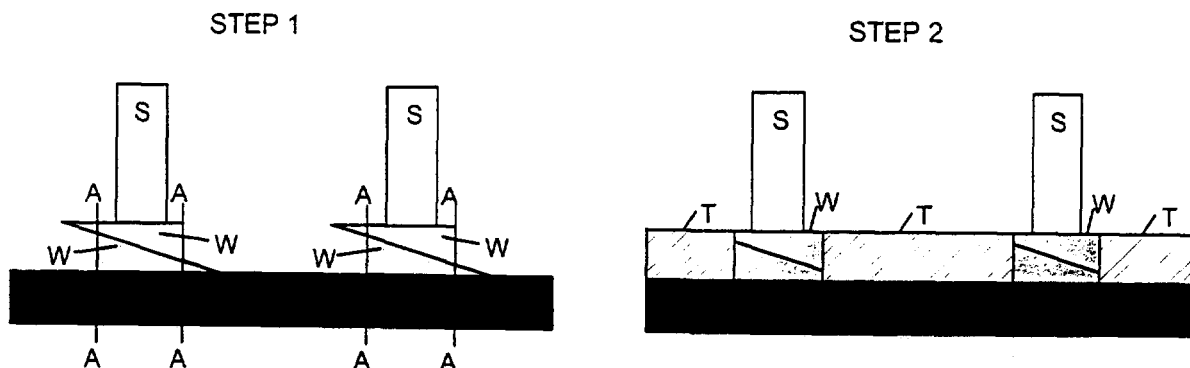


Figure 079-43-21. Locking Wedges

079-43.8 HOLDING DEVICES

079-43.8.1 CLEATS. Horizontal shoring member A can be supported temporarily by cleats C nailed to vertical shore B. Note that there is always a possibility that the cleats will split when nailed. [Figure 079-43-22](#) illus-

trates the use of cleats to give temporary support to a horizontal shoring member.

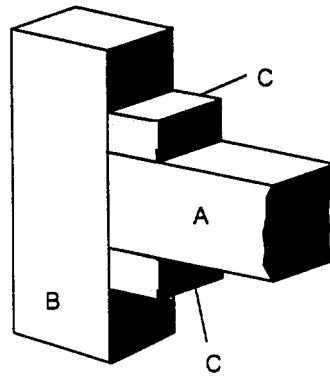


Figure 079-43-22. Temporary Support of Horizontal Shoring with Cleats

079-43.8.2 NAILS. On shoring structures, nails are used to secure battens and cleats to reduce the possibility of their jumping and slipping. Nails are also used to hold shoring members temporarily in place, before final adjustment to the structure. [Figure 079-43-23](#) illustrates both the incorrect way to use nails in shoring and correct method. [Figure 079-43-24](#) illustrates another effective method to lock shoring, using nails.

NOTE

There is a tendency to use nails where they do little or no good or where they actually can split shores and wedges; nails can also break off when the shoring structure exerts excessive lateral pressure upon the nail material.

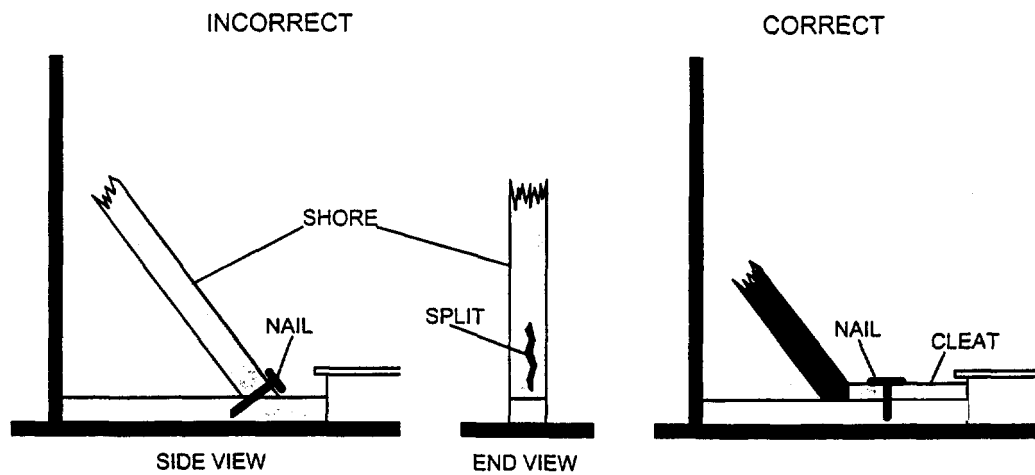


Figure 079-43-23. Use of Nails to Secure Shoring

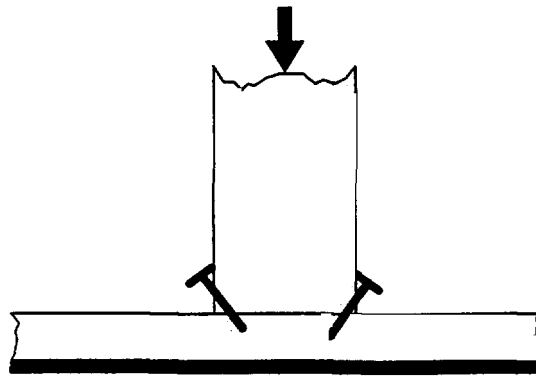


Figure 079-43-24. Use of Nails to Lock Shoring

079-43.8.3 NOTCHING. Members of a shoring structure can be supported by cutting shallow notches (one-fourth-inch plus) in one member and fitting the other member into the notched socket. Although this securing method will weaken the cut member slightly, it will prevent slipping (see [Figure 079-43-25](#)). Nails can be used as securing aids, provided there is no great pressure on the nails.

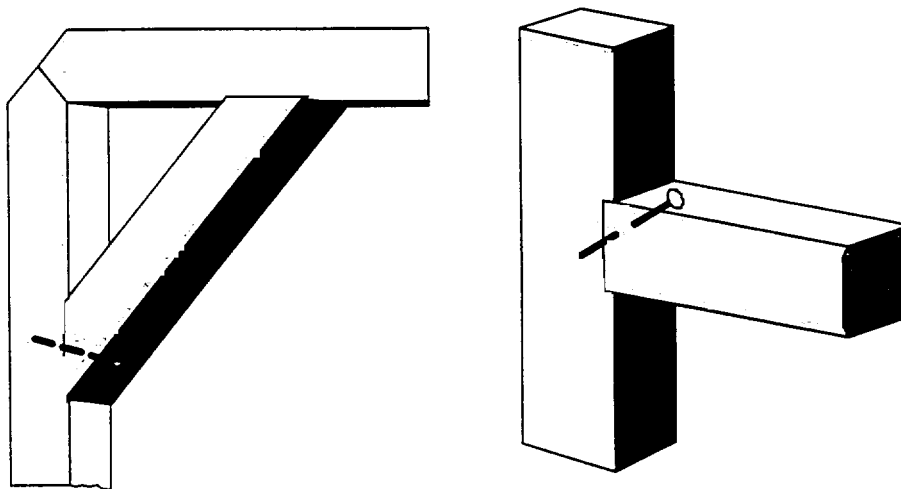


Figure 079-43-25. Notching Shores to Prevent Slipping

079-43.8.4 BATTENS. It is an acceptable practice to nail battens on the sides of shoring members to help support the structure. [Figure 079-43-26](#) illustrates the batten method.

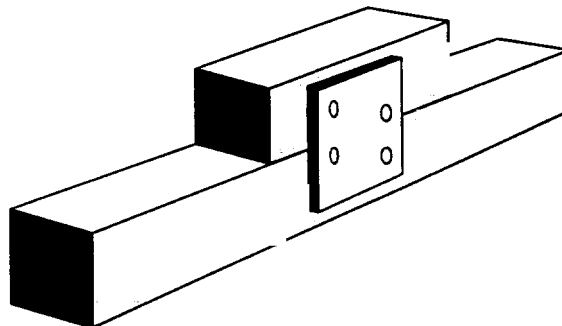


Figure 079-43-26. Use of Batten to Support Structure

079-43.9 SHORING SCENARIOS

079-43.9.1 SHORING DECKS AND OVERHEAD. When a compartment is flooded, the deck and all bulkheads around it (and possibly the overhead) are subject to pressure. It may be necessary to shore the entire containing structure, giving priority to any bulkhead that may have been weakened or is subjected to the greatest pressure. Decks of flooded upper compartments must be shored from next lower decks.

079-43.9.2 SHORING DOORS AND HATCHES. When shoring doors and hatches, the basic rule is to put as many points of pressure on the closure as it has dogs. As illustrated in Figure 079-43-27, doors and hatches may be complicated by scuttles and quick-acting handwheels R, in which case it will be necessary to build up a framework of shores to clear the wheel. Two strongbacks S are laid lengthwise to the hatch, near the knife edges, extending about two inches beyond the ends of the hatch. Cross-pieces Q are then laid over the strongbacks. Filler blocks K (shown cut away) are placed under the cross-pieces to keep the hatch from buckling. One or more strongbacks M are laid across the crosspieces; shore A and wedges W are then set in place. When heavy pressure is expected under the hatch, lay down two top strongbacks and erect several vertical shores similar to those indicated by the dotted lines, pressing on points P.

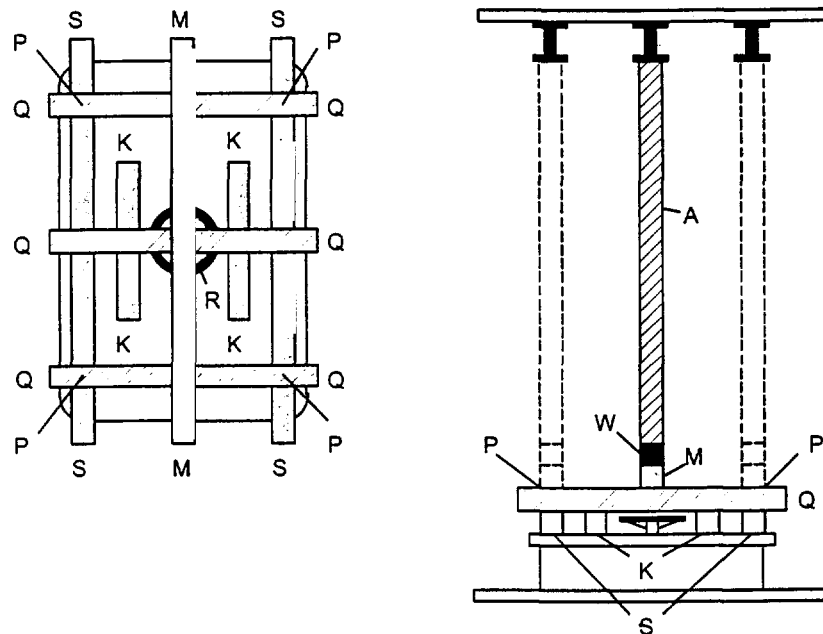


Figure 079-43-27. Shoring Doors and Hatches

079-43.9.3 DOOR WITH ORDINARY DOGS. Figure 079-43-28 illustrates how to shore a door with ordinary dogs. The dogs are used to obtain vertical support for strongbacks S and the deck provides support for cross-piece C. Any suitable shoring system can be used to keep the strongbacks in place on the hatch or door. If beams are not readily available overhead, a good anchorage can usually be obtained by putting a strongback across two adjacent beams. Should the door or hatch be badly warped or bent, it could be more satisfactory to erect a false closure that is - a large patch.

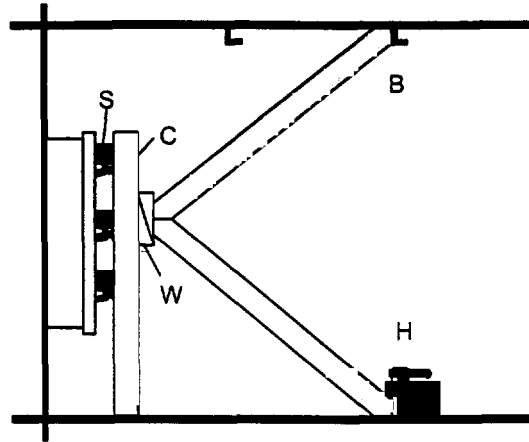


Figure 079-43-28 Shoring a Door with Ordinary Dogs

079-43.9.4 WOOD SHORING TO HOLD PATCHES. Wood shoring is frequently used to hold patches in place over holes or cracks. In [Figure 079-43-29-A](#), three mattresses H are held in place by T (joiner door or metal plate or wood boards), strongbacks S, a crosspiece C, and by shores A and B. Note that C extends to the deck for vertical support. In [Figure 079-43-29-B](#), two crew mattresses M and a backing plate T are held in place by a shoring structure consisting of strongbacks S and C, shores A and B, and wedges W. Shore A is supported vertically by cleat D. Shore B is held in place by stiffener F and brace E, which is held in place against hatch coaming G. Note how the protruding edges of the hole dig into the mattress. Patches of this type can be used to replace a defective hatch or door.

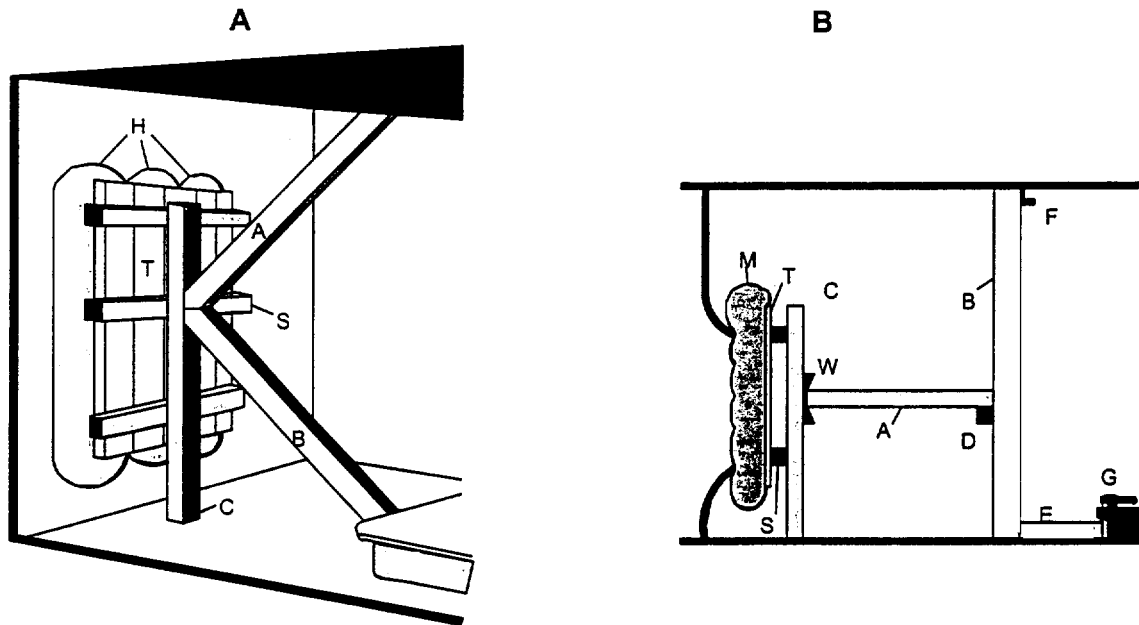


Figure 079-43-29. Wood Shoring to Hold Patches

079-43.9.5 STEEL SHORING TO HOLD PATCHES. Steel shoring is often used to support patches, as illustrated in [Figure 079-43-30](#). The spark-producing characteristic of this shoring method do not typically present a hazard when used as illustrated.

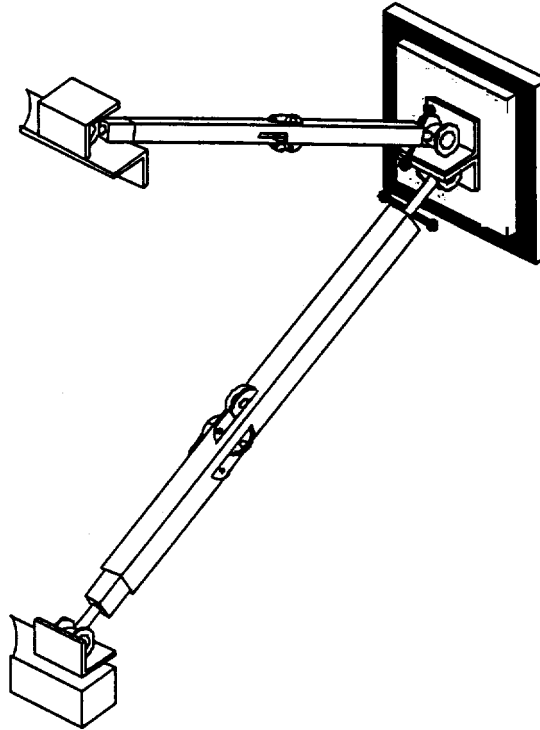


Figure 079-43-30. Steel Shoring Supporting Patch

079-43.9.6 SHORING FLUSH HATCHES. In [Figure 079-43-31](#) illustrates that flush patches should be shored with the pressure over the gaskets, as shown at P, and not at point N.

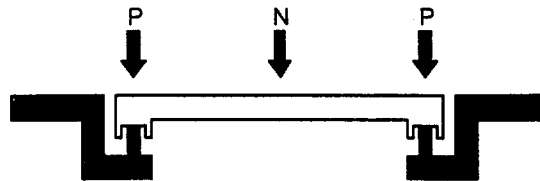


Figure 079-43-31. Shoring Flush Hatches

079-43.9.7 SHORING WITH NO ANCHORAGE AVAILABLE ON DECK. [Figure 079-43-32](#) illustrates a form of shoring frequently used in long compartments that have no stout anchorage available on deck. Vertical shore A is cut considerably longer than dimension X; when one end of A is secured to beam B, pressure transmitted through shore S forces strongback T against the bulkhead and pushes shore A tight against deck D, which serves as an anchorage. It is important to note that there are several inherent weaknesses when using this shoring method:

- a. Shore A is under cross-grain stress, its weakest position.
- b. If decks D and E are heaving, shore A will tend to jump and slip and may crack.
- c. The lower end of A may have to rest on a weak part of deck D not over a frame F.

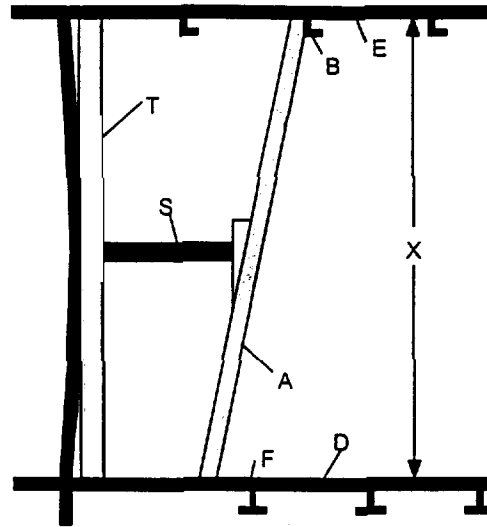


Figure 079-43-32. Shoring with No Anchorage Available on Deck

079-43.9.8 USING MULTIPLE SUPPORTS. Each horizontal strongback must be backed up by a number of shores exerting a pressure perpendicular to the bulkhead. In [Figure 079-43-33](#) the vector of supporting forces is in the direction K. This example shows why using multiple supports is so important. If only shores A and B were used, there would be insufficient pressure to support the bulkhead. Strongback S would exert maximum pressure at point C and practically none at point D. This would occur because the bulkhead is bowed and because the strongback tends to curl outward from the point of pressure.

