***TB 43-0144**

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

PAINTING OF WATERCRAFT

*This manual supersedes TB 43-0144, 5 October 1990, including all changes.

Approved for public release; distribution is unlimited.

HEADQUARTERS, DEPARTMENT OF THE ARMY
November_2005

WARNING SUMMARY

Check with local Environmental Protective Agency (EPA) laws prior to starting any paint operation.

This warning summary contains general safety warnings and hazardous materials warnings that must be understood and applied during operation and maintenance of this equipment. Failure to observe these precautions could result in serious injury or death to personnel. Also included are explanations of safety and hazardous material icons uses within this manual. Chapter 2 of this manual covers safety; please read it prior to starting your paint operation.

The Material Safety Data sheet (MSDS) contains important information and phone numbers regarding the safe handling of a product. The manufacturer is required to supply an MSDS with each item (hazardous material). An MSDS should always be on hand in the event of an emergency, but even more importantly, the MSDS should be read and understood before beginning a job.

Safety Precautions and Requirements for Power Tool Cleaning; goggles, face shields, or similar protection against flying particles should be worn. Respiratory protection filter masks should be provided for exposure.

Gas-Free Testing. Periodic tests shall be conducted to ensure safe, gas-free working conditions. The Marine chemist or competent person should conduct the initial test, with monitors conducting the follow-up tests. During paint operations, gas testing shall continue as necessary to detect dangerous accumulations of hazardous vapors.

Personnel mixing paint shall wear protective garments that fit snugly at the ankles, neck, and wrists, and solvent-resistant synthetic rubber or plastic gloves and an apron. NIOSH-approved respiratory protection shall be required when air-sampling data indicates solvent concentrations in excess of the exposure limit values, or when it is reasonable to assume that vapor concentrations cannot be controlled by ventilation and are expected to exceed the TLV for the thinner involved.

HAZARDOUS MATERIAL/SAFETY ICONS


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


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


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


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


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

LIST OF EFFECTIVE PAGES / WORK PACKAGES

NOTE: This manual supersedes TB 43-0144, dated 05 October 1990.

Dates of issue for revision are:

Revision 30 November 2005

TOTAL NUMBER OF PAGES IS 110 CONSISTING OF THE FOLLOWING:

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Front Cover ……..	0
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LOEP ……..	0
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Current as of May 2005

Headquarters, Department of the Army, Washington, D.C.

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

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HOW TO USE THIS MANUAL

This technical bulletin contains the procedures for painting Army watercraft. Please familiarize yourself with the contents in this manual prior to painting. Information in this manual is divided into 7 sections and 4 appendixes. Sections, paragraphs, and tables are numbered sequentially within each section.

Section 1 contains general introductory information and a description of corrosion control, marking and stenciling, zinc anodes, cleaning, touchup painting, paint film measurement, transitions of paint systems, color scheme and definitions.

Section 2 contains safety precautions for all aspects of paint handling and operations except for stowage.

Section 3 contains information on surface preparation; best quality paint will perform effectively only if applied to a surface, which has been properly prepared.

Section 4 contains information on paint equipment, gauges, and materials; the selection of the proper equipment and materials for any painting job requires a general knowledge of the equipment and materials needed to do the job correctly. The different tools that are available for the application of paints and for testing are described in this section. Also given in this section is information on the requisition, storage, and testing of paints.

Section 5 contains information on painting applications; there are basic requirements that shall be met whenever significant painting is accomplished aboard a US Army watercraft. This section covers basic paint application techniques that shall be followed.

Section 6 contains information on painting application procedures; detailed paint application procedures are frequently presented in specialty manuals, military or federal specifications and standards.

Section 7 covers the application of paints to shipboard equipment, bilges, tanks, and interior and exterior surfaces of US Army Watercraft.

Appendix A lists paint materials used on Army watercraft.

Appendix B lists paint systems used on Army watercraft.

Appendix C lists markings used on Army watercraft.

Appendix D contains information on the installation and maintenance of deck coverings.

SECTION 1. GENERAL

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1-1. Purpose. The purpose of this bulletin is to provide information, instruction, and guidance on the preservation of US Army Watercraft in service and in storage paints and cathodic protection. Satisfactory painting applied prior to issuance of this bulletin shall not be altered solely for the purpose of conformation.

1-2. Scope.

a. The information contained herein shall take precedence over all other preservation instructions except where deviation has been authorized by Commander, US Army Tank-Automotive and Armaments Command, Troop Support Group, Army watercraft, ATTN: AMSTA-LC-CJA, 6501 East 11 Mile Rd., Warren, MI 48397-5000. The e-mail address is watercraft@tacom.army.mil . Faxes can be sent directly to (586) 574-6968. Deviations will be granted on an individual basis.

b. The contents of this bulletin are applicable to all US Army Watercraft except those assigned to the US Army Corps of Engineers and Bridging Units.

c. This bulletin may be used as a procurement document and shall be used as the basis for writing repair and maintenance specifications.

1-3. Reporting of Errors. You can help improve this bulletin. If you find any mistakes, or if you know of a way to improve the procedures, please let us know. You may e-mail mail or fax DA Form 2028 (Recommended Changes to Publications and Blank Forms), to: Commander, US Army Tank-Automotive and Armaments Command, Troop Support Group, Army watercraft, ATTN: AMSTA-LC-CJW, 6501 East 11 Mile Rd., Warren, MI 48397-5000. The e-mail address is watercraft@tacom.army.mil . Faxes can be sent directly to (586) 574-6968.

1-4. Color Scheme. All crafts shall be painted with systems and colors designated in Appendix B.

1-5. Transition of Paint Systems. The decision to change paint systems will be made with prior approval from Commander, US Army Tank-Automotive and Armaments Command, Troop Support Group, Army watercraft, ATTN: AMSTA-LC-CJA, 6501 East 11 Mile Rd., Warren, MI 48397-5000. The e-mail address is watercraft@tacom.army.mil . Faxes will be sent directly to (586) 574-6968.

1-6. Cleaning. All safety precautions outlined in Section 2 shall be complied with at all times. Accomplish all cleaning in accordance with Section 3.

1-7. Touchup Painting.

NOTE

When touchup painting, use the same paint system (or equivalent) as to what is currently being used on the craft. Check with the Watercraft Inspection Branch to verify your current paint system. Commander, US Army Tank-Automotive and Armaments Command, Troop Support Group, Watercraft Inspection Branch, ATTN: AMSTA-LC-CJWW, BLDG 2796, Fort Eustis, Virginia 23604-5286. Faxes can be sent to (757) 878-5109.

a. When to Paint. Touchup or spot painting shall be performed when less than 50 percent of the paint surface or paint system of a major area has deteriorated to the extent that the underlying structure is no longer protected.

b. Preparation. Deteriorated surfaces shall be cleaned in accordance with Section 3. Adjacent areas of intact paint shall have marine organisms removed and the edges feathered. Clean all intact paint in accordance with Section 3.

1-8. Major Painting.

a. When to Paint. Major painting shall be performed when more than 50 percent of the paint surface, or paint system of a major area has deteriorated to the extent that the underlying paint or structure is no longer protected. The 50 percent failure stipulation applies when several separate damaged areas add up to more than 50 percent of total surface, as well as when the damage is concentrated in one area.

b. Renewal of Paint Surface. Accomplish when only the finish paint on a major area has deteriorated and the underlying paint is in good condition; new finish paint shall be applied over the intact undercoats.

(1) Hull surfaces shall be cleaned by abrasive blasting, pressure washing with fresh water, or by hand or power cleaning methods. Sound, adhering paint shall be left intact; loose, blistered paint, and deteriorated areas of old paint shall be removed. Old tightly adhering paint shall be featheredged sufficiently to permit the new paint coating to form a uniform and continuous surface.

(2) All surfaces to be painted shall be cleaned in accordance with Section 3.

c. Renewal of Paint System. Accomplish when the paint system on a major area has deteriorated through the primer coat. All existing paint shall be removed.

(1) Cleaning. The resulting bare structure shall be cleaned to remove all oil, grease, moisture, corrosion by-products, and other surface contaminants in accordance with Section 3. The clean surface shall then be primed within eight hours after cleaning, to prevent rusting, as specified in applicable tables in Appendix B.

(2) Painting. Surfaces shall be painted in accordance with Section 5 through 7 and Appendixes.

1-9. Paint Film Measurement.

a. Touchup Painting. For touchup painting, one brush coat shall be considered the equivalent of one mil, and two brush coats the equivalent of two mils of dry film thickness.

b. Major Painting. For major painting, a film thickness gage shall be used to assure proper paint film thickness application. At least one random reading shall be taken at appropriate stages for each 100 square feet (9.3 square meters) of surface area, or less, to determine conformity to minimum film thickness requirements of the applicable paint system.

c. Film Measuring Gages. Film measurements shall be accomplished by use of a measuring device, which can be calibrated down to 0.0005 inch (0.0127 mm) and up to 0.020 inch (0.508 mm) in steps of 0.0001 inch (0.00254 mm).

1-10. Marking and Stenciling.

a. General. Block lettering and numerals conforming to figure 3 of Appendix C, shall be used for all exterior designation markings and draft numerals. All other lettering shall be Gothic capitals and all numerals shall be Arabic, unless otherwise specified herein. Generally, the color will be black on a white or light colored background, and white on a black or dark colored background. Gray paint is considered a light background.

b. Application of Exterior Markings. Exterior designation markings, draft numerals, and load line markings shall be applied as follows: Steel Hulls. Outlines shall be fine bead weld and shall be painted the same color as the lettering.

c. Stenciling and Hand Painting. Designation markings, draft numerals, life-saving and firefighting equipment identification box, locker contents markings, name boards, and special signs shall be applied by stencils, decalcomanias, or hand lettering. Decalcomanias and stencils should be pigmented, adhesive electrometric letters and numerals or stencils conforming to sizes and colors in accordance with paint schedule in appendixes A thru D.

d. Designation Markings.

(1) Self-Propelled Watercraft.

(a) Bow. Designations shall be located on the hull or bulwark near the bow on both port and starboard sides in the sizes as shown on figure C-4 of Appendix C. The legend shall be centered at approximately three-fourths the height from the designed load waterline to the upper edge of deck or bulwark. Where practical the data shall be arranged in two lines; when the alternate one-line arrangement is used the legend "US Army" shall be to the left of the watercraft's number. If practicable, bow designations on tugs shall be located clear of permanently installed fenders, guards and bumpers.

(b) Stern designation. "US Army" and name or number shall be located on the hull or bulwark. Size of the stern designations shall conform to figure C-4, column "A" of Appendix C. The following shall apply to specific stern types:

1. Transom sterns. Designations shall be centered horizontally on the vertical centerline plane through the hull; designations shall be centered at approximately three-fourths the height from the designed load waterline to the upper edge of the deck or bulwark, whichever is higher.

2. Elliptical sterns. Designations shall be centered horizontally on the vertical centerline plane through the hull; designations shall be centered approximately midway between the fantail knuckle and the upper edge of the deck of bulwark, whichever is higher.

3. Cruiser stern. Designation shall be located near the stern on both port and starboard sides; designations shall be centered at approximately three-fourths the height from the designed load waterline to the upper edge of the deck or bulwark, whichever is higher.

(c) Name boards. Name boards shall be approximately nine (9) inches wide, one and one quarter (1 1/4) inches thick and of suitable length for name with three (3) inches border on each end. Name boards shall be attached port and starboard on the sides of the bridge, or on rail, or lifeline stanchions on top of the bridge. Name boards shall be painted black with six (6) inch Gothic capital engraved letters finished in gold color. Name boards shall be removed from the vessel and taken to a dust free environment prior to refinishing. Install new backing strips on name boards with mahogany strips. Strip existing finish from name board. Refinish name boards with Sikkens clear marine varnish, or equivalent;

number of coatings and application shall comply with manufacturer's recommendations. Paint lettering with urethane paint, matching existing color. All fasteners shall be constructed of corrosion-resistant steel (CRES) or other non-ferrous material.

(2) Non-propelled Watercraft Ship formed Hulls. Non-propelled ship formed watercraft shall have the same exterior designation markings as self-propelled watercraft.

(3) Barges with Long Deckhouses. If the length of the deckhouse is 40 percent or more of the overall length of the barge, the designation marking shall be centered on the port and starboard sides of the house. The designation marking shall also be centered on the forward and aft ends of the house. All markings on houses will be centered vertically at the midheight of the house or as near to midheight as possible. Sizes of designations shall be as shown on figure 4, Appendix C.