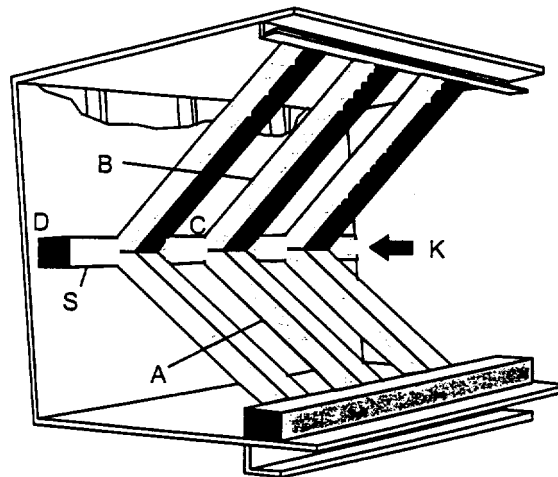


Figure 079-43-33. Multiple Supports

079-43.9.9 EXAMPLE TWO, MULTIPLE SUPPORTS. Figure 079-43-34 illustrates another application of multiple supports used in shoring. Note that compound shoring braces the bulkhead at B. The pressure on the shoring structure is spread over several supports in order not to overstrain any one of them. Pressure is absorbed by spreading it over several frames F on bulkhead T by means of strongback S.

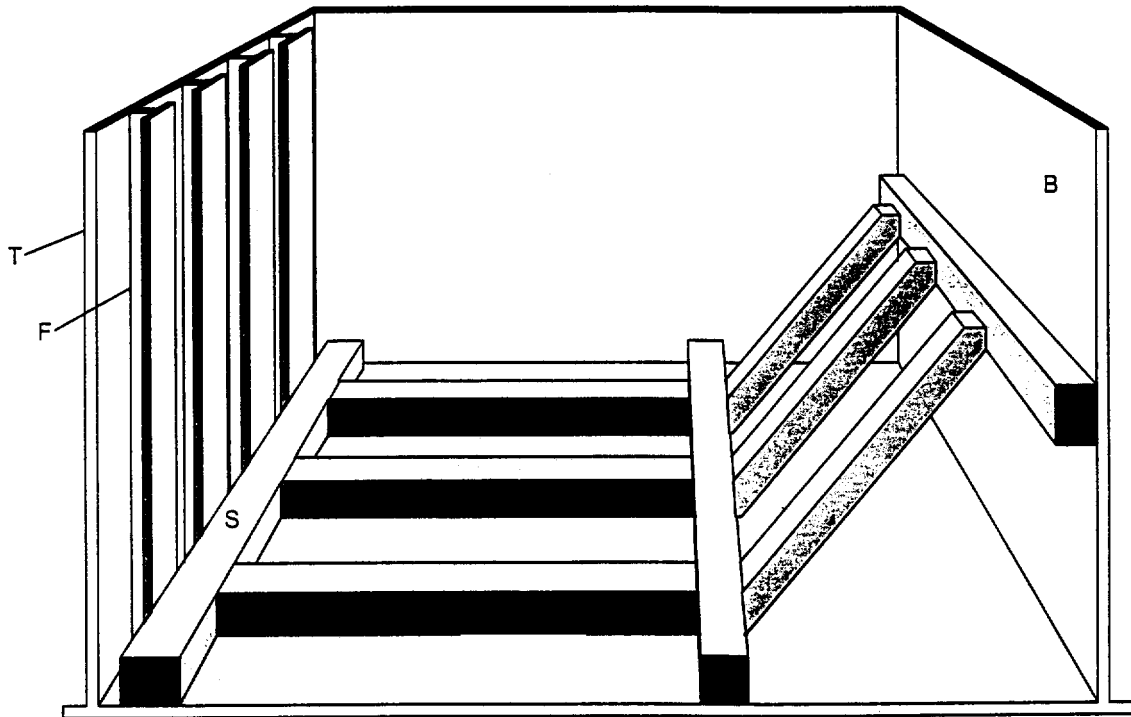


Figure 079-43-34. Compound Shoring

079-43.9.10 SUPPORTING FRAMES OR GIRDERS. When installing supporting shores at bulkheads or decks, always place them over frames or girders, as at A and B, and never at unstrengthened points as at C, as illustrated in [Figure 079-43-35](#). Shores or strongbacks also can be used to widen pressure areas.

CAUTION

Failure to properly install supporting shores over frames or girders will cause bulkheads or decks to warp and, possibly, rupture.

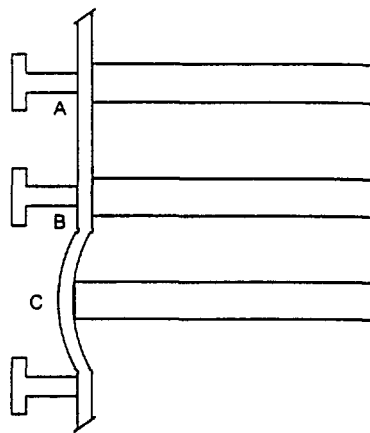


Figure 079-43-35. Placement of Shores Over Frames or Girders

079-43.9.11 USING RIGGING GEAR. Various types of rigging gear, such as chainfalls, wire straps, blocks and tackle and manila line can be useful during shoring operations, especially for clearing away wreckage and

restoring equipment to its original position. To a limited extent, this gear can be used to hold equipment in position, but keep in mind that all fiber lines will stretch under tension. Because rigging gear is, for the most part, not rigid, it cannot be relied upon to do the work of shores. When rigging such gear, ensure that the fixed end is secured to a strong, undamaged structure.

CAUTION

Do not use jacks (or other shoring methods) to attempt to remove a permanent set from a damaged bulkhead.

079-43.9.12 USE OF JACKS. As illustrated in [Figure 079-43-36](#), hydraulic jack (or screw) J can be used to push heavy weights back to their original positions. When using this method, shoring S also must be erected so, if the jack is suddenly knocked out of place, the weight it is supporting will not crash. Build up base B with wide blocks as the jack moves up and the structure returns to its original position.

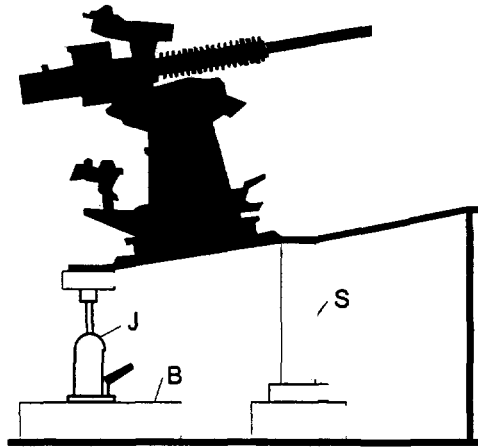


Figure 079-43-36. Use of Jack to Move Heavy Equipment

CAUTION

Do not use jacks (or other shoring methods) to attempt to remove a permanent set from a damaged bulkhead.

079-43.9.13 USE OF CHAINFALLS. Chainfalls or blocks and tackle can be obtained from the deck department and used to pull heavy weights back into position. Shoring should be added beneath the apparatus as indicated in [Figure 079-43-37](#) in case the hoisting gear fails. The chainfall must be secured to a stout padeye, beam or strongback. Wooden or steel strongbacks can be laid over holes or hatches to secure the hook of a chainfall or block and tackle. If one strongback is not sturdy enough, tie several together, ensuring that the ends of the strongback(s) protrude well over the edges of the opening. If the weight being pulled back into position is loose and free to move, it is important to check such motion with steadying lines while maneuvering the weight to a still position.

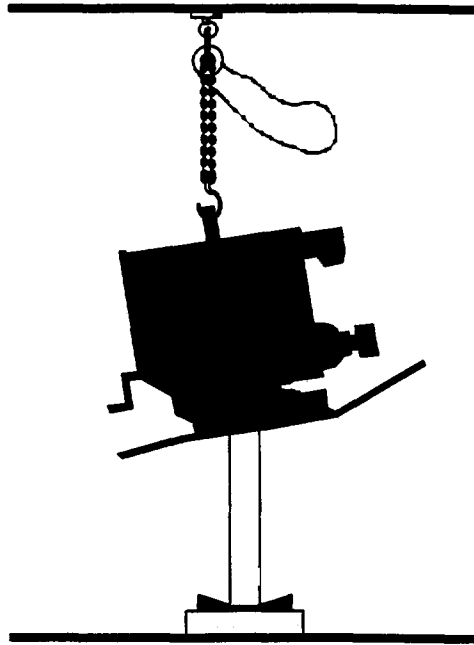


Figure 079-43-37. Use of Chainfalls to Move Heavy Weights

079-43.10 WATER PRESSURE IN FLOODED COMPARTMENTS

079-43.10.1 CAUSES OF PRESSURE. The pressure on a bulkhead or deck in flooded compartments is caused by the following:

- a. The depth of flooding
- b. The flooded area
- c. Additional pressure caused by the ship's motion
- d. Whether or not the compartment is open to the sea.

079-43.10.2 PRESSURE EXERTED AGAINST BULKHEADS. The following examples will show that the deeper the flooding is below the waterline, the progressively more pressure is exerted against the bulkhead. Sea water weighs approximately 64 pounds per cubic foot; the pressure over one square inch at a depth of one foot below the waterline of the ship is 0.444 pounds (sea water); at nine feet below the waterline, it is 3.996 pounds; at 20 feet below the waterline, pressure is 8.88 pounds. The pressure at any point is equal in all directions, whether downward toward the deck or horizontally toward the bulkhead. A bulkhead twenty feet wide and five feet high, at a depth of five feet below the waterline will be subjected to a total pressure of 16,000 pounds. A bulkhead eight feet high and twenty feet wide, at a depth of fifteen feet below the waterline will exert a total pressure of 112,640 pounds. This gives some idea of the pressure that must be contained. If the ship remained entirely motionless in all three planes, the pressure of any given point would remain constant and the problem of shoring would be relatively simple. It would be possible to erect a light shoring structure and then leave it without further inspection. It might not even be necessary to shore. However, the water pressure at any point on a submerged bulkhead is the same as the pressure of the water over it. The pressure, therefore, is directly proportional to the depth of the water, and for that reason watertight bulkheads on naval ships are built progressively stronger as they approach the ship's bottom. [Figure 079-43-38](#) illustrates this principle.

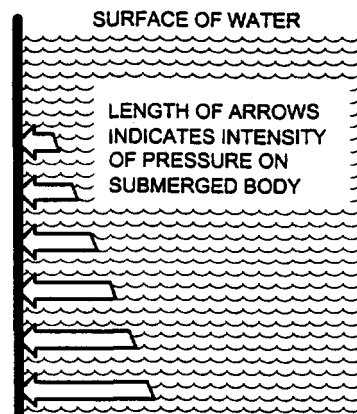


Figure 079-43-38. Pressure of Water Verses Depth of Water

079-43.10.3 PRESSURE WITH OCEAN ABOVE OVERHEAD. The depth of the water in a compartment open to the sea and completely flooded is measured from the ocean surface, not from the overhead of the compartment. Figure 079-43-39, shows pressure point P which is equal to the pressure of the water at that depth. Even if the lower compartment is not entirely flooded but contains a layer of entrapped air at the top, the air in the compartment will be compressed until it assumes the same pressure as the water column.

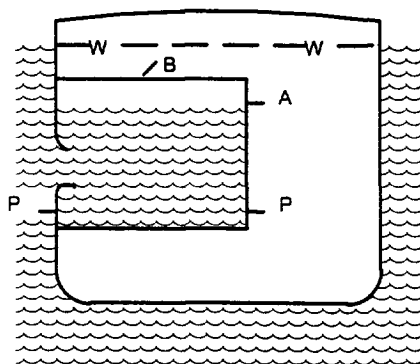


Figure 079-43-39. Air Trapped in Compartment Under Water

079-43.10.4 PRESSURE WITH OCEAN BELOW OVERHEAD. The same rule delineated in paragraph 079-43.10.3 applies when the ocean level is below the level of the overhead. In figure 079-43-40 the pressure on joint P is WP.

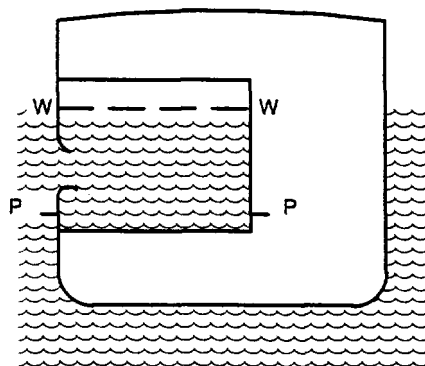


Figure 079-43-40. Pressure in Compartment - Ocean Below Level of Overhead

079-43.10.5 PRESSURE WITH COMPARTMENT OPEN AT TOP. There is one case in which the previous rule does not apply. That exception exists when the compartment is open at the top under the following conditions: Figure 079-43-41 shows the outside water level is at W and the inside level at X. Water is coming into the compartment through a relatively slow leak and the compartment is open at the top so that air can escape faster than water comes in. In this case, the pressure at P is XP. This type of flooding is often encountered in spaces surrounding compartments that have been blasted open to the sea.

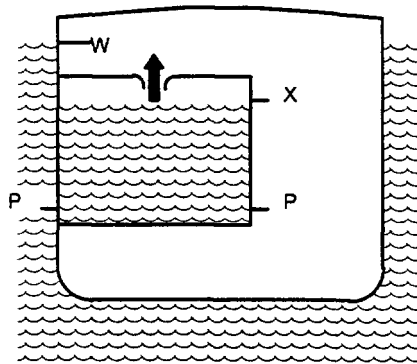


Figure 079-43-41. Pressure in Compartment Open at Top

079-43.11 EXAMPLES OF FLOODED COMPARTMENTS

079-43.11.1 CHANGE IN PRESSURE AS SHIP ROLLS. Consider a compartment ABCD, partly flooded, as shown in Example 1 of Figure 079-43-42. With the ship on an even keel and trim, the pressure on point X is YX, and on N it is MN. If the ship lists or rolls to port, as indicated in Example 2, the pressure on X will rise to ZX, and on N will decrease to RN.

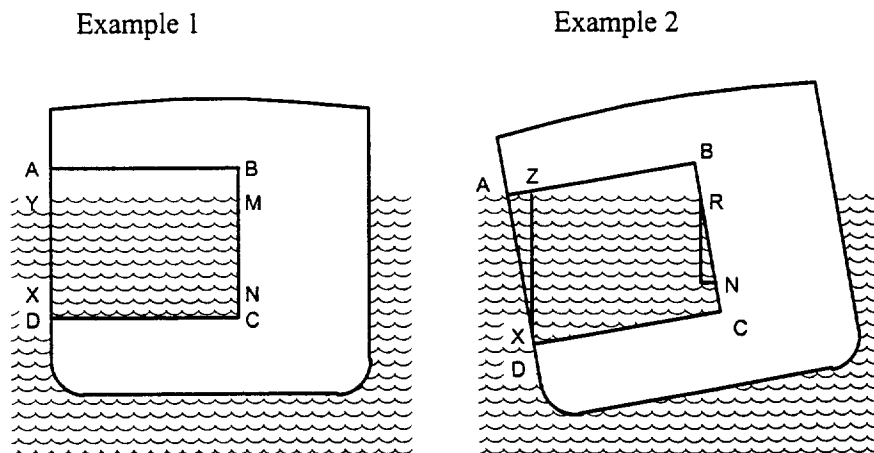


Figure 079-43-42. Change in Pressure in Flooded Compartment as Ship Rolls

079-43.11.2 CHANGE IN PRESSURE WITH CHANGE OF OCEAN LEVEL. Consider a compartment ABCD entirely flooded, with the ocean surface at L, as illustrated in Figure 079-43-43. The pressure on point X is YX. If, because of high waves or plunging, the ocean surface rises to S and then drops to T, the pressure head on point X will rise to ZX and then drop to VX.

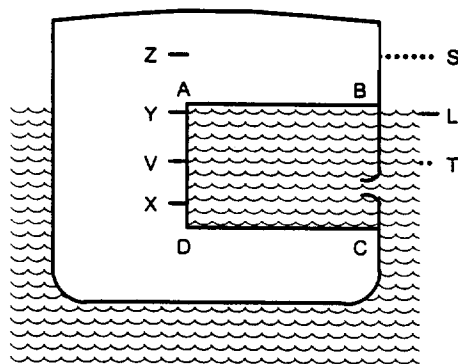


Figure 079-43-43. Change in Pressure in Flooded Compartment with Change of Ocean Level

079-43.11.3 CHANGE IN PRESSURE FROM SCOOP-TYPE RUPTURE. Consider compartment ABCD rupture at N as illustrated in Figure 079-43-44. If the compartment is partly full and the ship is stationary, the pressure on point X is ZX. However, if the ship moves ahead in the direction M, the ruptures N and P will scoop up water, raising the level in the compartment above that of the ocean outside. (P shows plate torn out and downward to form a dangerous scoop.) The water will tend to back up against bulkhead AD.

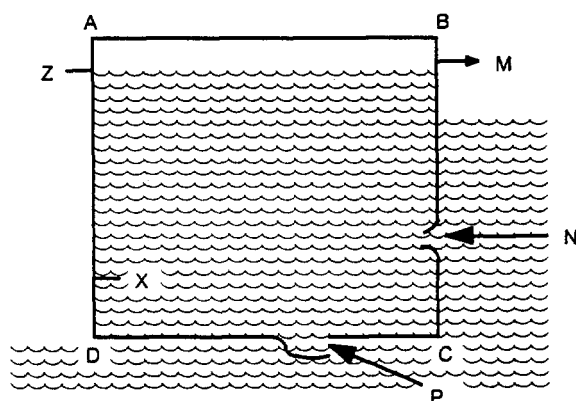


Figure 079-43-44. Effect of Scoop-Type Rupture on Pressure

079-43.11.4 CHANGE IN PRESSURE FROM MOVEMENT OF WATER. If a ship rolls or pitches slowly, or has no free surface, the effect will be a simple variation of pressure. If the water can run rapidly, it will have the same effect as a wave and it will pound heavily on bulkhead AD, momentarily increasing the pressure. This effect is illustrated in Figure 079-43-45.

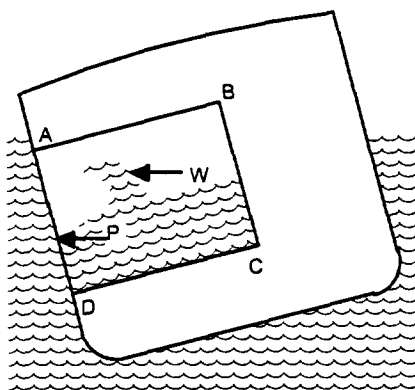


Figure 079-43-45. Change in Pressure from Movement of Loose Water

079-43.11.5 CHANGE IN PRESSURE WITH MOVEMENT OF SHIP. As the ship rises and falls with the sea, the pressure on the deck will increase and decrease. Likewise, if the ship is going in the direction of motion, the water in the compartment tends to exert more pressure on bulkhead CD than it does on bulkhead AB. This interaction is illustrated in [Figure 079-43-46](#).