(4) Barges with Short Deckhouses. If the length of the deckhouse is less than 40 percent of the overall length of the barge, the designation marking shall be as specified in paragraph (5). Barges without deckhouses, except the stern designation shall be centered on the aft end of the deckhouse.

(5) Barges without Deckhouses. Barges not having deckhouses, deck cargo bins or bulwarks shall have the designation marking centered longitudinally amidships on the port and starboard topside. These designations shall be centered vertically 12 inches (30.48 cm) below the edge of the deck at side or 12 inches (30.48 cm) below the uppermost fender guard or rubbing strake. Sizes of designations shall be as shown on figure C-4 of Appendix C. Where practical, these same designations will also be centered on the bow and stern immediately below the deck edge. Where sufficient space is available, bow and stern Markings will be the same size as those used amidships. If sufficient space is not available, the markings may be reduced in height to not less than one-half that specified for the amidships marking. Barges having deck cargo bins or bulwarks shall have the same designation markings, except that they shall be located at the mid-height of the deck cargo bins or bulwarks at the bow and stern and at amidships, port and starboard.

(6) Floating crane. Hulls of floating cranes shall have designations as specified in (5) above for barges without deckhouses. In addition, center the designation on both sides on the crane cab. See figure C-4, Appendix C.

(7) Modular Causeway System (MCS). All MCS modules shall have the applicable designation markings scribed on the data plate located on the modules. Additionally, the modules shall have designations marked in the following areas using 4-inch stencils. The designation markings will be stenciled in black. The designation will consist of the first initial of the module type and the last four of the serial number. For example, right rake end would be stenciled as R-0015.

(a) 40' Center module. Stencil the designation on both sides; center these designations vertically 6 inches below the edge of the deck edge. Stencil the designation on the top of each module approximately 2 inches below the J-tube on each end.

(b) Left, Right, and Center End Rakes. Stencil the designation on both sides and the end; center these designations vertically 6 inches below the edge of the deck edge. Stencil the designation on the top of each module on the end opposite the rake end, approximately 2 inches below the J-tube. Each 20-foot rake end must have safety markings painted on the rake end of the module. Safety markings shall consist of a 4-inch wide yellow stripe running across the modules located 24 inches back from the module corners. In addition, there shall be four 3-inch wide diagonal yellow stripes per module placed 24 inches apart and at a 45-degree angle slanting to the right. Stencil "CAUTION" in 4 inches high letters in the center of the Center rake end module only. See Figure C-6 in Appendix C. The yellow paint must be moisture-cured polyurethane.

(c) Combination Beach/Sea End. Stencil the designation on both sides and the end; center these designations vertically 6 inches below the edge of the deck edge. Stencil the designation on the top of each module on one end approximately 4 inches from the edge centered.

e. Load line Markings. Large self-propelled watercraft requiring loading certificates shall have load line markings as allowed by their design and scantlings; and as specified in the ABS rules for building and classing steel vessels; and in CFR 46 Subchapter E, load lines, as to location, type size and application.

f. Draft Numerals. Draft numerals shall be used on all watercraft more than 45-foot (13.72 meters) load waterline (LWL). Numerals shall conform to figure C-3 of Appendix C and shall be 6 inches (15.24 cm) high in vertical projection. Draft numerals are not required on watercraft of 45-foot (13.72 meters) load waterline length or less.

(1) Vertical Location. Draft numerals shall be so located that the bottom edge of each numeral shall establish the draft indicated by that numeral. Bottom edge of numeral shall be measured in exact feet normal to the designed load waterline and above the forward and aft reference points. Numerals shall extend from one numeral below the lightest draft, to one numeral above the deepest draft at which the watercraft may float at bow and stern under extreme loading operations.

(2) Forward Draft Numerals. The forward draft numerals shall be placed port and starboard as near the forward perpendicular as practicable. The forward perpendicular, for the purpose of draft mark location, shall be considered as the vertical line through the intersection of the designed load waterline and the face of the stem. The reference point, from which the vertical measurements for the forward draft marks will be determined, shall be the intersection of the forward perpendicular and the line passing through the aft reference point tangent to the lowest point of the keel or stem forward. For watercraft with a straight horizontal keel, this line may be horizontal; for other conditions, this line may assume any required angle.

(3) After Draft Numerals. The after draft numerals generally will be placed port and starboard as near the after perpendicular as practicable. On watercraft with transom sterns, they shall be located on the transom at the centerline of the watercraft. The reference point from which the vertical measurements for the after draft marks are determined shall be the lowest point of the keel propeller guard, or stern frame; except that on those watercraft where the propeller extends below the lowest extremity of the hull or appendages, the reference point shall be the lowest point of perpendicular circle.

(4) Draft Reference Marks for Wet-Stored Craft. Two white stripes 3 feet (91.44 cm) long by 4 inches (10.16 cm) wide shall be painted, using Enamel, Silicone Alkyd, and Copolymer on each side of the hull along the waterline of craft in wet-storage. The stripes shall extend from the bow aft port and starboard, and from the stern forward port and starboard.

g. Lifesaving Equipment.

(1) Lifeboats. Hull markings for lifeboats and other boats carried on board, except those having specifically authorized Army designations, shall consist of the legend "US Army" together with the authorized designation of the parent watercraft. Designation shall be on the stern (port and starboard) if boat is double ended or, on the center of the transom if boat is transom sterned. The number of each lifeboat shall be stenciled or marked on the bow in numerals 3 inches (7.62 cm) high. The cubical contents and the maximum number of persons allowed to be carried in each lifeboat shall be marked or stenciled on each side of the bow in letters and numbers 1/2 inches (3.81 cm) high. In addition, the maximum number of persons allowed shall be plainly marked or stenciled on top of at least two of the thwarts in letter and numbers 3 inches (7.62 cm) high. To ensure that markings will not be obscured when the lifeboat covers are installed, lifeboat markings shall not begin at less than 8 inches (20.32 cm) below the sheer line. The top of thwarts, side benches and footings of lifeboats shall be painted international orange using Enamel, Silicone Alkyd, and Copolymer. The lifeboat releasing gear handle shall be painted gloss red using Enamel, Silicone Alkyd, Copolymer and marked "Danger-Lever Drops Boat." The area 12 inches (30.5 cm) on a side surrounding the release lever shall be painted a contrasting white. All contents of the lifeboat not permanently affixed, i.e., oars, paddles, masts, containers, etc., shall be stenciled with "US Army" followed by the watercraft name or designation (LCU 2023) (HOBKIRK).