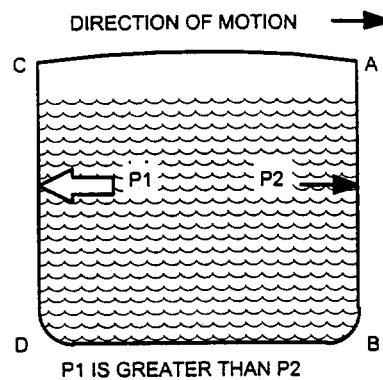


Figure 079-43-46. Change in Pressure with Motion of Ship

SECTION 44.

ELECTROMAGNETIC PULSE (EMP)

079-44.1 CHARACTERISTICS OF EMP

079-44.1.1 DETONATION RESULTS. When a nuclear weapon is detonated, gamma rays interact with air molecules to produce a very intense burst of electromagnetic radiation called an electromagnetic pulse (EMP): The most severe EMP occurs when a nuclear weapon is exploded at high altitudes (above 100 kin), capable of damaging shipboard electronics within a 3,000 mile radius.

079-44.1.2 NATURE OF EMP. Electric fields up to 50,000 volts/meter are produced in less than 10 nanoseconds. The broad bank EMP pulse then falls off and becomes small in less than one millisecond. Because of the relatively low frequencies of EMP (less than 100 Mhz), any topside conductor longer than a few feet can induce currents as large as thousands of amps. The EMP field itself cannot enter the exterior skin of the ship except for short distances through open doors and hatches.

079-44.1.3 EMP EVENT. An EMP event will induce currents in all exposed structures, including antennas, exposed cables, pipes and wave guides. Deck and bulkhead penetration are points of entry (POEs) that must be protected or hardened to prevent such currents from entering the ship's skin. Even though many systems can be individually hardened for such an event, shielding and grounding at POEs provide a Faraday cage (see [paragraph 079-44.2.4](#)) to prevent these high exterior currents from entering the ship.

079-44.1.4 SOLID STATE COMPONENTS. Computers and other equipment having solid-state components are particularly sensitive to EMP. The threat to any component, regardless of its susceptibility to operational upset or damage, is increased when it is connected to a large collector. EMP hardness measures are designed to provide a shield around signal cables and then ground the shield to prevent exposing sensitive electronics to high currents.

079-44.1.5 EFFECTS ON PERSONNEL. Despite the potential damage to electronic equipment, EMP poses no hazard to personnel. EMP is an electrical phenomena similar to a lightning strike 100 yards away. Despite the high field strength, little actual energy is deposited in humans because of the extremely short pulse and the slow response time of body tissue.

079-44.2 DAMAGE MECHANISMS

079-44.2.1 ANTENNAS. By design, antennas collect electromagnetic energy and direct this energy inside the ship. If an EMP event has occurred, the antennas will collect this energy just like any other electromagnetic energy. EMP field strengths exceed antenna and terminating equipment design tolerance and will, thus, damage antenna couplers.

079-44.2.2 UNINTENTIONAL ANTENNAS. Exposed cables, pipes, wave guides or any metal conductor of significant length can act as an antenna and collect the energy from an EMP event. For this reason, when the ship is being hardened to EMP these unintentional antennas must be hardened as well as traditional antennas.

079-44.2.3 CROSS-COUPPLING. Cross-coupling occurs when the current on one conductor (i.e., a cable) induces a current on a different conductor simply because they are adjacent to each other. A system thought to be "safe" from EMP can be damaged by cross-coupling. EMP-induced currents that enter the ship at an improperly protected hull penetration can cause damage in totally unrelated equipment on the other side of the ship due to cross-coupling. Such cross-coupling is very difficult to predict without full scale testing. The best protection against cross-coupling is to prevent EMP-induced currents from entering the ship.

079-44.2.4 FARADAY CAGE. The first level of EMP hardness centers on building a Faraday cage at the exterior boundary. Topside cables, pipes and wave guides are grounded using 360 degree shielding at deck and bulk-head penetrations. If induced currents are not allowed to enter the skin of the ship, they cannot cross-couple and induce a current that damages equipment. Installation of experimental or "off the shelf" electronic equipment without proper shielding and grounding can provide a point of entry for induced EMP currents to enter the Faraday cage. These must either be disconnected or EMP-hardened.

079-44.3 PROTECTION MEASURES

079-44.3.1 LEVELS OF EMP HARDENING. Shipboard protection from the effects of EMP are based on three levels of EMP hardening: the ship or platform level, the system level, and the equipment interface or circuit level. System level and equipment level hardening are usually a function of system design. Platform hardening, however, can be improved with temporary measures to dramatically improve ship EMP survivability.

079-44.3.2 PLATFORM HARDENING. High exterior currents will be induced by an EMP event. EMP protection measures are designed to prevent these high currents from entering the ship and damaging equipment. Sound powered phones and external equipment plugged into electrical outlets - should be disconnected, and external openings closed during a time of increased risk of an EMP event. When initial design does not provide adequate EMP survivability, temporary hardening should be installed on exterior cables, pipes and wave guides.

079-44.3.3 PRE-EMP PROCEDURES. When an EMP event is possible, such as during MOPP level 1, the following measures are employed to minimize EMP damage:

- a. If in port, disconnect shore power and shore telephone cables.
- b. Disconnect unprotected communications handsets and sound-powered phones which are exposed on flight or weather decks. Disconnect noncritical topside equipment (Loran, television antennas) as close as possible to the deck penetration.
- c. Disconnect signal searchlights, portable lighting and other equipment plugged into exterior jack boxes.
- d. If possible, move ordnance to ready magazines or staging areas inside the ship's skin. Exposed HERO safe ordnance is not likely to explode or ignite, but seeker electronics may be damaged. Material stored in ready use locker on weather decks is adequately protected (so long as hatches are closed) and need not be moved.
- e. Close all exterior doors and hatches including hangar doors.

079-44.3.4 POST-EMP PROCEDURES. After an EMP event has occurred the following measures will detect or repair most of the EMP damaged equipment:

- a. If possible, reload computer operating programs from master tapes or disks after the pulse has occurred. A pulse may cause undetected bit changes in computer memory. Tapes and disks not in use will not likely be affected.
- b. Conduct operability checks on equipment. In particular, inspect all interfaces with antennas and signal input and output cards.

079-44.3.5 PERMANENT HARDENING. Ships built after 1985 have incorporated various degrees of permanent EMP hardening. The hardening measures may include transient protection devices on antenna cables, cable shield grounding adapters and cable enclosed in metal conduit.

079-44.3.5.1 Transient Protection Devices (TPDs). TPDs are most widely used on antenna cables. This device is a gas-filled spark gap which establishes an electrical path to ground when its designed firing voltage is exceeded. TPDs may be constructed as hermetically sealed plastic blocks with copper straps or they may be designed as coaxial in-line devices. TPDs can also be installed as temporary hardening for particularly sensitive equipment.

079-44.3.5.2 Shields. Cables having shields built in (coaxial and shielded multi-conductors) do not require shielding by conduit. The important aspect of these cables is proper termination of the shield where it penetrates the deck or bulkhead, normally accomplished using cable shield grounding adapters (CSGAs). Shielded cable installations with a grounding adapter do not require any additional hardening treatment. Single cable runs of unshielded cables may be installed in EMI- and EMP-approved electrical conduit. Cables which run in groups on exterior wireways and up the mast may be enclosed in stainless steel trunking.

079-44.3.6 TEMPORARY HARDENING. Temporary EMP hardening, which should be expected to provide EMP protection for approximately one year, is applied by ship's force or IMA, either in port or at sea. Methods to apply temporary hardening are classified by type of penetration. Whichever method is used, it is vitally important to provide continuous electrical continuity to ground. Detailed instructions are provided in applicable *NAVSEA STD 407 (series) EM Control Topside Arrangement Drawings*.

079-44.3.6.1 Cable Penetration. Temporary hardening of cable penetrations involves enclosing the cable in metallic foil and circumferentially bonding the foil to the associated stuffing tube or kickpipe and terminating

device. The following paragraphs describe the surface preparation, the application of foil shielding and weather-proofing of individual topside cables, except those installed in trunks or wireways.

- a. A good clean circumferential ground path must be provided from the metallic foil to the ship's structure. This usually is accomplished with a grinder but care must be taken to avoid cutting into the cable, stuffing tube or kickpipe. The ground path must be 360 degrees around the penetration, with a bare metal section at least 4 inches in length or radius.
- b. Metallic foil shall be folded or wrapped completely to surround the cable lengthwise and overlap onto itself to form a metal-to-metal tube. The material should be compressed to conform to the cable being protected.
- c. Metal foil, screen or tape is then wrapped in a circular fashion around the metallic foil. Depending on the diameter and length of the exposed cable to be temporarily hardened, a 2- or 3-inch wide metallic foil tape should be selected. If metallic screen is used, the cable(s) need to be completely surrounded with wire screening material. (Screen should be overlapped at least 4 inches or folded onto itself several times to complete the enclosure.) All seams should be stitched with aluminum or copper wire to hold the screening material onto itself.
- d. The screen, metallic foil or tape must be bare-metal to bare-metal circumferentially bonded or connected for 360 degrees. The metallic foil will be directly connected to the ground point and secured by means of a metal adjustable hose clamp, a vent clamp, aluminum flat stock, "X" clamps or metal tape. Metal tape terminations are finished off by folding over the last 2 inches of the tape onto itself and banding, clamping or taping to the termination. The metallic foil or tape must be overlapped to ensure the protected element is completely covered.
- e. The temporarily hardened element is then protected from the weather by covering with one or more coats of 3M Scotchkote or other rubber or vinyl tape. This can be applied directly to the metallic foil or tape as a last layer.

079-44.3.6.2 Pipe Penetrations. Unlike cables that need protection along the entire length, pipe penetrations need only be protected at the penetration point. Protection can be accomplished by grinding the pipe (360 degrees) near the penetration and the adjacent ship structure. Ensure that the adjacent ship structure is electrically connected to the hull by using a milli-ohmmeter. Metallic foil or screen secured with hose clamps or straps can be used to connect the ground points. The connection must be 360 degrees to ensure a quality circumferential ground path (single point grounds are not effective for EMP). If metallic tape is used, the edges must be folded over (adhesive to adhesive) to achieve a good bare-metal to bare-metal connection. The installation is then weather-sealed to minimize corrosion and degradation of the hardening.

079-44.3.6.3 Wave Guides. Temporary hardening of wave guide penetrations is similar to those for pipe penetrations; however, wave guides are far more sensitive to rough handling. Bare-metal to bare-metal connection requires hand-sanding and wire-brushing instead of using a grinder. The hull connection point may be ground if it is a flange type of penetration, otherwise, surrounding deck area must be ground. The connection between the wave guide and bare-metal is handled in the same way as pipe penetrations. The connection to ground must be continuous for 360 degrees.

079-44.3.6.4 Cable Bundles. Mast cables that are bundled together and routed through an enclosed cable trunk are often wrapped too tightly to harden individually. The mast height might also make wrapping the entire structure impractical. There are usually short sections of cable exposed at the points where the cables leave the cable trunk. Because of the difficulty involved in individually hardening each cable with metallic foil tape, a series of magnetic cores or ferrites are installed where the cables exit the cable trunk and inside the trunk where they pen-

erate the ship. Ferrites are not as effective as metal foil or screen, but can still significantly reduce EMP-induced currents entering the ship. It will be necessary to remove the cable trunk cover plates at the base of the enclosed trunk to get to the cables.

079-44.3.6.5 Non-Vital Equipment. Non-vital equipment should be disconnected closest to the point where the cable penetrates the skin of the ship.

079-44.4 RESTORATIVE PROCEDURES

079-44.4.1 OPERATING SYSTEMS TESTS. After an EMP event, maintaining the ship's warfighting capability is the first concern of the crew. Systems aboard ship may have been affected by EMP. Even those systems hardened to withstand an EMP should be checked for damage. Operating system tests should be performed on all electronics to verify they are in proper working order. System programs should be reloaded as soon as possible because EMP can cause bit changes to disks and tapes in use during the pulse. Other electronic systems may need to be reset to correct any spurious signals from the pulse.

079-44.4.2 EQUIPMENT CARDS INSPECTION. Equipment input and output cards or components and interfaces to antennas are particularly susceptible to damage. Front end cards (integrated circuits) for electronic systems that were unhardened or had degraded hardening may need to be replaced. An over voltage transient caused by EMP is the most common failure for such cards. Visual inspection of the cards may show the protective diodes or resistors to be burned out if the transient was severe enough; however, a visual inspection that reveals no damage is not necessarily a sufficient indication that the system was not damaged.

079-44.5 MAINTENANCE

079-44.5.1 INSPECTION. Installed hardening measures shall be inspected in accordance with applicable Planned Maintenance Service (PMS) procedures. Temporary EMP hardening measures installed aboard ship should be visually inspected monthly for signs of degradation. TPD's should be visually inspected for signs of corrosion and water leaks. Shielded cables should be checked for loose connectors, damaged cables or shield braid damage. Visible signs of rust and corrosion, cracking or peeling of cable jackets or any new, unapproved or unshielded cable runs, especially on temporary hardened elements, should be checked.

079-44.5.2 REPAIRS. Repairs to permanent hardening measures should be performed in accordance with applicable technical manuals. Repairs to temporarily hardened measures include, at a minimum, removing the temporary hardening, cleaning the area of any corrosion and reapplying the temporary hardening.

SECTION 45.

SHIPBOARD DAMAGE CONTROL TRAINING

079-45.1 FOCUS

079-45.1.1 SCHEDULING. One of the aspects of damage control is that under normal conditions it can be ignored with no serious loss to the operating efficiency of the ship. It is easy to forget how important damage control is until an emergency arises and special measures become necessary for the ship to be kept afloat. It is then that a crew, well-trained in damage control, can prevent disaster. Every individual aboard, from the com-

manding officer down, should be familiar with damage control practices. Regularly-scheduled training programs provided in departmental, divisional and battle station groupings must be variously adapted to conditions in port and at sea.

079-45.1.2. THREE OBJECTIVES OF TRAINING. The primary aim of damage control training is to ensure readiness of ship's personnel to accomplish basic objectives, described below.

079-45.1.2.1 The first objective of damage control training is to ensure that personnel understand how to take all practical preliminary measures before damage occurs, including maintenance of watertight and fumetight integrity, provision of reserve buoyancy and stability, removal of fire hazards and upkeep and distribution of emergency equipment.

079-45.1.2.2 The second objective of damage control training is to ensure that personnel understand how to minimize and localize such damage as does occur by controlling flooding, preserving stability and buoyancy, combating fires and providing first aid treatment to injured shipmates.

079-45.1.2.3 The third objective of damage control training is to ensure that personnel understand how to quickly accomplish emergency repairs after the occurrence of damage, by supplying casualty power, regaining safe margins of stability and buoyancy, replacing essential structure, manning essential equipment and decontaminating ship and personnel.

079-45.2 TRAINING OF CREW

079-45.2.1 PROGRESSIVE TRAINING. Damage control training of ship's company should be progressive, commencing with basic or elementary exercises and proceeding to more advanced exercises until the ship is qualified to handle complicated and realistic damage control conditions which will be present in warfighting scenarios.

079-45.2.2 REALISTIC EXERCISES. Damage control exercises should be presented in a realistic manner and provide the maximum practical simulation of warfighting conditions.

079-45.2.3 TRAINING REDUNDANCY. Every opportunity must be taken to train several individuals for each key position. Full use should be made of shore-based damage control and firefighting schools for training that cannot be conducted aboard ship.

079-45.2.4 EDUCATIONAL TOPICS. An efficient damage control organization can be attained only through regularly scheduled education for the entire ship, to include the following:

- a. Individual damage control duties and responsibilities.
- b. Knowledge of the ship's vital systems.
- c. Ship's organization for attaining damage and casualty control objectives.
- d. Damage control principles, the necessity for them and their applicability to the ship.
- e. Maintaining damage control material and equipment in highest degree of operational readiness.

- f. Basic principles of detection, use of detection equipment and means of determining amount and kind of contamination resulting from attack by chemical, biological or radiological (CBR) agents.
- g. Equipment, methods and processes to decontaminate the ship's interior and exterior after a CBR attack.
- h. First aid treatment for all types of casualties.
- i. Ship's inherent resistance to damage and its ability to remain afloat.
- j. Lessons learned from previous damage control experiences.

079-45.2.5 SCHEDULED TRAINING TOPICS. Regularly scheduled damage and casualty control training shall include the following:

- a. Correct setting of material conditions of readiness.
- b. Maintenance of watertight integrity.
- c. Proper operation, use and maintenance, for damage control purposes, of general combat and engineering systems and all damage control material and equipment.
- d. Interior communications.
- e. Emergency repair methods.
- f. Personnel movement about the ship under adverse conditions (i.e., darkness, list, flooding, smoke, wreckage).
- g. Locating leaks and controlling flooding.
- h. Determining extent of damage under adverse conditions.
- i. Fighting fires of all types.
- j. Taking proper defensive measures before, and effecting all countermeasures after, a CBR attack.
- k. First and self aid.

079-45.2.6 SIMULATING DAMAGE FOR TRAINING. Drills are the best means to teach the materials presented in lectures and videos. If drills are to achieve their full potential, an element of realism must be introduced. Some examples of ways to simulate damage using props are shown in Appendix C of this publication; other battle damage effects can be simulated by the following:

- a. Turning out lights.
- b. Using smoke.
- c. Cutting out power circuits.
- d. Disrupting communications between personnel and machinery.
- e. Closing valves to isolate systems or portions of systems (i.e., firemain, compressed air, steam, fuel oil).
- f. Wearing emergency gear.
- g. Using emergency tools.
- h. Blocking normal access routes and using blindfolds for personnel egress training.
- i. Stopping vital machinery unexpectedly.
- j. Removing equipment from its customary location.

- k. Introducing water into drill areas.
- l. Putting a list on the ship.
- m. Using damage control casualty flag set to simulate progressive casualty damage for DCTT and repair party training.
- n. Playing *Sounds of Damage* CD as part of drills, over ship's announcing system and locally at simulated damage scenes.
- o. Using DCAMS to train DCTT and repair party personnel. DCAMS should be used to simulate casualty scenarios, preplan drills, record action during drills, debrief after drills and supplement communications (both voice and electronic) between stations.

APPENDIX A.**AUTHORIZED ABBREVIATIONS FOR DAMAGE CONTROL USE**

Abbreviation	Description
AB	Auxiliary Boiler Support (steam, feed, drains and fuel combustion air)
ABFS	Auxiliary Boiler Fuel System
ABT	Automatic Bus Transfer
AC	Air Condition
ACDG	Diesel Generator Intake Air
ACDP	Propulsion Diesel Intake Air
ACN	Auxiliary Condensate
ACSW	Air Conditioning/Refrigeration Sea Water Cooling
ACTGV	Actuating Valve
ACTGV HALON	Actuating Valve Halon
AD	Armored Door (Non-Magazine Related)
ADB	Deballast Air
ADBAL	Deballast Air
ADS	Control Air
AE	Auxiliary Exhaust Steam
AEB	Emergency Breathing Air
AED	Electronic Dry Air
AF	Feed and Drains
AFFF	Aqueous Film Forming Foam
AFFFCOV	Aqueous Film Forming Foam Cutout Valve
AFFFPMP	Aqueous Film Forming Foam Pump
AFFFV	Aqueous Film Forming Foam Valve
AH	Armored Hatch
AHC	Ammunition Hoist Cover
AHD	Ammunition Hoist Door
AHP	High Pressure Air
AIR ESC	Air Escapes
AIRLK	Air Lock
AJP	Auxiliary JP-5
AL	Air Lock
ALM	Alarm
ALP	Low Pressure Air
ALPV	Low Pressure Air, Vital
AMP	Medium Pressure Air
AOR	Area of Responsibility
AP	Airport
APC	Deep Fat Fryer Fire Extinguishing
AQAES	Armored Quick Acting Escape Scuttle
AS	Automatic Sprinkler or Auxiliary Steam
ASW	Auxiliary Seawater Cooling
AT	Airtight or Atmosphere Analyzer
ATC	Air Test Cap
ATD	Airtight Door

- Continued

Abbreviation	Description
ATDOOR	Airtight Door
ATE	AirTest Fitting or Air to Torpedo Fire Control
ATMH	Airtight Manhole
ATS	Airtight Scuttle
AUX	Auxiliary
AUX JP	Auxiliary JP-5
AUX PWR SUPPLY	Auxiliary Power Supply
AUX SW	Auxiliary Seawater Cooling
AVHC	Air Vent Hose Cairn
AWTD	Armored Watertight Door
AWTH	Armored Watertight Hatch
BA	Bleed Air
BAL	Ballast
BALF	Ballast Firemain Fill
BALH	Ballast Hydraulic
BALR	Ballast Tanks Relief Valves
BALV	Ballast Vent and Blow
BB	Boiler Blow
BDS	Battle Dressing Station
BEA	Battery Electrolyte Agitation
BERP	Bolted Equipment Removable Plate
BFD	Bilge Flooding Detection
BEW	Boiler Feed Water
BHD	Bulkhead
BKR	Electrical Breaker
BLST	Ballast
BLST PMP	Pump Ballasting
BLTRN-P	Battle Lantern Portable
BLTRN-S Battle	Lantern Solenoid
BP	Battle Port
BYP	Bypass
BYP HALON	Bypass Halon
C	Cap or Closure or Cover
CA	Control Air
CAC	Control Air, Air Conditioning
CAD	Catapult Steam Drain
CAF	Catapult Feed
CAS	Catapult Steam
CASREP	Casualty Report
CASUALTY PWR	Casualty Power
CASUALTY PWR CPC	Casualty Power Cable
CBR-D	Chemical, Biological, Radiological Defense
CCOL	Compartment Checkoff List
CCS	Central Control Station
CF	Condensate and Feed
CFD	Compartment Flooding Detection
CG	Capacity Gauges (such as for depth)

- Continued

Abbreviation	Description
CHT	Collection, Holding and Transfer
CHTV	Collection, Holding and Transfer Valve
CHW PMP	Pump Chilled Water
CHW	Chilled Water, Chilled Water Valve
CHWCOV	Chilled Water Cutout Valve
CHWDRV	Chilled Water Drain Valve
CIC	Combat Information Center
CJP	Cargo JP-5
CJPST	Cargo JP-5 Stripping
CKT	Circuit
CKT BKR	Circuit Breaker
CL	Countermeasure Launcher
CLOS	Closure
CMWD	Countermeasure Washdown System
CMWWDV	Countermeasure Water Washdown Valve
CN	Condensate
CO	Cargo Oil
CO ₂	Carbon Dioxide Fire Extinguishing
COMPT	Compartment
CONFLAG	Conflagration Station
CONTROLLER	Controller Ventilation
COS	CO ₂ Removal Service
COSAL	Consolidated Onboard Shipboard Allowance List
COST	Cargo Oil Stripping
COV	Cutout Valve
CP	Casualty Power
CPP	Controllable Pitch Propeller
CPPT	Casualty Power Passing Tube
CPS	Collective Protection System
CPT	Casualty Power Terminal
CPW	Cold Potable Water
CPWCOV	Cold Potable Water Cutout Valve
CPWV	Cold Potable Water Valve
CS	Catapult System
CSGA	Cable Shield Grounding Adapter
CSMP	Current Ship Maintenance Project
CTC	Cargo Tank Cleaning
CV	Check Valve
CW	Chilled Water or Circle WILLIAM
CWR	Chilled Water Return
CW RTN	Chilled Water Return
CWS	Chilled Water Supply
CW SPLY	Chilled Water Supply
CX	Circle XRAY
CY	Circle YOKE
CZ	Circle ZEBRA
D	Door

- Continued

Abbreviation	Description
DA	Diesel Air (starting and shut down)
DBAL	Deballast
DC	Damage Control
DCAMS	Damage Control Asset Management Software
DCC	Damage Control Central
DCPO	Damage Control Petty Officer
DCREL	DC Reentry Locker
DCRS	DC Repair Station
DCUL	DC Unit Locker
DCUPS	DC Unit Patrol Station
DD	Deck Drain (Without Closure Device)
DDV	Deck Drain Valve
DECON	Decontamination
DECON STA	Decon Station
DEG	Degaussing
DEWTRG	Dewatering
DEW	Diesel Fresh Water Cooling
DG	Diesel Generator
DGEXH	Diesel Generator Exhaust
DGFS	Diesel Generator Fuel
DGJW	Diesel Generator Jacket Water
DGLO	Diesel Generator Lube Oil
DGSW	Diesel Generator Seawater Cooling
DIAL TEL	Dial Telephone
DIS	Draft, Trim, List, Ship Motions
DISCH PMP	Pump Discharge Drainage
DK	Deck
DK PLUG DRAINAGE	Deck Plug Drainage
DK PLUG FUEL	Deck Plug Fuel Oil
DK PLUG JP-5	Deck Plug JP-5 Fuel
DK PLUG VAC SE	Deck Plug Vacuum Sewage/CHT
DK SKT CHT	Deck Socket (Reach Rod)
DK SKT DRAINAGE	Deck Socket (Reach Rod)
DK SKT FIREMAIN	Deck Socket (Reach Rod)
DK SKT FUEL	Deck Socket (Reach Rod)
DK SKT JP-5	Deck Socket (Reach Rod)
DLO	Diesel Lubricating Oil
DO	Diesel Oil
DOS	Diesel Oil Service (and Purification)
DP	Differential Pressure Detector
DR	Drain
DRCOV	Drainage Cutout Valve
DS (*)	Deck Socket (*List: i.e., Reach Rod)
DSW	Diesel Seawater Cooling
DU	Desalination Plant
DUB	Desalination Plant Brine Overboard or Distilling
DUD	Distilling Plant Brine Overboard

- Continued

Abbreviation	Description
DUF	Desalination Plant Feed or Distilling Plant Feed
DV	Drain Valve
DWS	Demineralized Water System
DWT	Demineralized Water Transfer System
DZ	Dog ZEBRA
EAB	Emergency Breathing Air
EAFW	Electronics and Auxiliary Fresh Water Cooling
ECC	Electronics Casualty Control
ECW	Electronic Cooling Water
ECWR	Electronic Cooling Water Return
ECWS	Electronic Cooling Water Supply
ED	Eductor
EDG	Emergency Diesel Generator
EDUC OVBD	Eductor Overboard
EDUC	Eductor
EEBD	Emergency Escape Breathing Device
EF	Emergency Feed
EGL	Equipment + Guide List
ELEC PNL	Electric Panel
ELEC PWR DIST	Electric Power Distribution
ELEC PWR SUPPLY	Electric Power Supply
ELEC PWR UNIT	Electric Power Unit
ELEC VENT CONT	Electrical Ventilation Controller
ELEC VENT MOTOR	Electrical Ventilation Motor
ELEC	Electric or Electrical
ELEV	Elevator
EMBT	Emergency Main Ballast Tank
EMERG PWR	Emergency Power
ENCL	Enclosure
ERF	Emergency Reserve Feed
ERFW	Engine Room Fresh Water
ES	Escape Steam
ESC	Escape
EVC	Electrical Ventilation Controller
EVM	Electrical Ventilation Motor
EXH	Exhaust Ventilation
F	Fitting
FAN	Fan Ventilation
FCA	Fan Coil Assembly
FCU	Fan Coil Unit
FD	Fire Door
FDET	Fire Detector
FDR	Fire Door
FD WTR	Feed Water
FD WTR PMP	Feed Water Pump
FEC	Fixed Foam Connection
FEE	Firefighter's Ensemble

- Continued

Abbreviation	Description
FIRE EXT AFEF	Fire Extinguisher Portable AFEF
FIRE EXT CO ₂	Fire Extinguisher Portable CO ₂
FIRE EXT HALON	Fire Extinguisher Portable Halon
FIRE EXT PKP	Fire Extinguisher Portable PKP
FLAM LKR	Flammable Locker
FLWV	Flushing Water Valve
EM	Fire Main
EMCOV	Fresh Water Cutout Valve
EME	Firemain to Eductor
EMEOB	Firemain to Eductor Overboard
FMES	Firemain to Eductor Suction
EMP	Fleet Modernization Program
EM PMP	Firemain Pump
FMR	Fire Main Riser
FMRV	Firemain Riser Valve
FMV	Firemain Valve
FO	Fuel Oil
FOCOV	Fuel Oil Cutout Valve
FO PMP	Fuel Oil Pump
EO TK	Fuel Oil Tank
FO TRAF PMP	Fuel Oil Transfer Pump
FOV	Fuel Oil Valve
FOVV	Fuel Oil Vent Valve
EP	Fire Pump
FPL	Fire Plug
FR	Frame
ES	Fuel Service
EST	Fuel Stripping
FT	Fuel Transfer and Fill or Fume Tight
FTD	Fire Tight Door
ETS	Fuel Tank Stripping
EW	Fresh Water
FWDC	Fresh Water Drain Collecting
EWEF	Fresh Water Firefighting
EWV	Fresh Water Valve
FZ	Fire Zone (Boundary)
FZD	Fire Zone Door
GA	Gauge
GCOV	Gauge Cutout Valve
GE	Gland Exhaust
GEN	Electrical Generator
GES	Diesel Generator Fuel Service
GJW	Diesel Generator Jacket Water
GLO	Generator Lubricating Oil (Diesel Fill and Transfer)
GLOS	Diesel Generator Lubricating Oil Service
GS	Gland Seal and Exhaust
GSV	Gagged Scupper Valve

- Continued

Abbreviation	Description
GSW	Diesel Generator Seawater Cooling
GT	Gas Tight
GTW	Gas Turbine Water Wash
H	Hatch or Hoist or Hydrogen
HALON	Halon 1301 Fire Extinguishing Service
HAZ	Hazardous Gas Detector
HAZMAT	Hazardous Materials
HCM	Hydraulic Oil, Independent Periscope
HD	Hydraulic Oil, Diving System
HE	Hydraulic Oil, External System
HFP	Heptafluoropropane (Fire Extinguishing)
HM	Hydraulic Oil, Main System
HMHC	Hinged Manhole Cover
HNDST	Handset
HOSE	CONN Hose Connector
HOSES	Fire Station Hoses
HP	High Pressure
HPA	High Pressure Air
HPAC	High Pressure Air Compressor
HPACOV	High Pressure Air Cutout Valve
HPAV	High Pressure Air Valve
HPD	High Pressure Steam Drain
HPS	High Pressure Steam
HPW	Hot Potable Water
HPWC	Hot Potable Water Circulating
HPWCOV	Hot Potable Water Cutout Valve
HR	Hose Reel (AFFF or CO ₂)
HS	Hydraulic Oil, Steering System
HSD	Heat Sensing Device
HV	Hydraulic Oil, Vital System
HVAC	Heating, Ventilation & Air Conditioning
HYDR AFFEV	Hydraulic AFFF Valve
HYDR DRV	Hydraulic Drainage Valve
HYDR FMV	Hydraulic Firemain Valve
HYDR SPKV	Hydraulic Sprinkling Valve
HYDR SWV	Hydraulic Saltwater Valve
HYDR WDCM	Hydraulic WDCM Valve
HYDR	Hydraulic
IC(*)	Interior Communication (*list system, i.e., 1MC, 2JZ)
IMA	Intermediate Maintenance Activity
INSURV	Board of Inspection and Survey
IPS	Iron Pipe Size
IVCS	Internal Voice Communication System
JP-5 COV	JP-5 Cutout Valve
JP-5 PMP	JP-5 Pump
JP-5 TK	JP-5 Tank
JP-5V	JP-5 Valve

- Continued

Abbreviation	Description
JPD	JP-5 Defueling and Hose Flushing
IPS	JP-5 Service
JPST	JP-5 Stripping
JPT	JP-5 Transfer and/or Filling
JW	Jacket Water
LB	Lineshaft Bearing
LB	Lithium Bromide Air Conditioning
LC	Load Center, Locked Closed
LCAC	Landing Craft, Air-Cushion
LCWD	Landing Craft Washdown
LEL	Lower Explosive Limit
LHP	Line Handling Port
LIGHT COVER	Darken-Ship Light Cover
LIN	Nitrogen, Liquid
LKR	Locker
LO	Locked Open or Lubricating Oil Fill, Transfer and Purification
LOCAL HALON	AC Local Halon Act Station
LOS	Lubricating Oil Service, Main
LOUD SPEAKER	1MC
LOX	Oxygen, Liquid
LP	Low Pressure
LPA	Low Pressure Air
LPAC	Low Pressure Air Compressor
LPACOV	Low Pressure Air Cutout Valve
LPAV	Low Pressure Air Valve
LPC	Low Pressure Condensate
LPD	Low Pressure Steam Drain
LPS	Low Pressure Steam Drain
LS	Liquid Level Switch
LTG	Lighting
LTRN	Lantern
LUBOV	Lube Oil Valve
LWWS	LCAC Engine Water Wash System
MA	Masker Air
MAG	Magazine
MAGSPR	Magazine Flooding and Sprinkling
MBT	Manual Bus Transfer
MCHRY	Machinery
MCN	Main Condensate
MCS	Machinery Control System
MCV	Manual Control Valve
MD	Main Drainage
MF	Main Feed
MH	Manhole
MHC	Manhole Cover
MHCH	Manhole Cover Hinged
MLC	Mooring Line Cover

- Continued

Abbreviation	Description
MN	Main
MNL OPR	Manually Operated
MOG	Automotive Gasoline
MOGAS	Automotive Gasoline
MOPP	Mission-Oriented Protective Posture
MPA	Medium Pressure Air
MPA COMP	Medium Pressure Air Compressor
MPACOV	Medium Pressure Air Cutout Valve
MPWWD	Medium Pressure Waste Water Drain
MS	Main Steam
MSCOV	Magazine Sprinkler Cutout Valve
MSW	Main Seawater Circulating and Cooling
MUF	Make-Up Feed
MULTI LINE TEL	Multiline Telephone
MULTI PURP	Multipurpose Outlets
N ₂	Nitrogen
N ₂ V	Nitrogen Valve
NAP	Navy All-Purpose (Nozzle)
NETI	Naval Firefighter's Thermal Imager
N-O	Normally Open
N-S	Normally Shut
NSSW	NATO Sea Sparrow Seawater Cooling
NT	Non-Tight
NTD	Non-Tight Door
NTH	Non-Tight Hatch
NWT	Non-Watertight
O ₂	Oxygen
O ₂ COV	Oxygen Cutout Valve
O ₂ V	Oxygen Valve
OBA	Oxygen Breathing Apparatus
OBDV	Overboard Drain Valve
OCUA	Outer Clothing Undressing Area
OG	Oxygen Generator "services"
OR	Orifice
OT	Oil Tight
OTK	Oil Tank
OVBD	Overboard
OWL	Overflow
OW	Oily Waste or Oily Water Drain Collecting
OWT	Oily Waste Transfer
P	Port
P & S	Port and Starboard
PA	Prairie Air
PD	Propulsion Diesel
PD	Pulsation Damper
PDEXH	Propulsion Diesel Exhaust
PDFS	Propulsion Diesel Fuel Service

- Continued

Abbreviation	Description
PDJW	Propulsion Diesel Jacket Water
PDLO	Propulsion Diesel Lubricating Oil Fill, Transfer and Purification
PEB	Propulsion Examining Board
PFS	Propulsion Diesel Fuel Service
PHS	Propeller (CPP) Hydraulic System
PJW	Propulsion Diesel Jacket Water
PJHS	Pipe Jumper Hose System
PKP	Potassium Bicarbonate Powder (formerly Purple-K Powder)
PKPV	Potassium Bicarbonate Powder Valve
PKPVV	Potassium Bicarbonate Powder Vent Valve
PL	Plumbing or Pressure Lock
PLMB	Plumbing
PLMBV	Plumbing Drain Valve
PLMBVV	Plumbing Drain Vent Valve
PLO	Propulsion (Diesel) Lubricating Oil (Fill, Transfer and Purification)
PLOS	Propulsion Diesel Lubricating Oil Service
PLUG	Plug
PMA	Prairie Masker Air
PMP	Pump
PMP DISCH	Pump Discharge
PMS	Planned Maintenance System (Service)
PNL	Panel
POTW	Potable Water
POTW PMP	Pump Potable Water
POTW FV	Potable Water Fill Valve
POTWH	Potable Water Heater
POTWV	Potable Water Valve
PRI	Primary or Priority
PRO	Propulsion Control
PRP	Pneumatically Released Pilot (Valve)
PS	Passing Scuttle or Pressure Switch
PSFT	Propulsion Shafting
PT WC	Passing Tube With Cap
PT WOC	Passing Tube Without Cap
PT	Pressure Transmitter
PUSHBUTTON AFF	Pushbutton Station AFFF
PUSHBUTTON DR	Pushbutton Station Drainage
PUSHBUTTON FIR	Pushbutton Station Firemain
PUSHBUTTON EU	Pushbutton Station Fuel
PUSHBUTTON SPL	Pushbutton Station Supply Ventilation
PVV	Plumbing Vent Valve
PW	Potable Water
PWD	Plumbing Waste Drains
PWR	Power
PWR PNL	Power Panel
PWR XFMR	Power Transformer
PWS	Potable Water Sodium Hypochlorite