(2) Other Lifesaving Equipment. Lifeboats and life rafts shall have the legend "US Army" together with the authorized designation of the parent watercraft clearly stenciled on them in letters 2 inches (5.08 cm) high, on the center of the front and backside or face.

(3) Color. International orange Enamel, Silicone Alkyd, Copolymer shall be applied to wood and plastic surfaces of life rafts and life raft covers of all watercraft when, in the judgment of the commanders, a higher degree of visibility is essential to the accomplishment of assigned missions.

(4) Emergency Lights. Installed emergency lights shall be identified by stenciling the letter 'E " adjacent to the light fixture Portable emergency lights shall be stenciled with a number and the letter "E" on the light, adjacent to the light bracket. Portable lights shall be numbered similar to fire extinguisher described in paragraph h. (1) below.

(5) Emergency Gear. Storage lockers containing emergency gear shall be identified by stenciling the locker door or hatch as follows:

(a) Emergency Squad Equipment.

(b) Self-Contained Breathing Apparatus.

(c) Foam Storage.

h. Firefighting Equipment.

(1) Fire Station. All fire stations shall be painted red and have titles FIRE HYDRANT, FIRE VALVE etc., in 1-inch (2.54 cm) red letters above them on the bulkhead on which they are mounted. Fire stations shall be numbered consecutively fore to aft with even numbers to port and odd numbers to starboard. Portable fire extinguishers shall be numbered similarly on both the location and fire extinguisher. Fire hoses shall be stenciled "US Army" followed by watercraft designation in black.

(2) General Alarm Bells. General alarm bells shall be painted red and have legend "GENERAL ALARM BELL WHEN BELL RINGS GO TO YOUR STATION" painted in 1-inch (2.54 cm) red letters beneath them on the bulkhead on which they are mounted.

(3) Crash Panels. Crash panels and emergency escapes shall have legend "EMERGENCY EXIT" painted on them in 2-inch (5.08 cm) letters in locations as follows:

(a) On compartment side of fire screen doors.

(b) On corridor side of stairwell doors.

(c) On inside of stairwell doors leading to boat deck. Color shall be that which is most legible against the color of the respective doors.

i. Piping Systems. Shipboard piping shall be identified by color coding and marking in accordance with figure C-4 (Appendix C) using the Navy Standard System. Color codes shall be applied to valve hand-wheels only. Valve stems, threads, and tags shall not be painted. Fire Hose racks shall be painted red. Color-coded arrows indicating the direction of flow shall also be stenciled on the piping. The liquid within the piping system shall be identified by lettering whenever two or more fluids fall within a color (i.e., hydraulic oil and lube oil are both color coded orange). Exception is potable water lines, which shall be painted light blue or striped with 6-inch (15.24 cm) light blue bands at fittings on each side of partitions, decks and bulkheads, at intervals not to exceed 15 feet (4.57 meters) in all spaces. The lettering together with arrows indicating the direction of flow shall be located at the following points on each piping system:

(1) Where entering or leaving mechanical equipment.

(2) Where appearing or disappearing through a deck or bulkhead.

(3) At all tee, cross, or Y branches of systems.

(4) At all valves.

(5) At any point which will clarify a complicated system. Piping system markings may be omitted for those locations where another marking on the same system is clearly visible from the specified location. Thus a straight run through a relatively small compartment need be marked only once and not at both bulkheads. Nonpotable fresh water line outlets shall be labeled as being unfit for drinking.

NOTE

Fittings will not be painted.

(6) Storage tanks shall be stenciled with the name of its contents. Lettering shall be color coded and applied to the manhole cover or other visible location. Lubrication fittings shall be marked by the color-coded letter '"L" applied adjacent to the fitting.

j. Marking the Anchor Chain. For the safety of every ship, the ship's officers and the boatswain must know at all times how much anchor chain has been paid out. To make this information quickly available, a system of chain markings shall be used as illustrated in figure C-1 of Appendix C.

k. Obliteration of Watercraft's Markings. On watercraft to be disposed of, all exterior Army Designations such as '"US ARMY," watercraft's name and/or number, etc., shall be removed. Name boards shall be removed from the watercraft as well. To provide for future identification, builder's nameplates and other designative markings located within the interior of the watercraft shall not be obliterated. When markings are painted on, they shall be completely obliterated; where welded onto the hull or other structural member, markings shall be removed by grinding off the weld.

1-11. Corrosion Control.

a. Cathodic Protection. Although coatings are used as the principal corrosion prevention measure on metal surfaces, a supplemental method of protection is needed for the underwater hull and appendages of ships to safeguard against premature paint failures, e.g., porosities, cracking, poor adhesion, abrasion, aging, and erosion. Cathodic protection (an electrochemical technique) can successfully arrest or control the corrosion of metals in a marine environment.

b. Cathodic Protection System. The type of cathodic protection system used is as follows: Sacrificial (galvanic) Anode System.

c. Sacrificial Anodes System. A system based upon the theory that a less noble metal when connected to a more noble metal in a corrosive environment will generate a current of sufficient magnitude to protect the more noble metal. In so doing, it in turn is sacrificed. Such is the case, when magnesium, aluminum or zinc anodes, attached to a ship's hull slowly dissolve generating a current to protect the hull and its appendages against corrosion by eliminating local anodes and cathodes on the hull. The disadvantage with this type of protective system is that periodic replacements of the anodes are required.

(1) Sacrificial anode systems require maintenance on a continual basis. The system specified herein is designed to last 3 or 4 years to conform to normal overhaul periods. The actual service life is dependent upon a combination of many factors.

(2) During Dry-dock Overhaul (3-year schedule), the ship shall be inspected to determine the need for anode replacement. All anodes shall be replaced when 3 years or more have elapsed since the last dry-docking involving anode replacement. Normally, stern anodes deteriorate more rapidly than those installed midships. However, this may not be the case where large bare metal areas may exist in the forward area due to beaching operations. In addition, the leading and trailing anodes usually deteriorate

more rapidly than those in the center of the vessel Therefore, spot replacement of certain anodes may be required from time-to-time without the expense of complete replacement of the system. As general criteria, anodes should always be replaced when they are approximately 50 percent or more deteriorated.

(3) Anodes shall conform to Sacrificial Zinc Alloy Anode, type ZHC. The lower driving potential and current limiting characteristics, when providing protection to a steel surface, are desirable properties. Although zinc anodes do not require dielectric shields, zinc should not be installed over a bare steel hull. The same coating system that is used to coat the hull should be applied beneath the zinc anodes to act as a barrier. Proper functioning of the anode depends upon complete immersion in seawater, a clean anode surface, and a positive contact between the anode and the surface requiring protection. Anodes shall not be attached to propellers, propeller shafts, strut arms, strut barrels, or on the exterior of the stern or strut tube fairwaters.

(4) Anodes shall be attached to the hull by the bolt-on method to facilitate replacement. A doubler plate, as per figure 1-1 will be installed. The attaching studs will be welded to the doubler plate. The doubler plate, stud, washer and nut will be made of corrosion resistant steel (CRES). Stud location and anode strap drilling will be determined using the information in Figure 1-2. Prior to anode installation, the stud will be cleaned to remove all paint, rust or other matter to insure a positive contact between it and the anode strap. After installation of the anode, the nut, stud and washer will have the same coating system applied as the hull. The stud can be cut off flush with the top of the nut to minimize turbulence in service.

(5) Occasionally, a zinc anode may develop an oxide film, which renders it inactive. Although this is the exception rather than the rule, this inactive state can readily be detected by comparing the anode with others in the system. The inactive anode usually will have a hard to remove, dark grey or black film on the surface, however, the anode manufacturer's identification will still be prominent; such anodes should be replaced. A light colored soft deposit on the surface, even though quite thick, is normal and may be prevalent under conditions of low velocity.

(6) The quantity of anodes specified for the hull shall be installed. The hull surface beneath the zinc should be properly coated with the complete anti-corrosive system specified for the hull. Areas blistered from welding shall be painted the same as the hull.

CAUTION

Do not paint the zinc anode surface, this will insulate the anode and stop the flow of current. Only use specified steel for studs, deviation from this would cause deterioration of the hull.

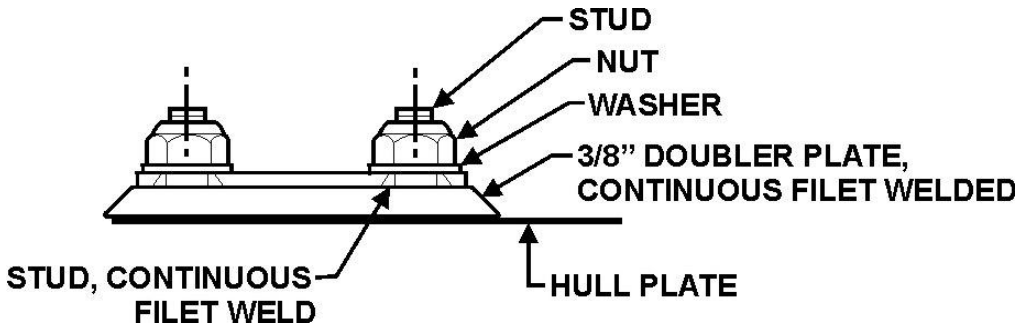

Figure 1-1. Zinc Anode Stud and Doubler Plate Attachment

(a) 3/8 " doubler plate, stud, washer and nut will be made of corrosion resistant steel (CRES).

(b) Stud for ZHC is 5/8" diameter.

(c) Doubler plate for ZHC to be 3/8" (T) x 6" (W) x 12" (L)

(d) Stud and doubler plate to be continuous filet welded.

(e) Drill and countersink, 1/4 inch deep, the doubler plates to allow for flush welding of the studs. Figure 1-2 can be used to locate the studs on the doubler plate.

(7) The following is an accepted rule to follow in determining the quantity of zinc required under velocity conditions of active service. Two zincs of type ZHC protect 400 square feet (37.25 square meters) of freshly painted steel, 200 square feet (18.6 square meters) of steel coated with paint one year old, or 100 square feet (9.3 square meters) of bare steel. This rule also applies to aluminum hulls. No less than two zinc anodes equivalent to the ZHC type shall be provided for the protection of steel hull boats.

(a) Midships Area. Two-thirds of the calculated quantity or zinc anodes that's needed to give complete protection shall be equally divided into two rows on both port and starboard sides of the hull. Half the anodes for each side shall be installed butted end-to-end, long axis fore and aft on the forward end of each bilge keel and half on the aft end of each bilge keel. As an alternate method, the anodes may be installed port and starboard just beneath the turn of the bilge, butted end-to-end and long axis fore and aft. Half the anodes for each side shall be installed forward of midships and the other, aft of midships. Where practical the rows shall be positioned to avoid passing over fuel tanks even though the rows become discontinuous. This precaution is taken to avoid "gas-freeing" the fuel tanks, in case welding is necessary to attach studs or straps for mounting the anodes.

(b) Stern Area The entire stern system, or 1/3 the anodes necessary for the complete hull system, shall be butted end-to-end with the axis fore and aft. They shall be located along the centerline keel or just beneath the turn of the bilge and divided equally between the port and starboard sides of the hull. If a large number of zincs are required for stern protection, it may be practical to increase the number of rows. However, in no case should the spacing between rows be less than four feet. Begin all rows at least five feet forward of the propeller plate and extend forward. Zincs shall be positioned so that the anodes are always 100% immersed under light load.

(c) Sea Chests. Zinc anode protectors conforming to shape and size as necessary will be attached to the interior of sea chests. No less than one 6-inch by 6-inch anode shall be provided for each sea chest. If nonferrous sea valves are fitted in conjunction with steel sea chests, a medium steel protection sleeve, to serve as a waster piece, should be fitted inside the sea chest at the junction of the sea chest and the valve. The sleeve should project down into the sea chest and be long enough so that it can be removed for replacement through the valve opening once the valve has been removed. As an alternative, the sleeve may be fitted in sections, which can be removed from the exterior of the ship through the sea chest.