- Continued

Abbreviation	Description
PZ	Pressure Zone (CPS)
QAAD	Quick Acting Armored Door
QAAH	Quick Acting Armored Hatch
QAAS	Quick Acting Armored Scuttle
QAATD	Quick Acting Airtight Door
QAES	Quick Acting Escape Scuttle
QAWTD	Quick Acting Watertight Door
QAWTH	Quick Acting Watertight Hatch
QAWTS	Quick Acting Watertight Scuttle
RA	Refrigerant-Air Conditioning
RAC	Refrigerant-Air Conditioning
RB	Reboiler Support (steam, feed and drains)
RC	Remote Control
RCS	Refrigerant-Cargo Stores
RCV (*)	Remote Control Valve (*List Sys: i.e., f, cht)
RCV DR	Remote Control Valve Drainage
RDCR	Reducer
RECIRC	Recirculate or Recirculation
RECP	Receptacle
RE	Reserve Feed
RG	Main Reduction Gear
RLO	Reduction Gear Lubricating Oil Service
RLOS	Main Reduction Gear Lubricating Oil Service
RLSE	Release
RSS	Refrigerant-Ship Stores
RSV	Reserve
RTN	Return
RV	Relief Valve
S	Scuttle or Starboard
SA	Salvage Air or Starting Air
SBM	Submersible
SBM PMP OVBD	Submersible Pump Overboard
SC	Salinity Cell
SCBA	Self Contained Breathing Apparatus
SCHT	Sewage Collection and Holding Tank
SCOV	Sprinkler Cutout Valve
SCU	Shaft Control Unit
SCUP	Scupper
SCZ	Smoke Control Zone
SD	Secondary Drainage or Steam Distilling Plant
SDET	Smoke Detector
SDRV	Soil Drain Valve
SDRVV	Soil Drain Vent Valve
SD	Secondary Drainage
SEED	Supplementary Emergency Egress Device
SES	Smoke Ejection System

- Continued

SEC	Static Frequency Converters
SG	Steam Generator
SGCOV	Sight Glass Cutout Valve
SIB	Ship's Information Books
SKT	Socket
SLF	Security Light Fixture
SLM	Ship Logistics Manager
SLO	Shaft Lubricating Oil Service
SND PWR TEL	Sound Powered Phone
SOLID	Sanitary Facility Transfer
SOPV	Solenoid Operated Pilot Valve
SPK	Sprinider
SPKCOV	Sprinkler Cutout Valve
SPLY	Supply
SPNR	Spanner
SPOD	Submersible Pump Overboard
SS	Service Steam or Ship Service
SSD	Service Steam Drains
SSDCB	Standard Submarine Damage Control Books
SSDG	Ship Service Diesel Generator
SSGTG	Ship Service Gas Turbine Generator
SSM	Ship's Systems Manual
SSTG	Ship Service Turbo Generator
SSW	Seawater Service to Shaft Seal/Stem Tube
ST	Sounding Tube
ST FUEL	Sounding Tube Fuel
ST JP-5	Sounding Tube JP-5
STA	Station
STBD	Starboard
STC	Sounding Tube Cap
STC W/V	Sounding Tube Cap With Valve
STFG TUBE	Stuffing Tube
STFG TUBE W/W	Stuffing Tube With Wire
STFG TUBE WO/W	Stuffing Tube without Wire
STG	Steering System
STM DR	Steam Drains
STOKES STRETCH	Stokes Stretcher
ST POTW	Sounding Tube Potable Water
STR	Strainer
STSW	Stem Seal Seawater
ST VOIDS	Sounding Tube Voids
SUCT	Suction
SUMP TK	Sump Tank
SV	Safety Valve
SW	Seawater
SW FLCOV	Saltwater Flushing Cutout Valve
SW PMP	Sea Water Pump
SWBD	Switchboard
SWCOV	Salt Water Cutout Valve

- Continued

SWD	Seawater Dechlorination
SWITI	Schedule of Watertight Integrity Test and Inspection
SWS	Seawater Sodium Hypochlorite
TA	Twin Agent Fire Extinguishing
TD	Trim and Drain
TDS	Turbine Drain Steam
TH	Thermometer
TK	Tank
TKV	Tank Drain Valve
TV	Air Escapes or Overflow or Sounding Tube
UEL	Upper Explosive Limit
V	Valve
VALVE CO	Valve Cutout
VALVE MANF CO	Valve Manifold Cutout
VC	Ventilation Closure
VCHT	Vacuum, Collection, Holding and Transfer
VD	Vapor Compression Distilling Plant
VENT	Ventilate, Ventilation, Vent
VENTC	Ventilation Cover
VENTV	Ventilation Valve
VH	Hydraulic Valve Control or Ventilation and Air Conditioning
W	WILLIAM
WASTE DRAIN	Waste Plumbing Drain
WD	Waste Drain, Weather Drain
WDCM	Countermeasure Water Washdown System
WDR	Waste Drains
WDRVV	Waste Drain Vent Valve
WEA DK	Weather Deck
WERP	Welded Equipment Removable Plate
WHB	Waste Heat Boiler Support (steam, feed and drains)
WHW	Waste Heat Hot Water Circulating
WIFCOM	Wire Free Communication
WM	Watertight Fire Extinguishing
WT	Watertight
WT DOOR	Watertight Door
WT HATCH	Watertight Hatch
WT SCUTTLE	Watertight Scuttle
WTC	Watertight Cover
WTD	Watertight Door
WTH	Watertight Hatch
WTMH	Watertight Manhole
WTS	Watertight Scuttle
WW	Waste Water
WWD	Waste Water Drain Collection
X	XRAY
XCONN	Cross Connection
Y	YOKE
Z	ZEBRA

- Continued

ZONE	Zone
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APPENDIX B

STANDARD SYMBOLOGY FOR DAMAGE CONTROL MANUAL AND COMPUTER CASUALTY REPORTING AND PLOTTING

079-B.1 CONTENTS AND USAGE

Appendix B contains two sections: Appendix B-1, [Figure 079 B-1](#), Standard Symbolology for Damage Control Manual Casualty Reporting and Plotting, is to be used on those ships that have only paper damage control diagrams. Appendix B-2, [Figure B-4](#), Standard Symbolology for Damage Control Computer Casualty Reporting and Plotting, is to be used on those ships that have computers for damage control and is plotted on the deck plan view (vs. isometric). Computer-generated symbology and casualty plotting replaces manual grease pencils and DC diagrams with advanced, rapid situational awareness icons, through standardization. The computer-generated symbology in DCAMS can be used as a stand-alone tool in DC central, as a damage control organization communication tool or as a command structure damage control tool (depending on the level of automation within the ship).

APPENDIX B-1

**STANDARD SYMBOLOGY FOR DAMAGE CONTROL MANUAL CASUALTY REPORTING AND
PLOTING**

BOUNDARIES
FIRE BOUNDARIES

Explanation	Example
FB Fire Boundaries Ordered (Identify all Primary and Secondary Boundaries) FB Fire Boundaries Set	FB SPPS 2221 7407 0505 FB EXAMPLE- Final Triangle for DC Plates SPPS 2221 7407 0505

SMOKE BOUNDARIES

Explanation	Example
SB Smoke Boundaries Ordered (Identify all Primary and Secondary Boundaries) SB Smoke Boundaries Set	SB SPPS 2221 7407 0505 SB EXAMPLE- Final Triangle for DC Plates SPPS 2221 7407 0505

Figure B-1. Manual Symbology for Damage Control (1 of 19)

BOUNDARIES
FLOODING BOUNDARIES

Explanation	Example
FLB (Identify all Primary and Secondary Boundaries) FLB Flooding Boundaries Ordered	FLB SPPS 2221 7407 0505 FLB SPPS 2221 7407 0505 EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (2 of 19)

INSTALLED FIRE SUPPRESSION SYSTEMS

AFFF BILGE SPRINKLING SYSTEM

Explanation	Example
 AFFF Station Manned	
 AFFF Station Activated/Time	
 AFFF Station Secured/Time	 EXAMPLE- Final Triangle for DC Plates

FIXED CO₂ SYSTEM

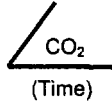
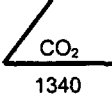
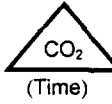
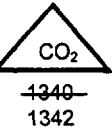
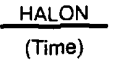
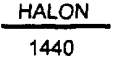
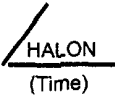
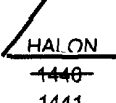
Explanation	Example
 CO ₂ System Manned	
 CO ₂ System Activated/Time	
 CO ₂ Discharged	 EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (3 of 19)

INSTALLED FIRE SUPPRESSION SYSTEMS

FIXED HALON SYSTEM

Explanation	Example
 HALON (Time)	 HALON 1440
 HALON (Time)	 HALON ~~1440~~ 1441
 HALON (Time)	 HALON ~~1440~~ ~~1441~~ 1456 EXAMPLE- Final Triangle for DC Plates

MAGAZINE SPRINKLER SYSTEM

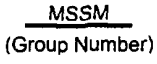
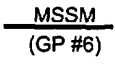
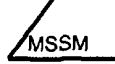
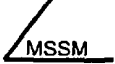
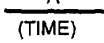
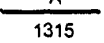
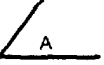
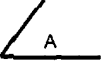
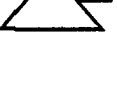
Explanation	Example
 MSSM (Group Number)	 MSSM (GP #6)
 MSSM	 MSSM (GP #6)
 MSSM	 MSSM (GP #6) EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (4 of 19)

FIRE
FIRE (Class A, B, C, or D)

Explanation	Example
 A (TIME) Class ALPHA Fire Reported	 A 1315
 A Class ALPHA Fire Contained	 A
 A Class ALPHA Fire Out	 A
 A Class ALPHA Fire Reflash Watch Set (Name Not Required)	 A
 A Class ALPHA Fire Overhauled	 A EXAMPLE- Final Triangle for DC Plates

SMOKE

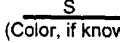
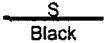
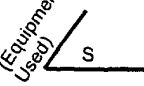
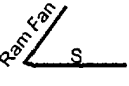
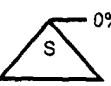
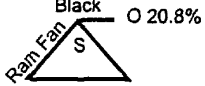
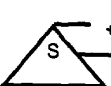
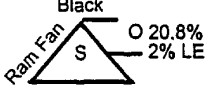
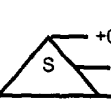
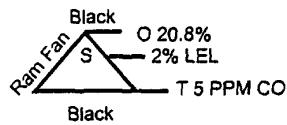
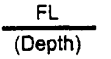
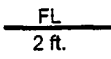
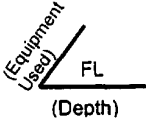
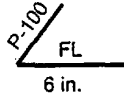
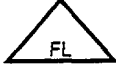
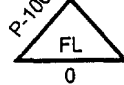
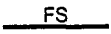
Explanation	Example
 S (Color, if known) Smoke Reported	 S Black
 S (Equipment Used) Smoke Being Cleared (Method)	 S Ram Fan
 S Smoke Cleared	 S Ram Fan
 S 0% Oxygen Test Safe	 S O 20.8% Ram Fan
 S +0 E% Explosive Gas Test Safe	 S O 20.8% 2% LEL Ram Fan
 S +0 E% -T Toxic Gas Test Safe	 S O 20.8% 2% LEL T 5 PPM CO Ram Fan Black

Figure 079-B-1 Manual Symbology for Damage (5 of 19)

DAMAGE CONTROL

FLOODING

Explanation	Example
 Flooding Reported (Depth in IN or FT) (use of "or" not allowed)	
 Flooding Being Pumped	
 Flooding Dewatered	 EXAMPLE- Final Triangle for DC Plates
 Flooded Solid	 EXAMPLE- Final Symbol for DC Plates

FIREFIGHTING WATER

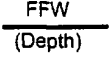
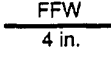
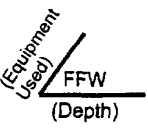
Explanation	Example
 Firefighting Water Reported (Depth in IN or FT)	
 Firefighting Water Being Pumped (Equipment Used)	
 Firefighting Water Dewatered	 EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbolology for Damage Control (6 of 19)

DAMAGE CONTROL
PROGRESSIVE FLOODINGS

Explanation	Example
PFL (Depth) Progressive Flooding Reported (Depth in IN or FT)	PFL 4 in.
(Equipment Used) PFL (Depth) Progressive Flooding Being Pumped	ESP PFL 2 in.
PFL Progressive Flooding Dewatered Removed	ESP PFL 0 EXAMPLE- Final Triangle for DC Plates

COMMUNICATIONS

Explanation	Example
T (Circuit Lost) Communications Reported Lost on Circuit	T 2JZ
(Alternate Circuit) T Communications Established Using Alternate Circuit	X40J T 2JZ
T (Circuit Restored) Communications Restored on Reported Circuit	X40J T 2JZ EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (7 of 19)

DAMAGE CONTROL

SAGGING

Explanation	Example
SAG (Location)	SAG FR 57
(Shore Type) SAG	I-Type SAG FR 57
SAG	I-Type SAG FR 57
SAG	I-Type SAG FR 57

PANTING

Explanation	Example
PANT (Location)	PANT FR 57
(Shore Type) PANT	I-Type PANT FR 57
PANT	I-Type PANT FR 57
PANT	I-Type PANT FR 57

Figure 079-B-1. Manual Symbology for Damage Control (8 of 19)

DAMAGE CONTROL
CASUALTY POWER

Explanation		Example	
	Casualty Power Ordered		
	Casualty Power Rigged		
	Casualty Power Energized		EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (9 of 19)

DAMAGE CONTROL
ELECTRICAL

Explanation	Example
 Electrical Power Lost	
 Electrical Power Ordered Isolated	
 Electrical Power Isolated	
 Electrical Power Restored	 EXAMPLE- Final Triangle for DC Plates

ELECTRICAL DAMAGE

Explanation	Example
 No Apparent Electrical Damage	
 Electrical Damage Reported	
 Electrical Damage Under Repair	
 Electrical Damage Repaired	 EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (10 of 19)

DAMAGE CONTROL
MECHANICAL

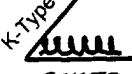
Explanation	Example
 Mechanical Isolation Ordered	
 Mechanical Isolation Complete	
 Mechanical Isolation Restored	 EXAMPLE- Final Triangle for DC Plates

COMPARTMENT DEMOLISHED

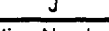
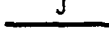
Explanation	Example
 Compartment Demolished	
 Compartment Cleared	 EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (11 of 19)

DAMAGE CONTROL
SPRUNG FITTING

Explanation	Example
 (Fitting Number)	 (Fitting Number)
 Type of Repair	 K-Type QAWTD 1-306-2
 Sprung Fitting Repaired	 K-Type QAWTD 1-306-2

HOT AND JAMMED DOORS,
HATCHES, QAWTD, ETC.

Explanation	Example
 (Fitting Number)	 QAWTD 1-220-2
 Unjammed	 QAWTD 1-220-2

EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbolology for Damage Control (12 of 19)

DAMAGE CONTROL
PERSONNEL CASUALTY

Explanation	Example
P (Name or Billet, if known) Personnel Casualty Reported	P SN DRUM
P Corpsman at Scene	P SN DRUM
P Personnel Casualty Evacuated	P SN DRUM EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (13 of 19)

DAMAGE REPAIR

HOLE

Explanation	Example
 Hole Reported (Size in IN or FT) (use of "or" not allowed) (Pinpoint the Damage)	 4 IN FR 96, STBD 2 FT off deck
 Hole Patching or Plugging in Process	 4 IN FR 96, STBD 2 FT off deck
 Hole Patched or Plugging Complete	 EXAMPLE- Final Triangle for DC Plates 4 IN FR 96, STBD 2 FT off deck

RUPTURE

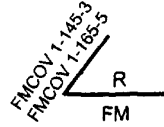
Explanation	Example
 Rupture Reported (System) (Svstem. if known)	 FM FM FR 155 STBD, Overhead
 Rupture Isolated (System)	 FM FM FR 155 STBD, Overhead
 Rupture Bypassed (How, Where)	 FM Jumpered Around FM FR 155 STBD, Overhead
 Ruptured System Repaired and COVs Opened	 EXAMPLE- Final Triangle for DC Plates FM Jumpered Around FM FR 155 STBD, Overhead

Figure 079-B-1. Manual Symbology for Damage Control (14 of 19)

DAMAGE REPAIR

SPLIT SEAM OR CRACK

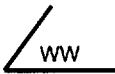
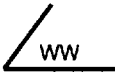
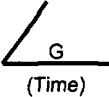
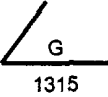
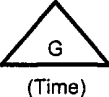
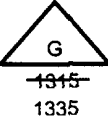
Explanation	Example
 Split Seam or Crack Reported (Size in IN or FT) (use of "or" not allowed) (Pinpoint the Damage)	 4 IN by 2 FT FR 96, STBD 2 FT off deck
 Split Seam or Crack Repairs in Process	 4 IN by 2 FT FR 96, STBD
 Split Seam or Crack Repairs Complete	 EXAMPLE- Final Triangle for DC Plates 4 IN by 2 FT FR 96. STBD

Figure 079-B-1. Manual Symbology for Damage Control (15 of 19)

ORDNANCE HAZARD

GUN

Explanation	Example
 Hot Gun Casualty Reported	
 Cool-Down Started	
 Hot Gun Safe	 EXAMPLE- Final Triangle for DC Plates

MISSILE

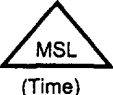
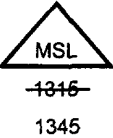
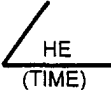
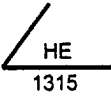
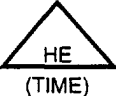
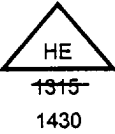
Explanation	Example
 Missile Misfire	
 Cool-Down Started or Jettison Ordered	
 Jettisoned or Safe	 EXAMPLE- Final Triangle for DC Plates

Figure 079-B-1. Manual Symbology for Damage Control (16 of 19)

ORDNANCE HAZARD
HIGH EXPLOSIVE

Explanation	Example
 High Explosive Casualty Reported	
 Recovery Started	
 Area Safe	 EXAMPLE- Final Triangle for DC Plates

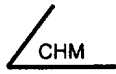
MAGAZINE

Explanation	Example
 Magazine High Temperature Reported	
 Cool-Down Started (Method)	
 Area Safe	

Figure 079-B-1. Manual Symbology for Damage Control (17 of 19)

CBR CONTAMINATION

CHEMICAL CONTAMINATION

Explanation	Example
<u>CHM</u> Chemical Contamination Reported (Agent, Location if known)	<u>CHM</u> MUSTARD/FR 96, STBD
 Chemical Contamination Isolated	 MUSTARD/FR 96, STBD
 Decontamination Complete	 EXAMPLE- Final Triangle for DC Plates MUSTARD/FR 96, STBD

BIOLOGICAL CONTAMINATION

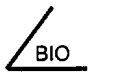
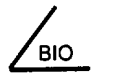
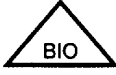
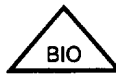
Explanation	Example
<u>BIO</u> Biological Contamination Reported (Agent, Location if known)	<u>BIO</u> RICIN/FR 96, STBD
 Biological Contamination Isolated	 RICIN/FR 96, STBD
 Decontamination Complete	 EXAMPLE- Final Triangle for DC Plates RICIN/FR 96, STBD

Figure 079-B-1. Manual Symbology for Damage Control (18 of 19)

RADIOLOGICAL (NUCLEAR) CONTAMINATION

Explanation	Example
NUC Radiological Contamination Reported (Intensity) (Agent Location, if known)	NUC 180R/HR; FR 102, STBD
NUC Radiological Contamination Isolated	NUC 180R/HR; FR 102, STBD
NUC Decontamination Complete	NUC EXAMPLE- Final Triangle for DC Plates 180R/HR; FR 102, STBD

TOXIC GAS SYMBOLOGY

Explanation	Example
TOX Toxic gas or HAZMAT Spill (Hazard if known) Reported	TOX H₂S
TOX Toxic gas or HAZMAT Spill contained	TOX H₂S
TOX Toxic gas or HAZMAT Spill removed	TOX H₂S
TOX Oxygen Test	TOX H₂S 20.8
TOX Explosive Gas Test	TOX H₂S 20.8 2% LEL
TOX Toxic Gas Tests	TOX H₂S 20.8 2% LEL 5 PPM H₂S

Figure 079-B-1. Manual Symbology for Damage Control (19 of 19)

079-B-1.1 MANUAL PLOTTING TECHNIQUES.