(d) Internal Bilge Areas. Each compartment where water is held shall be considered for cathodic protection. Zinc anodes should be installed in all bilge spaces, which are subjected to water more than 50 percent of the time, and in those areas, which are susceptible to excess corrosion. One zinc anode (ZHC type) should be installed for every 250 square feet of steel surface. Bolt-on anodes should be used for this installation so that depleted anodes can readily be replaced by crewmembers. Anodes should normally be located on the garboard strake close to the centerline keel. Care should be taken to mask anodes when painting bilge spaces so as not to coat the zincs. Optimum functioning of the anodes depends upon the zinc being completely immersed in water and the surface being free of paint and excessive grease and oil.

(e) Salt Water Pumps. Zinc anodes should be located as close to the base of the pump as possible to protect against excessive corrosion due to salt-water leakage.

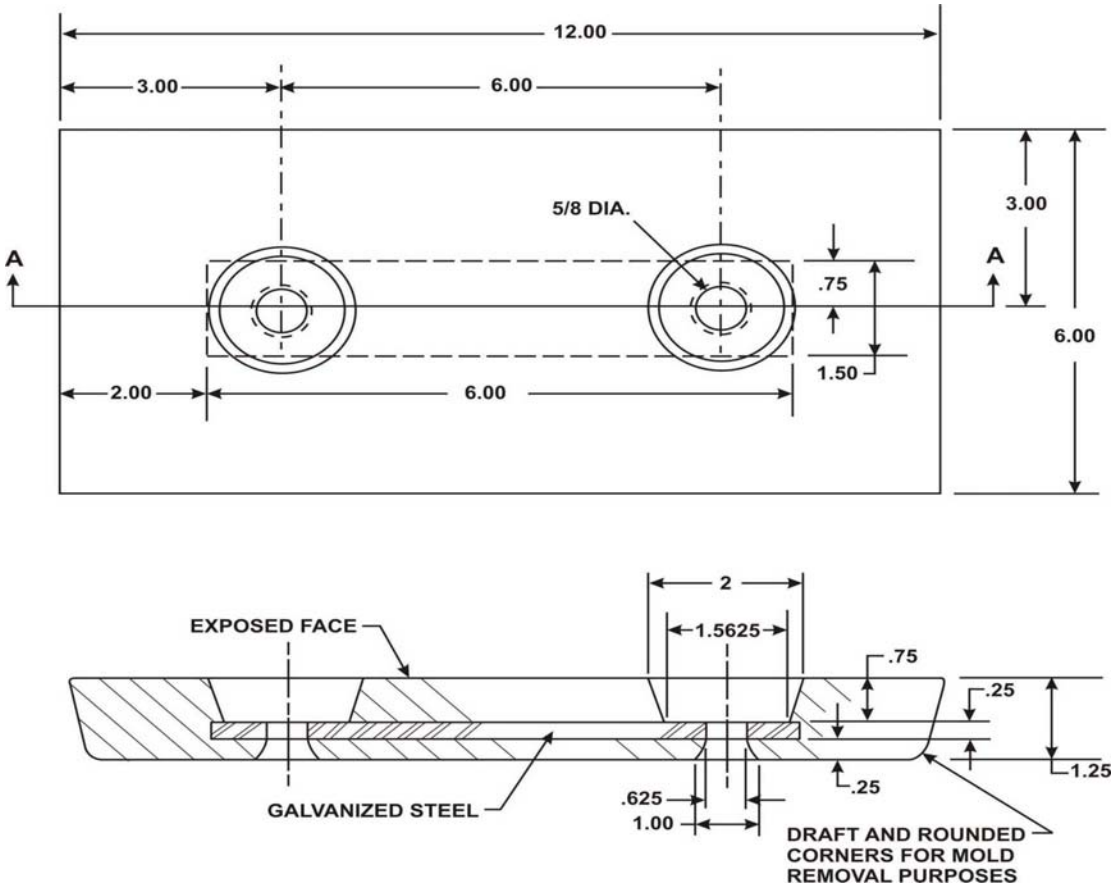

Figure 1-2. Bolting Pattern for type ZHC ZINC hull slab (core strap)

(f) Heat Exchangers and Condensers. Where required, zinc anodes of appropriate style and type must be installed.

(g) Dissimilar Metals Protection. Zinc anodes of an appropriate style and type should be installed whenever dissimilar metals (e.g. bilge pump strainers, valves and piping) are immersed in or frequently flooded with seawater (more than 50 percent of the time). Install anodes near the dissimilar metals junctions.

(8) Cathodic Protection for Aluminum Hulls. Cathodic protection shall be applied to aluminum hulled boats and ships in seawater. Sacrificial Zinc Alloy Anodes type ZHC shall be installed unless specific approval is granted for other systems. Doubler plates will be installed as per Figure 1-1.

CAUTION

Magnesium anodes and mercury bearing aluminum anodes shall not be used on aluminum hulls. Deviation from this will cause accelerated deterioration of the hull.

(a) Corrosion protection for the hull shall be provided by type ZHC zinc anodes.

(b) Calculate the quantity of hull anodes required for 2 years of protection.

N = 6.5W/1000; where N = the number of ZHC anodes and W = the total wetted surface area in square feet.

(c) Internal bilge areas shall be protected by 1 square foot of exposed zinc surface for each 200 square feet of coated surface or 50 square feet of bare metal. Anodes of type ZHC shall be used.

CAUTION

The nature of aluminum boats merits special attention for mooring locations, particularly next to steel ships, boats, buoys, and piers. Under these conditions it is essential that non-conducting mooring lines and insulating camel sections be used to prevent electrical contact of the aluminum hull with a steel structure since this could result in galvanic corrosion of the aluminum hull.

SECTION 2. SAFETY INFORMATION

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2-1. General. This section contains safety precautions for all aspects of paint handling and operations except for stowage. The storage of flammable and combustible liquids shall meet the requirements of National Fire Protection Association (NFPA) Flammable and Combustible Liquids Code, NFPA 30.

2-2. Painting Operations. The two most important factors with regard to a safe painting operation concern responsibility and training. Their importance shall be firmly established and clearly understood by all supervisors and personnel handling or applying any materials.

a. Responsibilities. At the level of actual operations, line supervisors are responsible for all operations; the gas-test and safety personnel are responsible for providing staff assistance to the line supervisors. The responsibility factor is also particularly important at those supervisory levels where painting work is coordinated with other types of work.

b. Training. Commensurate with their responsibilities and participation, all personnel connected with these operations shall be made aware of the hazards associated with the handling and use of flammable materials, as well as the appropriate safety precautions. This information shall be part of each individual's job training.

2-3. Supervisory Responsibilities. The supervisor shall plan the work and manage projects in such a manner as to produce the safest possible conditions. Personnel safety is the supervisor's prime responsibility. A safety checklist shall be used before a job gets underway. In addition, all supervisors shall adhere to the following program.

a. Always be aware of potential hazards in the area.

b. Be sure that each painter understands and accepts personal responsibility for safety and is informed of all safety rules.

c. Be sure that all safety measures have been taken before each work shift begins.

d. Insist that crewmembers work safely. Use disciplinary action in accordance with existing personnel directives, if necessary.

e. Be sure that all equipment meets safety standards. Use non-sparking tools in fire-hazardous areas. Anticipate possible risks with new types of equipment. Secure expert advice on potential hazards in advance.

f. Encourage personnel to discuss the hazards in their work. No job shall proceed if any question about safety remains unanswered. Be receptive to their ideas and suggestions; their field experience can be a source of information that will help prevent accidents.

g. Set a good example for the crew by demonstrating safety awareness in personal work habits.

h. Ensure personnel are using the proper respiratory protection for the hazard. A false sense of security can be created by using the wrong respirator. In addition, all personnel must be trained in how to wear respiratory protective equipment. An industrial hygienist or safety personnel should be consulted prior to start of work.

i. The following is an example of a supervisor's safety checklist.

(1) No smoking signs posted.

(2) Warning tags and signs posted.

(3) Required protective clothing and safety shoes.

(4) Required eye protection, available as needed.

(5) Required respiratory protection, available as needed.

(6) Buddy system setup, if warranted.

(7) Safety belts, harnesses, and tending lines, on hand as required.

(8) Toxic material control, as needed.

(9) Burn hazards (chemical, hot pipes, other).

(10) Falling objects.

(11) Moving objects, cranes, and other traffic considered.

(12) Location of safety showers and eye baths.

(13) First aid materials on hand.

(14) Location of fire alarm station.

(15) Fire extinguishers and fire blankets, on hand as required.

(16) Location of nearest telephone.

(17) Barricades, as necessary.

(18) Electrical hazards in vicinity taken into account.

(19) Working electrical equipment grounded.

(20) Spark proof tools, as required.

(21) Flammability and flashpoints of painting materials posted nearby stowed materials.

(22) Safety and fire permits secured.

(23) Gas Free Engineer's approval secured.

(24) Condition of ladders and scaffolding checked.

(25) Safe footing provided for workers.

2-4. Material Safety Data Sheets. The Material Safety Data sheet (MSDS) contains important information and phone numbers regarding the safe handling of a product. The manufacturer is required to supply an MSDS with each item (hazardous material). An MSDS should always be on hand in the event of an emergency, but even more importantly, the MSDS should be read and understood before beginning a job.

2-5. Product Data Sheets. The Product Data Sheet should be used whenever you work with any paint system. The data sheet contains information about recommended use, coating type, color, mixing ratios, cure times, cure temperatures, VOC content, thinning, pot life, shelf life, recommend film thickness, suggested application methods, surface preparation, and contact information.

2-6. General Painting Hazards. Every painting operation exposes maintenance personnel and others in the area to conditions and situations that are actually or potentially dangerous. Use of toxic and flammable materials, pressurized equipment, ladders, scaffolding, and rigging presents potential hazards. Hazards may also be inherent in working conditions or caused by operator inexperience, lack of training, or carelessness. Awareness of all potential hazards is therefore essential, because continuous and automatic observance of precautionary measures will minimize the danger and improve painting crew efficiency and morale. The following areas require alertness when painting operations are planned and executed.

a. Paint Materials. Most paint materials are hazardous to some degree. All except water-thinned paints are flammable, many are toxic, and others can irritate the skin.

b. Environment. Working conditions will vary from job to job. In addition to the hazards inherent in the painting operation, the painter may encounter other hazards in the work area itself. For example, slippery decks or obstacles located on decks may cause falls; electrical or mechanical equipment may produce shocks or other serious injuries; uninsulated steam lines or hot pipes may cause severe burns; fire hazards; or, too rapid evaporation of a solvent can create a toxic atmosphere.

(1) The working environment shall be studied before painters are sent into any work area. Hazards such as poor ventilation, noxious fumes, high temperatures, types of material and how they are applied, and the type of space where the work is to be done shall be considered. Before painters are allowed to enter the working area, they shall be protected by devices that will allow them to work in safety.

(2) Special action is required if any of the following conditions exist.

(a) If oxygen concentration is less than 19.5 percent.

(b) If combustible gas meter readings show differences between the workspace and outside air.

(c) If it is impractical, with on-hand equipment, to test the workspace atmosphere for known or suspected toxic vapors or gases (such as bilge gases, distillate fuels, kerosene, or Navy standard fuel oil).

c. Painting Crew. Lack of training, experience, or knowledge of hazards on the part of any painter produces a possible threat to the safety of the ship, painting crew, and others in the painting area. Carelessness of any painter will increase hazards. Shortcuts often produce unsafe working conditions resulting in accidents, personnel injuries, and loss of time and materials. An element of risk is present even when well-trained workers follow all prescribed safety procedures. Observance of all safety precautions at all times will reduce this risk to a minimum.

d. Equipment. Ladders, scaffolding, and rigging must be used for areas not readily accessible from the deck, pier, or dock. Pressure equipment is often used to prepare surfaces and to apply paint. All of this equipment can be hazardous if handled carelessly. Proper equipment setup, dismantling and cleaning, required safety checks, and observance of basic precautions for handling equipment may require more time than actual use of the equipment. Nevertheless, precautions shall never be omitted.

e. Respiratory Protection. Personnel shall wear the proper type of respirator in hazardous areas. All devices shall be approved by the National Institute for Occupational Safety and Health (NIOSH) and Mining Safety and Health Administration (MSHA). Respirators shall be selected, used, maintained and stored in accordance with TB MED 502, Respiratory Protection Program. Questions/concerns shall be addressed to the Industrial Hygienist or Safety Officer.