Damage reports received at DC repair stations are to be recorded, plotted and forwarded to DCC. The overall ship's survivability status is illustrated by the plot maintained in DCC; there, it is imperative that DC repair stations rapidly forward information which affects the status of the ship in any way. Plotting techniques are illustrated in Figure B-2. All damage will be plotted on the DC subdivision plates to summarize the damage in each compartment. Examples of plotting are listed below:

1. Line method

- a. Draw a diagonal line from the affected compartment and connect a horizontal line to it.
- b. Write the compartment number along the top of the diagonal line and the compartment noun name under the diagonal line.
- c. Plot along the horizontal line using it as the base of all triangles.
- d. Continue closing in the triangle when updating the same piece of damage (instead of plotting each update separately).

2. Box Method

- a. Draw a diagonal line from the affected compartment.
- b. Write the compartment number along the top of the diagonal line and the compartment noun name under the diagonal line.
- c. Plot damage in the box.
- d. Connect diagonal to a large box.

3. Column Method

- a. To one side of the DC plate, make a column or series of columns with compartment numbers at the top of each column.
- b. Below each compartment number plot damage vertically.

079-B-1.2 PREPRINTED MESSAGE FORMAT USE

The preprinted message format is used as a backup method of communications between DCC, DC repair stations and scene leaders as illustrated in Figure B-3. Additional information required on message blanks includes the following:

1. Damage should be pinpointed. When applicable, include:
 - a. Compartment
 - b. Frame
 - c. Location
2. All messages must indicate both sender and receiver.
3. Only one report per message blank.

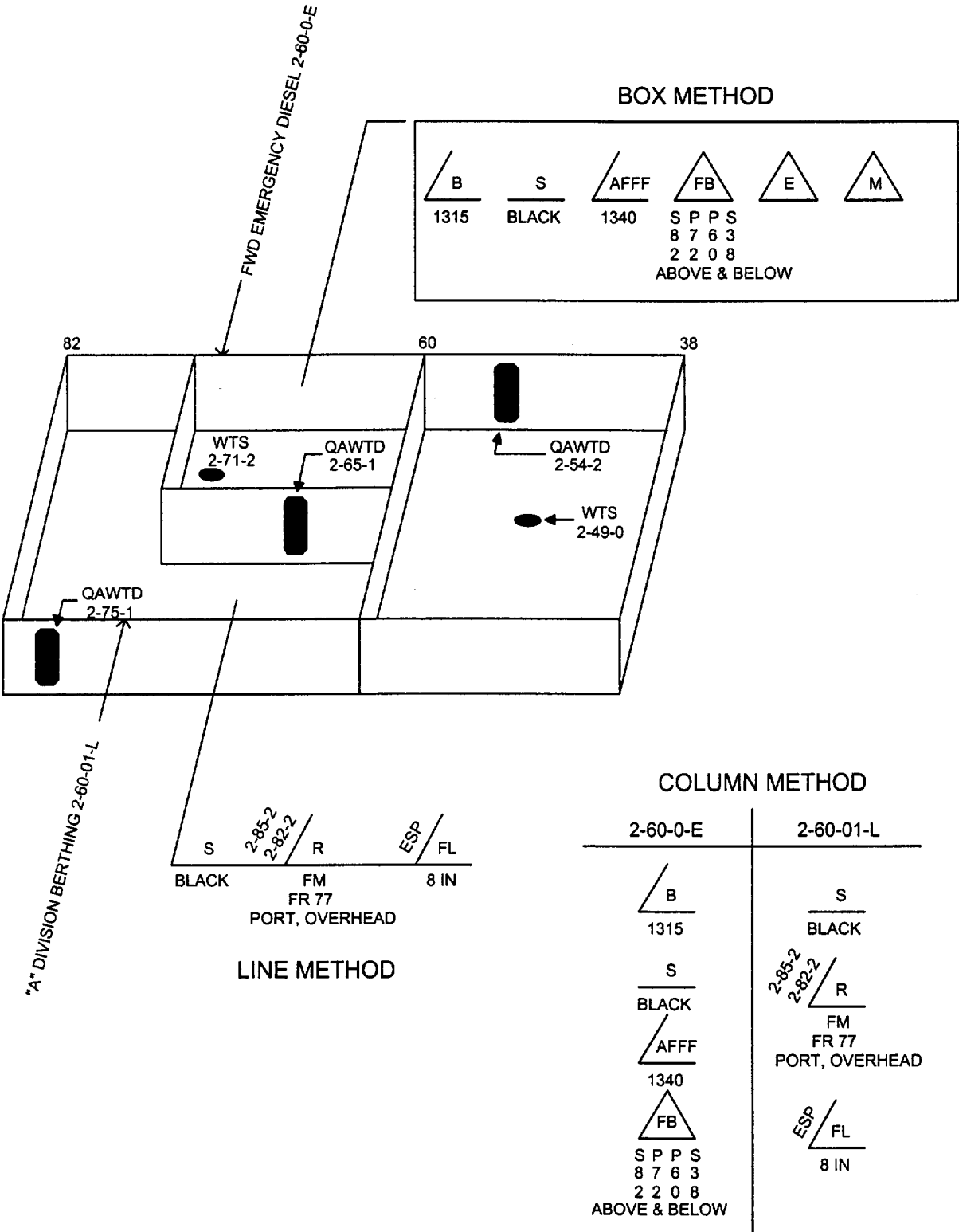


Figure B-2. Plotting Techniques

APPENDIX B-2**STANDARD SYMBOLOGY FOR DAMAGE CONTROL COMPUTER CASUALTY REPORTING AND PLOTTING****079-B.2.1 COMPUTER (ELECTRONIC) PLOTTING TECHNIQUES IN DCAMS.**

Damage control casualty reports are received at DC repair stations and are recorded and plotted on computer terminals, then automatically forwarded to all other stations. If using a stand-alone terminal, electric plotting will be accomplished on-line as voice reports are received. When using electronic plotting with voice communications, it is not a requirement to use message blanks. Regardless of the system hardware configuration (i.e., stand-alone or LAN), the intent of DCAMS is to provide the best damage control tactical management situation awareness of the locations and types of casualties, and to track the personnel engaged in combating the casualty. DCAMS casualty plotting provides rapid, accurate tactical information to shipboard decision-makers in order to reduce response time.

APPENDIX B-2

**STANDARD SYMBOLOGY FOR DAMAGE CONTROL COMPUTER CASUALTY REPORTING AND
PLOTTING**

FIRE - CLASS UNKNOWN			
	REPORTED	ENGAGED	NO
FIRE - CLASS "A"			
	REPORTED	ENGAGED	NO
FIRE - CLASS "B"			
	REPORTED	ENGAGED	NO
FIRE - CLASS "C"			
	REPORTED	ENGAGED	NO
FIRE - CLASS "D"			
	REPORTED	ENGAGED	NO
SMOKE - UNKNOWN			
	REPORTED	ENGAGED	NO
SMOKE - WHITE			
	REPORTED	ENGAGED	NO
SMOKE - BLACK			
	REPORTED	ENGAGED	NO

Figure 079-B.4. Computer Symbology for Damage Control (Page 1 of 9)

HEAT TRANSFER			
	REPORTED	ENGAGED	NO
FLOODING			
	REPORTED	ENGAGED	NO
RUPTURE - MISC			
	REPORTED	ENGAGED	NO
RUPTURE - AFFF			
	REPORTED	ENGAGED	NO
RUPTURE - CHILL WATER			
	REPORTED	ENGAGED	NO
RUPTURE - ELECTRICAL COOLING WATER			
	REPORTED	ENGAGED	NO
RUPTURE - FIRE MAIN			
	REPORTED	ENGAGED	NO
RUPTURE - FUEL OIL			
	REPORTED	ENGAGED	NO
RUPTURE - HYDRAULIC OIL			
	REPORTED	ENGAGED	NO

Figure 079-B-4. Computer Symbology for Damage Control (Page 2 of 9)

RUPTURE - JP-5	 REPORTED	 ENGAGED	 NO
RUPTURE - LUBE OIL	 REPORTED	 ENGAGED	 NO
RUPTURE - PRESSURIZED AIR	 REPORTED	 ENGAGED	 NO
RUPTURE - POTABLE WATER	 REPORTED	 ENGAGED	 NO
RUPTURE - STEAM	 REPORTED	 ENGAGED	 NO
RUPTURE - SALT WATER	 REPORTED	 ENGAGED	 NO
POINT OF WEAPON IMPACT	 REPORTED	 ENGAGED	 NO
FRAGMENTATION	 REPORTED	 ENGAGED	 NO

Figure 079-B-4. Computer Symbolry for Damage Control (Page 3 of 9)

DEBRIS			
	REPORTED	ENGAGED	NO
HOLE IN DECK			
	REPORTED	ENGAGED	NO
HOLE OVERHEAD			
	REPORTED	ENGAGED	NO
HOLE IN BULKHEAD			
	REPORTED	ENGAGED	NO
STRUCTURAL DAMAGE			
	REPORTED	ENGAGED	NO
JAMMED ACCESS			
	REPORTED	ENGAGED	NO
ELECTRICAL POWER LOST			
	REPORTED	ENGAGED	NO
ELECTRICAL DAMAGE			
	REPORTED	ENGAGED	NO

Figure 079-B-4. Computer Symbology for Damage Control (Page 4 of 9)

CASUALTY POWER	 REPORTED	 ENGAGED	 NO
CASUALTY POWER LOST	 REPORTED	 ENGAGED	 NO
COMMUNICATIONS LOST	 REPORTED	 ENGAGED	 NO
MECHANICAL FAILURE	 REPORTED	 ENGAGED	 NO
MECHANICAL DAMAGE	 REPORTED	 ENGAGED	 NO
HAZMAT / TOXIC SPILL	 REPORTED	 ENGAGED	 NO
CHEMICAL HAZARD	 REPORTED	 ENGAGED	 NO
BIOLOGICAL HAZARD	 REPORTED	 ENGAGED	 NO

Figure 079-B-4. Computer Symbolology for Damage Control (Page 5 of 9)

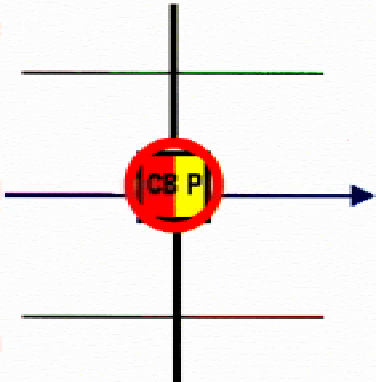
RADIATION HAZARD				
	REPORTED	ENGAGED	NO	
UNEXPLODED ORDNANCE				
	REPORTED	ENGAGED	NO	
PRIMARY CASUALTY BOUNDARY			When a casualty boundary is ordered, the icon should be placed on the centerline at the specified Frame number. Once the boundary is set, the icon should become circled and heavy lines should extend from the boundary icon to the portmost and starboardmost points on the ship deck image. See example below. 	
	ORDERED	SET		
SECONDARY CASUALTY BOUNDARY				
	ORDERED	SET		
PRIMARY FIRE BOUNDARY				
	ORDERED	SET		
SECONDARY FIRE BOUNDARY				
	ORDERED	SET		
PRIMARY FLOOD BOUNDARY				
	ORDERED	SET		
SECONDARY FLOOD BOUNDARY				
	ORDERED	SET		
PRIMARY SMOKE BOUNDARY				
	ORDERED	SET		
SECONDARY SMOKE BOUNDARY				
	ORDERED	SET		

Figure 079-B-4. Computer Symbolology for Damage Control (Page 6 of 9)

	Attack Team
	Boundary Man
	Crew
	DECON Team
	Desmoking Team
	Flooding Team
	Gas Free Engineering Team
	Incident Commander
	Investigator Team
	Safety Team
	Other Personnel
	Crew Casualty

Figure 079-B-4. Computer Symbolology for Damage Control (Page 7 of 9)

	440 Volt Outlet		Eductor Peri Jet		Halon Actuation
	AFFF 5 Gallon		EEBD		Halon Extinguisher DCRS
	AFFF Actuator		Electric Outlet		Halon Extinguisher
	AFFF Extinguisher		Emergency Equipment		Hazard - Combustible
	AFFF Hose Reel		Emergency Life Saving		Hazard - Toxic
	AFFF Outlet		Emergency Lighting		HAZMAT - Spill Kit
	AFFF Station		FF Helmets		Helmets, Battle
	Block and Fall		FFE		Helmets -Phone Talker
	Box Patches		Fan - Medium Capacity		Hose 1 1/2 inch
	Casualty Power DCRS		Fan -Red Devil		Hose 2 inch
	Casualty Power Rack		Fan - Water Driven		Hose 2 1/2 inch
	Casualty Power Terminal		Fire Plug		Hose 2 1/2 inch 10feet
	CBR Equipment		Fire Pump		Hose 3 inches
	CO ₂ Extinguisher		Firemain COV		Hose 3 inches
	CO ₂ Extinguisher DCRS		Fog Applicator		Medical Locker
	Comms Outlet		Fresh Water Hose Reel		Medical Stretcher
	DC Equipment		Emergency Life Saving		NDI
	Dewater Hose		GQ Gear Locker		OBA Canister
	Eductor 1 1/2		Gas Free Locker		OBA Locker

Figure 079-B-4. Computer Symbology for Damage Control (Page 8 of 9)

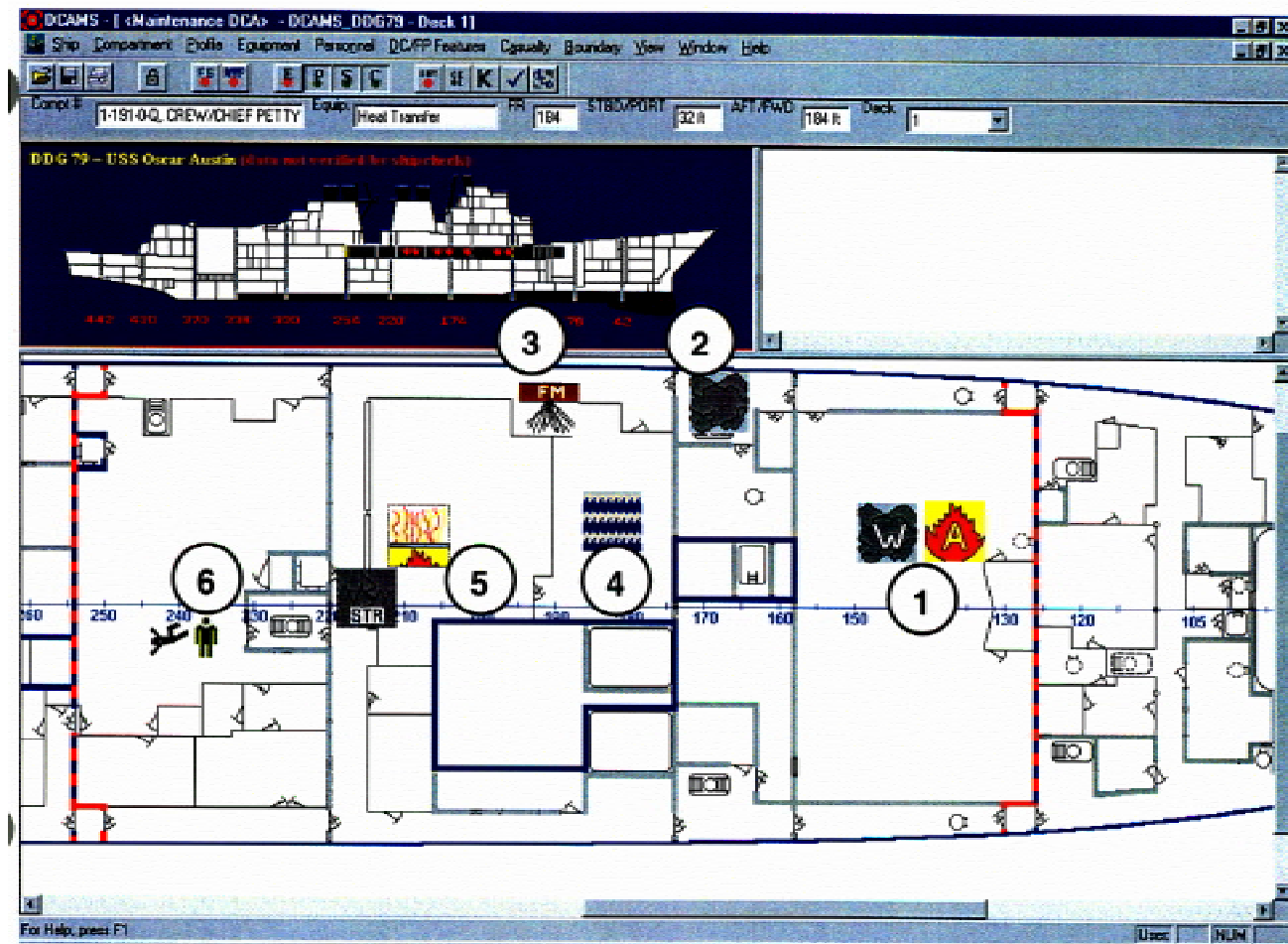
	OBA Single		Smoke Curtains
	Overboard Discharge		Sprinkler Actuation
	P100		Submersible Pump
	P250		Vent Control Unit
	PHARS		Vent Hose
	Pipe Patches		WDCM Control Panel
	PKP Extinguisher DCRS		
	PKP Extinguisher		
	Plate Patches		
	SAR/SCBA		
	SCBA		
	SCBA Charging Station		
	SCBA Cylinders		
	SCBA Lockers		
	SCBA Portable Compressor		
	Shoring Lumber		
	Shoring Metal 3 to 5 feet		
	Shoring Metal 6 to 11 feet		

Figure 079-B-4. Computer Symbology for Damage Control (Page 9 of 9)

079-B.2.2 DCAMS ILLUSTRATIONS

Figure 079-B-5, DCAMS Screen Grabs Illustrating Electronic Casualty Plotting, shows three different scenarios on the following pages:

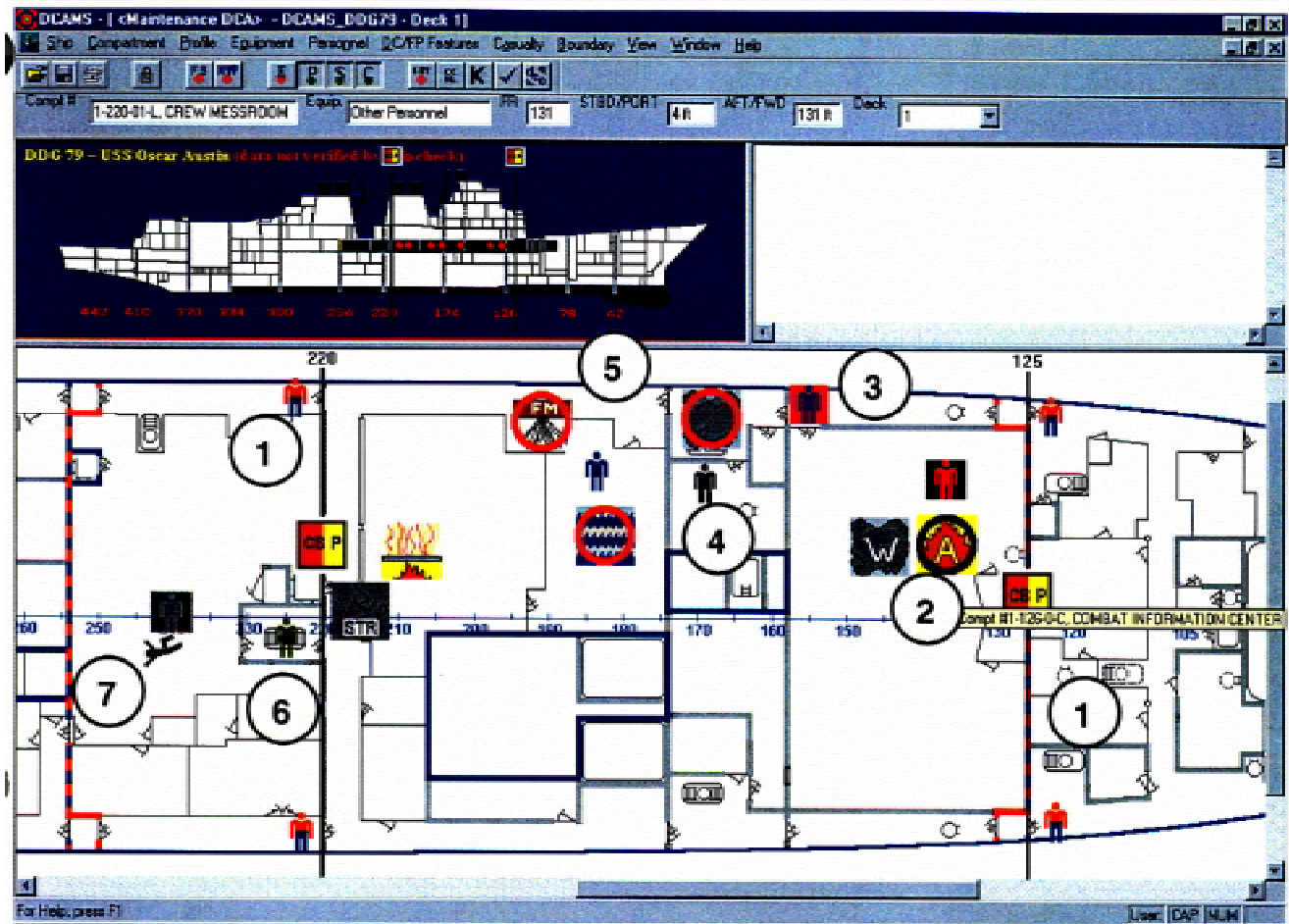
1. Investigation Route of the Investigator. This screen shows an investigator reporting damage in steps 1 - 6.
2. Engagement of Casualties. This screen shows the progression of the casualty and personnel actions in steps 1 - 7.
3. Ongoing Casualty Engagement. This screen shows the ongoing casualty progress through to completion in steps 1 - 6.



INVESTIGATION ROUTE OF THE INVESTIGATOR

- 1) Investigator has reported a Class "A" Fire and White Smoke in compartment 1-126-0-C, Combat information Center.
- 2) Investigator has reported smoke in 1-158-8-L, Passage.
- 3) Investigator has reported a ruptured firemain in 1-174-01-L, Passage.
- 4) Investigator has reported flooding in 1-174-0-L, CPO Mess Room and Lounge.
- 5) Investigator has reported heat transfer from below and a bulging deck in 1-191-0-Q. Probable fire below.
- 6) Investigator is now in 1-220-0-L, Crew Mess Room and has reported a personnel casualty.

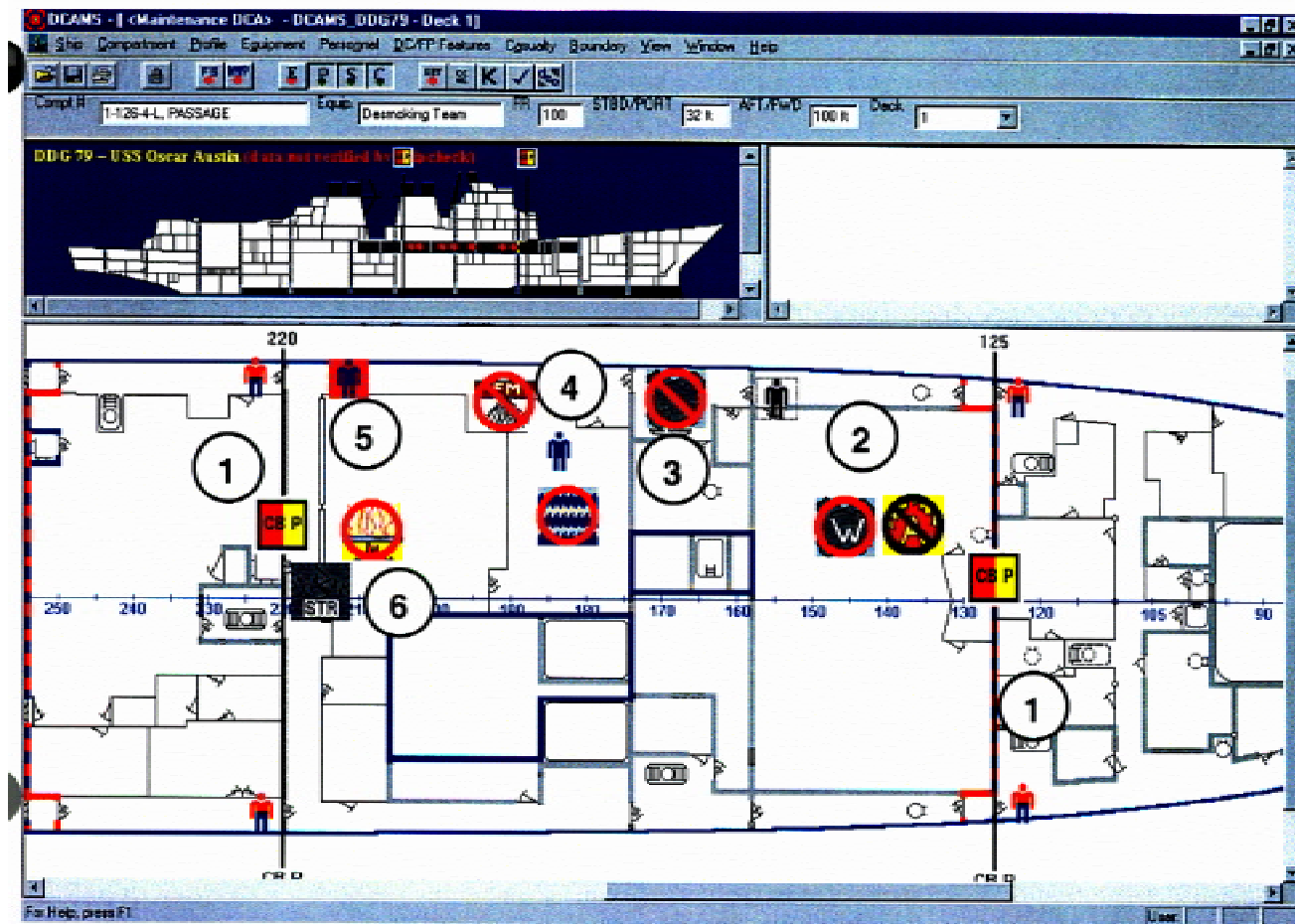
Figure 079-B.5 DCAMS Screen Grab Illustrating Electronic (Computer) Casualty Plotting (Page 1 of 3)



ENGAGEMENT OF CASUALTIES

- 1) Casualty Boundaries are ordered and set at frames 125 FWD, and 220 AFT, by Boundary Men.
- 2) Attack Team engages Class "A" Fire in CIC.
- 3) Scene Leader is the Incident Commander managing all casualty engagement.
- 4) Smoke engaged in Passage by Desmoking Team.
- 5) Firemain Rupture and Flooding engaged by Flooding Team.
- 6) Investigator goes below to investigate source of heat transfer from hot deck.
- 7) Medical Personnel attending to personnel casualty.

Figure 079-B.5 DCAMS Screen Grab Illustrating Electronic (Computer) Casualty Plotting (Page 2 of 3)



ONGOING CASUALTY ENGAGEMENT

- 1) Casualty Boundaries maintained
- 2) No Fire Remains in CIC; Smoke from fire is engaged by Desmoking Team.
- 3) No Smoke remains in Passage; removed by Desmoking Team.
- 4) Dewatering Team has engaged Flooding in CPO Mess Room. No Firemain Rupture in Passage, Isolated form DC Console.
- 5) Incident Commander relocated and continues to act as the Scene Leader.
- 6) Heat Transfer at Hot Deck engaged by Firefighting Attack Team from Below.

Figure 079-B.5 DCAMS Screen Grab Illustrating Electronic (Computer) Casualty Plotting (Page 3 of 3)

APPENDIX C.

DAMAGE CONTROL TRAINING AIDS STANDARD SIMULATIONS AND PROPS

Table 079-C-1 DAMAGE CONTROL SIMULATIONS AND PROPS

SIMULATION	PROPS	NSN (if applicable)
Damage Control Casualties	Damage control casualty flag sets	none
<i>Sounds of Damage Control</i>	Audio CD of casualty sounds	none
Fire A, B, D	Red streamers	9905-00-194-9698
	Red rags	7290-00-044-9281
	Red lens battle lantern	6230-00-729-8881
	Flashlight	6230-00-926A33 1
	Chemlights	6260-01-178-5559
Fire C	Strobe light	6230-00-067-5209
	Crush bubble wrap to make popping noise	
Presence of Fire	Activate High Temp Alarm	
Heat Source for NFTI/Fire Finder	Hot potato	
(Note: Fire Finder can be activated by shining a flash-light into the lens)		
	Heat Gun	4940-01-286-7079
	Drop light (can be wrapped in foil)	6230-00-010A506
	Box of welding rods from the rod oven	
	Microwaved bag of rice	
Fire Contained	Props at waist level	
Fire Out	Props out of sight, on the deck or turned off	
Smoke	Smoke Machine	7H-1040-01-302-0470
	White rags	7290-00-044-9281
	White streamers	9905-00-684A645
	Black rags	7290-00-044-9281
	Blue rags	7290-00-044-9281
Fire Rollover (Used to drive fire team to use fog attack)	Red streamers hung from the overhead	
	Sheet or plastic bag hung across overhead near the space entrance (used to simulate burning gases in the overhead)	
Residual or deep seated fire Activation of Plug	Place heat source simulation in space Allow Plugman to open valve, then DCTT secure it	
Testing of Firefighting Agent	Water: Blue streamer	9905-01-056-5319
	Blue rag (on deck or wrapped around the nozzle)	7920-00-044-9281
	CO ₂ : White rag	7290-00-044-9281
	Talcum Powder	
Testing of Firefighting Agent (cont.)	AFFF: White rag	7920-00-044-9281
	Plastic bag full of packing materials (white styrofoam peanuts)	
	PKP: Purple rag	7290-00-044-9281
Desmoking	Remove props	
	Actual removal of smoke	

Table 079-C-1 DAMAGE CONTROL SIMULATIONS AND PROPS -

Continued

SIMULATION	PROPS	NSN (if applicable)
Firefighting Water on Deck AFFF/FFW in Bilge	Blue streamer/rag/chemlight at the specified level 4 by 4 blocks painted blue for FFW and topped by white to the depth of AFFF (can be various size blocks) Grease pencil markings on hand-held bilge level indicator	
Jammed WTD/WTH	Large masking tape X on the fitting DCTT member hold fitting handle to prevent opening	
Hot Surface	Bubble wrap on fitting, deck or bulkhead	
Bulkhead/Deck Removed by the PECU	Size of hole cut from black sheet rubber and placed in position	
Gas Free Test	Grease pencil marks on 4-Gas Analyzer, Explo- sive Meter or O ₂ Indicator and Drager Tubes	
Electrical Isolation OBA Activation	Actual isolation Hang SECURED signs after Watchstander places hands on correct component Member take actual canister. DCTT member replace canister with sticker or masking tape with date written on it.	
AFFF Activation	Post ACTIVATED sign on control switch after Watchstander attempts to push it. (Ensure station is in RECIRC)	
Panting Bulkhead/Sagging Overhead	DC Plate/cardboard/thin sheet metal inserted between frames	
Empty CO ₂ Extinguisher	Tap on extinguisher Remove white rag or talcum powder	
Flooding	Blue streamers Blue rags Blue chemlight	7920-00-044-9281 6260-01-178-5559
Flooding (cont.)	Spray bottle with H ₂ O Activate flooding alarm Blue chemlight or rag attached to a ruler and slide up or down to indicate flooding level	
Ruptured Piping	Masking tape with crack drawn on it and rags indicating proper hazard color	
Dewatering	Set up equipment, lower props to indicate flood- ing level	
Piping System Isolation	Allow member to close valve(s), DCTT open valve(s) and hang CLOSED sign	
Toxic Gas	Toxic gas simulator	1H 1365-01-367-5695
Man Down	OSCAR or actual personnel	
Injuries	Moulage set Simulation cards	6910-00-540-6378
Use of AFFF (Installed Systems)	Grease pencil marks on sight glass Run magnet down sight glass	

Table 079-C-1 DAMAGE CONTROL SIMULATIONS AND PROPS -

Continued

SIMULATION	PROPS	NSN (if applicable)
AFFF Cutout to Main Space	Allow member to close valve, DCTT open valve and hang CLOSED sign	
Use of Sub Pumps	Allow member to rig pump but do not allow it to be energized Place pump in drum or container filled with water, then energize. Secure when container is empty.	
Halon Effective	Hang gray streamers from overhead near view ports Cool boundaries in surrounding spaces Gray streamers near main space ventilation outlets and stack	
Halon Ineffective	Hang black streamers from overhead near view ports Hot boundaries (bubble wrap) Black streamers near main space ventilation outlets and stack	
Heavy Smoke (to prompt active desmoking)	White or black rag over Scene Leader's OBA facepiece	
Bilges Vapor Secured	Bucket of soapy water secured	
Use of AFFF (Inline Eductor)	Lower blue chemlight or rag on side of empty AFFF container as AFFF is consumed	
Halon/CO ₂ Flooding Activation/Release	Operate pressure switches for vent shutdowns and alarms	
Halon Soak Time	IAW MSFD	
Loss of Firemain	Grease pencil mark on firemain gauge False gauge face	
Use of Installed Eductor	Post OPEN signs on valves after Watchstander explains system line-up Activate discharge and firemain valves and hang OPEN sign on suction valve	
Hazard	Type of spill on deck or from piping: Water: Blue rags F/O, L/O: Yellow rags Hydraulic Fluid: Orange rags	
PKP Extinguisher Empty	Tap on PKP extinguisher Remove purple rag	
ENGINEERING STANDARD SIMULATIONS AND PROPS		
Change in Meter/Gauge Reading	Grease pencil, suction cups with pointers	
Local/Remote	False gauge faces	
Contaminated Oil Samples	Oil samples labeled for EEOCC Use Only containing dirt/grit, metal shavings, black fibrous material, fuel or water as required	
Hazard on Deck	(See DAMAGE CONTROL-HAZARD)	
Hot Surface (Equip Covers)	Bubble wrap, red hand outline	

Table 079-C-1 DAMAGE CONTROL SIMULATIONS AND PROPS -

Continued

SIMULATION	PROPS	NSN (if applicable)
No Oil Flow	Black paper covering sight flow (if two ports are available, leave one uncovered for monitoring) Black paper placed next to sight flow Indicator if only one view port is available	
Sight Glass Level	Magnet with arrow Grease pencil mark at level desired Tape with mark at level desired Clear plastic tube with insert to show level desired	
Sump Level Low	Wipe dipstick to level desired after removal from sump by Watchstander	
Unusual Noise/Vibration from Rotating Equipment	Metallic: Metal on metal (2 metal pipes) Non Metallic: Strike wood on wood/hammer in plastic bucket	
GAS TURBINE-POWERED SHIPS		
Class B Fire in GT Module	Pictures of smoke, flames Red and black paper/rag covering module inspection window	
F/O or L/O leak in GT Module	Yellow rag/paper attached to module door window Drawing of GT engine showing location of leak Flashlight directed to deck/leak location (if visible)	
GG Stall	Bang two trash can lids together Strike the underside of a trash can with a rubber mallet If provided, open and close the inlet plenum view port door	
MRG and LSB Temperatures at DDI	Decade box Stickers indicating desired temperature(s) DDI used by placard covering SSI used by W/S Sound alarms by depressing horn/siren test and placing placard covering SSI	
STEAM POWERED-SHIPS		
Black Smoke at Boiler Periscope	Black paper	
Clogged Boiler Atomizer	Mock clogged atomizer	
Damage Equipment	Hand drawings of damage	
Fire Out in all Boiler Burns	Black disc	
Moisture in Boiler Periscope	Spray bottle	
White Smoke at Boiler Periscope	Orange paper	

APPENDIX D

DAMAGE CONTROL FLOWCHARTS

079-D.1 DESCRIPTION

The flowcharts which follow trace the necessary steps and thought processes associated with immediate damage control efforts at the scene for damage control personnel. The initial chart, Flooding Overview Flowchart, shows the preferred sequence of actions to take during a flooding casualty. The flow chart's sequence of events leads the user to four additional sub-flowcharts, each depicting specific damage and associated decision paths:

1. CHART 1 illustrates flooding from structural damage
2. CHART 2 illustrates a pipe rupture
3. CHART 3 illustrates dewatering
4. CHART 4 illustrates shoring.

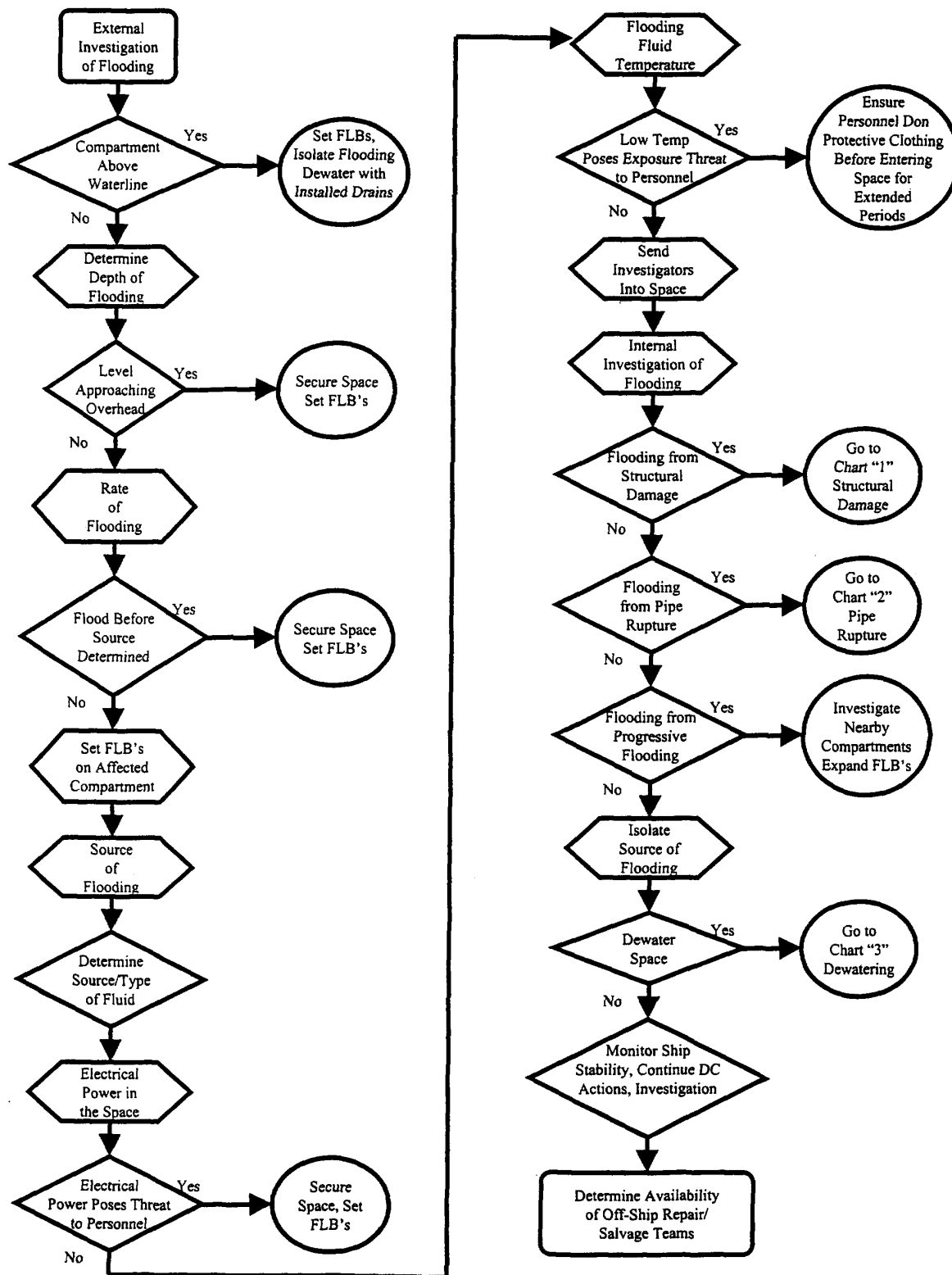


Figure 079-D-1 FLOODING OVERVIEW FLOWCHART

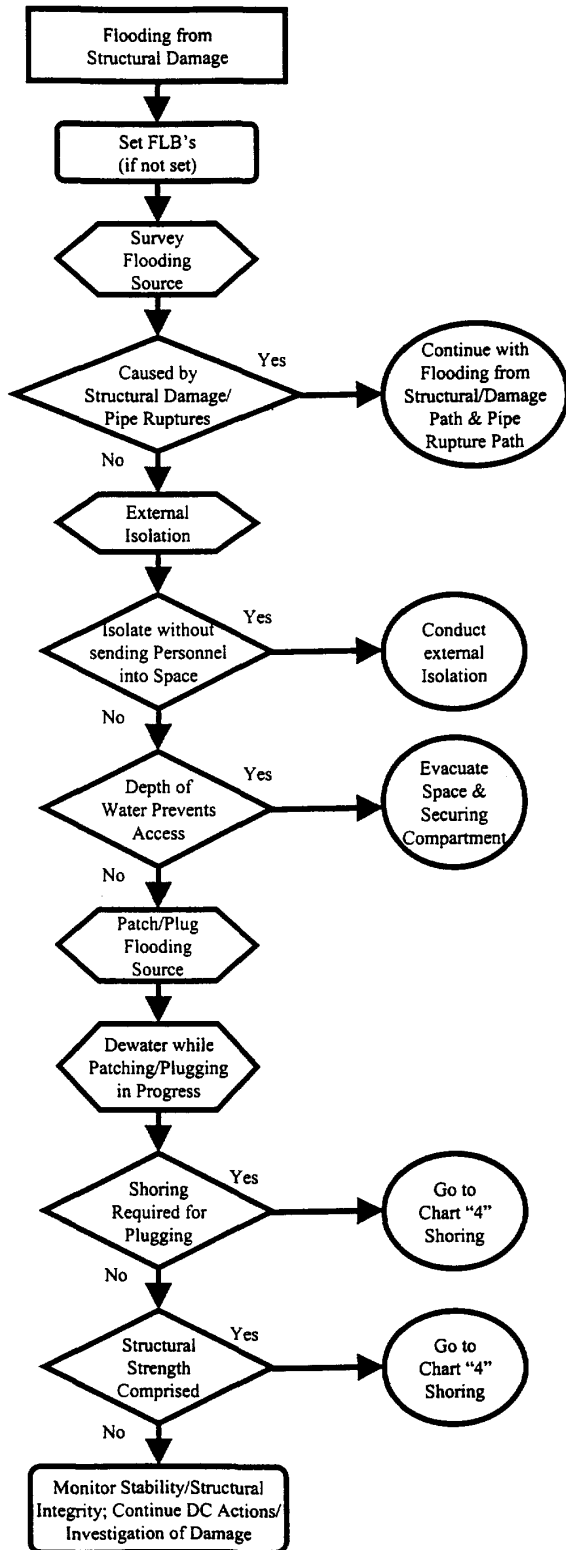


Figure 079-D-2 CHART 1 FLOODING FROM STRUCTURAL DAMAGE

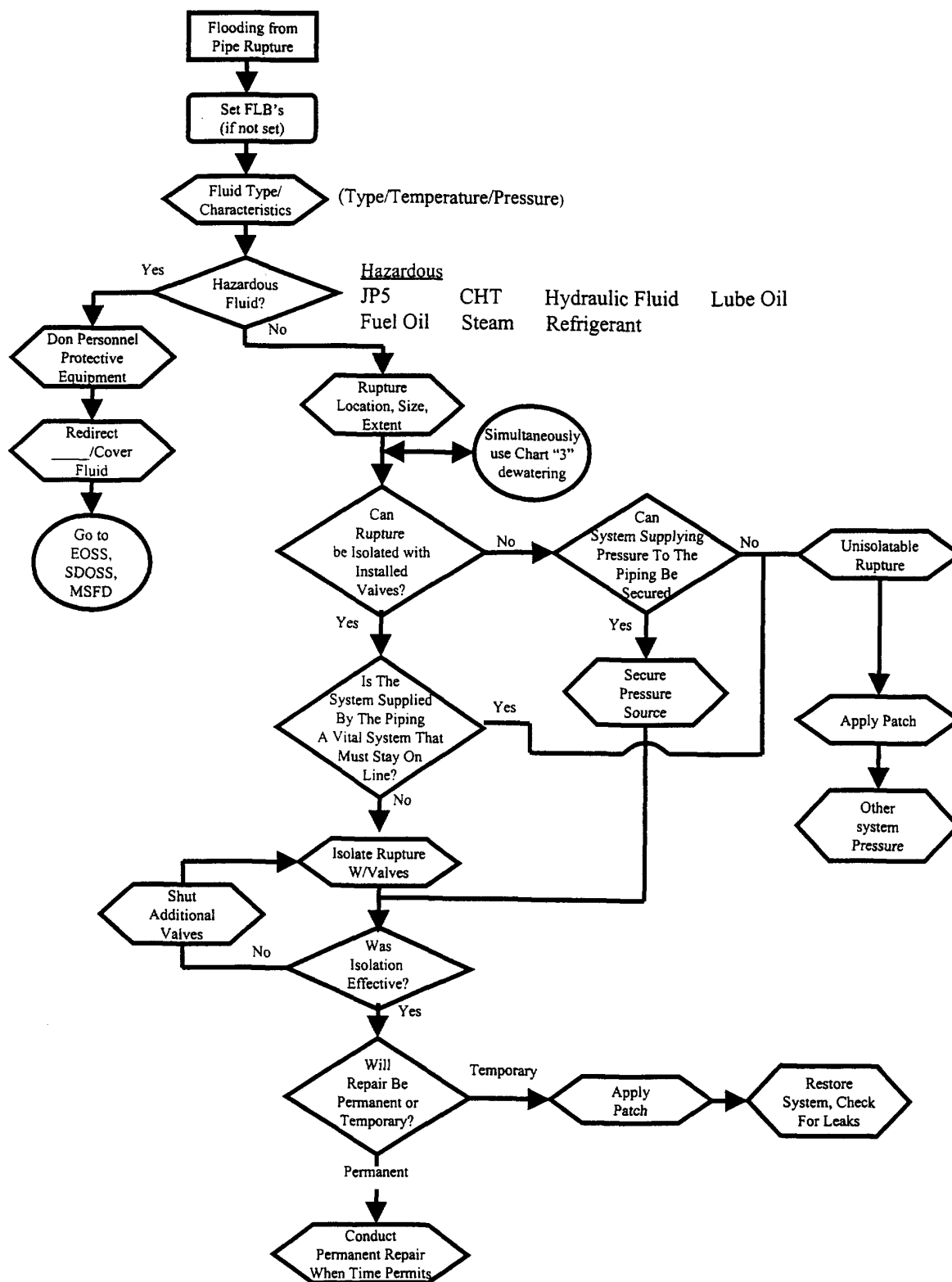


Figure 079-D-3 CHART 2 PIPE RUPTURE

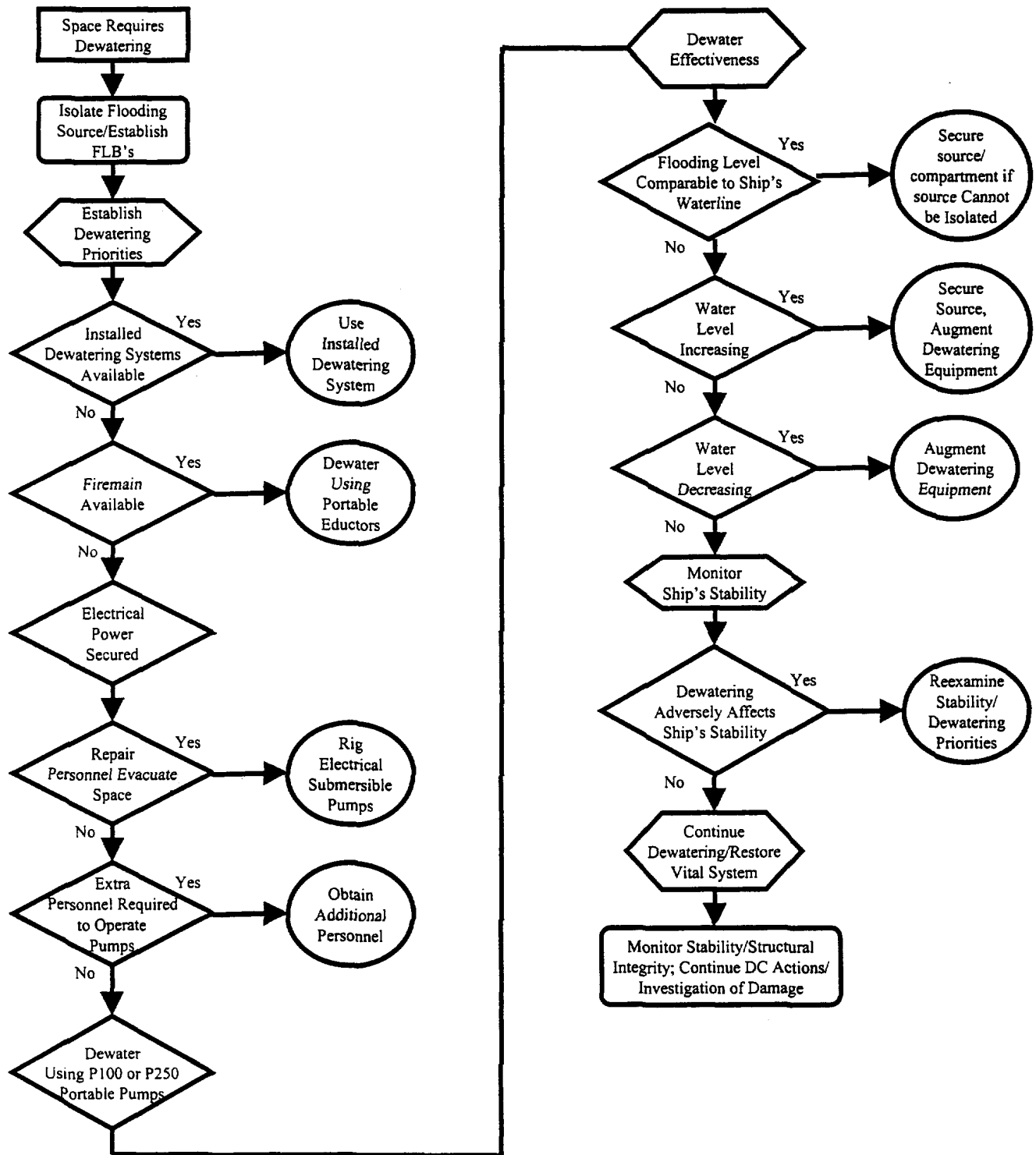


Figure 079-D-4 CHART 3 DEWATERING

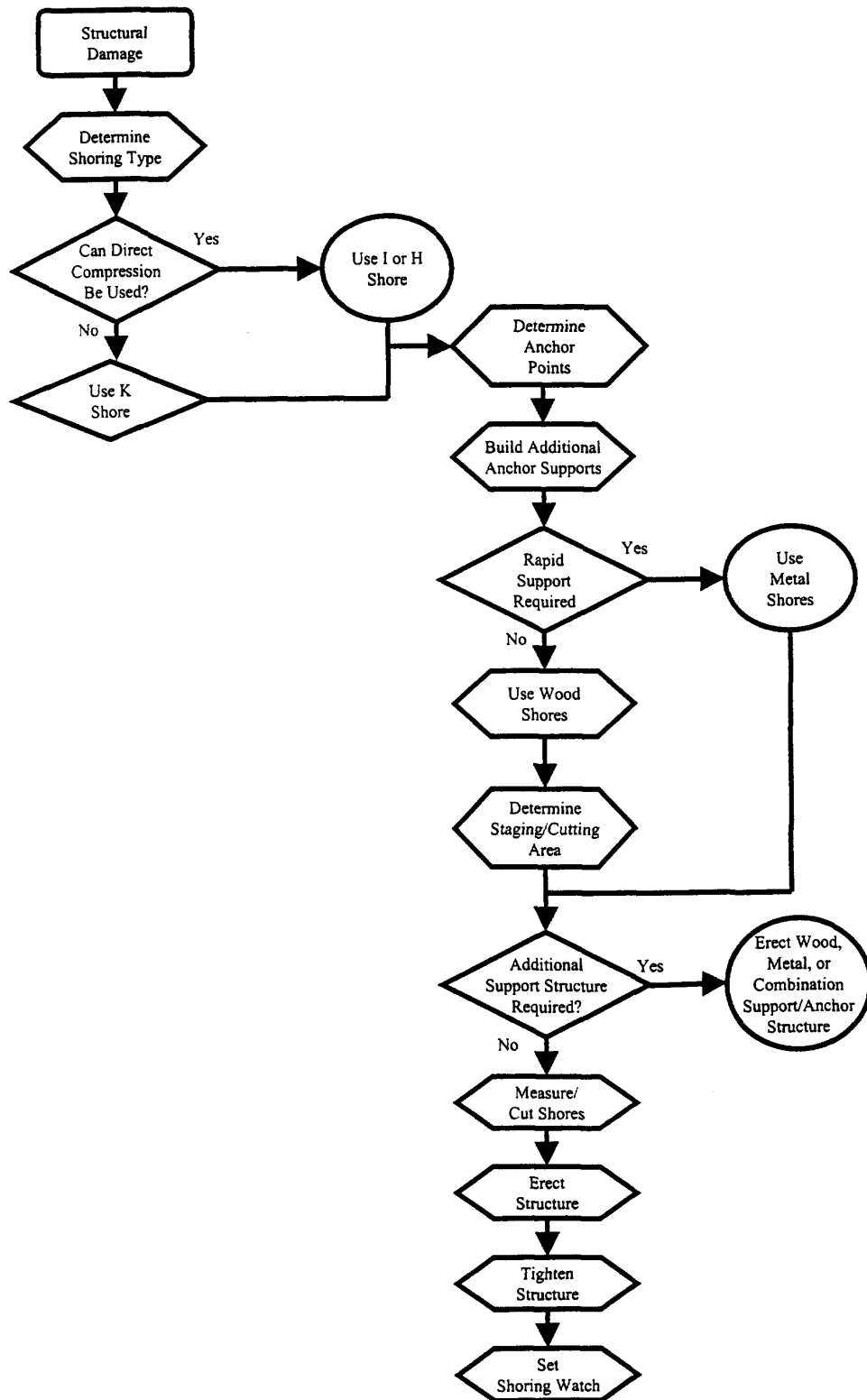


Figure 079-D-5 CHART 4 SHORING

APPENDIX E.**TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT(TMDER)****NOTE**

Ships, training activities, supply points, depots, Naval Shipyards, and Supervisors of Shipbuilding are requested to arrange for the maximum practical use and evaluation of NAVSEA technical manuals. All errors, omissions, discrepancies, and suggestions for improvement to NAVSEA technical manuals shall be reported to the Commander, NAVSURFWARCENDIV, 4363 Missile Way, Port Hueneme, CA 93043-4307 in NAVSEA/SPAWAR Technical Manual Deficiency/Evaluation Report (TMDER), NAVSEA Form 4160/1. To facilitate such reporting, print, complete, and mail NAVSEA Form 4160/1 below or submit TMDERS at web site <http://nsdsa.phdnswc.navy.mil/tmder/tmder.htm>. All feedback comments shall be thoroughly investigated and originators will be advised of action resulting therefrom. Extra copies of NAVSEA Form 4160/1 may be requisitioned from DDSP Susquehanna Pennsylvania, 05 E Street, Mechanicsburg, PA 17055-5003. (S/N 0116-LP-019-5300)

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