f. Exhaust Systems. When exhaust systems are used, the system must pull vapors or gases from the bottom of the tank or area in which the work is being done. The hazard potential of stagnant areas and pockets shall be recognized. A crewmember shall never work alone in a hazardous area. Exhaust system discharges shall be arranged so that the contaminated air will not create health hazards in surrounding areas.

g. Ventilation. If ventilation is required, outside air shall be provided at a minimum no less than that required to provide a safe, life-supporting atmosphere. If such ventilation is not possible, respiratory protective equipment shall be provided. Equipment required shall be determined by an industrial hygienist, medical personnel, or safety personnel.

h. Eye Protection. "Suitable eye protection shall be provided and worn where machines or operations present the hazards of flying objects, chemical splashes or mists, caustic substances, or any condition considered hazardous by the supervisor or the operation." Safety eyewear shall be kept clean and available. Crewmembers working with chemicals shall wear chemical safety goggles.

(1) If there is a chance of liquids splashing in a crewmember's face, a full-face shield should be used.

(2) "Portable eyewashes capable of providing 15 minutes of continuous irrigation to both eyes simultaneously with a flow rate of not less than 0.4 gallons per minute (GPM) shall be available "

i. Degree of Hazard. Each supervisor is responsible for ensuring that special precautions are taken, designating the equipment required, and advising the crew of the specific hazards of each job. Ignoring these hazards will increase the odds that accidents will occur. Relaxing of precautions in one job will inevitably lead to carelessness in subsequent jobs, regardless of the degree of hazard, eventually resulting in an unnecessary increase in accident rates.

2-7. General Safety Measures. Potential hazards that exist in all painting operations make a continuing and enforced safety program essential. A good safety program that has adequate safety procedures will provide protection against the three major types of hazards: accidents, fire, and toxicity. All personnel shall observe all established precautionary measures and safety rules, and shall be thoroughly familiar with all safety measures

a. General Health. Only personnel not sensitive to heights shall work on ladders, scaffolding, or rigging. Painting crews shall be composed of personnel who have a proper attitude toward safety and who are in good physical condition. The medical examiner shall determine that employees are physically able to perform work and use respirators.

b. Protective Clothing. Personnel shall wear adequate clean clothing and gloves to prevent skin contact with painting and cleaning materials. Clothing with cuffs, loose pockets or rips, and loose ties and jewelry shall not be worn since they are potential causes of hang-ups. The following precautions shall be adhered to with regard to protective clothing.

(1) Gloves, proper eye protection, and safety helmets shall be worn during abrasive blasting.

(2) Hard-hats and steel-toed safety shoes shall be worn wherever there is possible danger from falling objects.

(3) Nonskid, rubber-soled shoes shall be worn for work in enclosed spaces or where flammable vapors may be present (spark prevention).

(4) Acid-proof clothing shall be worn when handling acid or caustic cleaners.

(5) Acid-proof, air-supplied suits shall be worn when using acid or caustic cleaning materials in enclosed areas.

c. Buddy System. Personnel shall never work alone in hazardous areas. At least two crewmembers shall be assigned to such jobs with at least one additional person available for rescue work, should the person in the tank be overcome. (Personnel performing such duties shall be properly trained to perform tank rescue work. Additional personnel with such training should be available.) These individuals shall maintain communication with each other at all times during operations in hazardous areas. If an accident occurs in a tank or other confined space, the crewmember stationed on the outside must never enter the tank to give assistance alone, but shall seek the help of the additional person available for rescue work. Multiple deaths have occurred from failure to follow this basic precaution. Personnel entering tanks shall be equipped with suitable approved respiratory protective equipment, lifebelts or harnesses and lifelines. If the accident happens outside a confined space, the other crewmember can seek help or come to the aid of the injured one.

2-8. Inspection Safety Precautions. Safety precautions that shall be taken to ensure safety during inspection of tanks, voids, and other hazardous areas to be painted.

a. Pre-Entry Requirements. Do not enter any enclosed or poorly ventilated space until a Marine Chemist or Competent person has certified that the space is free of noxious fumes and flammable gases and sufficient oxygen is present. After the area is certified, the marine chemist or competent person may monitor the area to make sure the area stays within the limits.

b. Safety Equipment. Use necessary safety equipment. This may include hardhats, safety glasses, steel-toed rubber-soled footwear, gloves, coveralls, respirators, explosion-proof lights, and safety harnesses. Lifejackets and safety harnesses shall be worn when working near or over water. Lifelines shall have no more than 2 feet of slack so that the jolt from a fall will not cause injury.

c. Personnel Health. Do not smoke, eat, or drink inside a tank or other hazardous area. Wash hands and face thoroughly before smoking, eating, drinking, or using the toilet. Obtain medical attention immediately for fume inhalation and for any cuts or abrasions that are incurred during the inspection of these spaces.

2-9. Safety Precautions for Paint Mixing.

a. Shore Facilities. The mixing area shall be adequately ventilated to prevent personnel overexposure to solvents and other toxic materials. If possible, detached shops or temporary structures shall be provided for paint mixing and for storing paint buckets, brushes, and rags. Permanent structures created for paint mixing and storage shall be equipped with automatic sprinklers. Signs reading "NO SMOKING IN OR AROUND THIS BUILDING" shall be posted conspicuously inside and outside of each paint shop or other building in which paint is used, mixed, or stored. Only the quantity of solvent and paint needed for one workday shall be taken into the mixing area.

b. Afloat. Paint shall not be stowed in the mixing area. Mixing of paints, varnishes, lacquers, and their solvents shall be confined to the paint mixing room or other designated compartments. Paint products shall not be mixed in a closed compartment without adequate ventilation. Posted barricades or other suitable measures shall be provided to ensure that there is no smoking, open flame, or hot work within mixing compartments or in adjacent passageways.

2-10. Fire Prevention Precautions for Paint Mixing. Smoking, open flames (such as matches and torches), and hot work are prohibited in or near the area where paint, varnishes, lacquers, and their solvents are mixed. Spilled paint or solvents must be wiped up immediately to reduce fire and vapor hazards. Rags or other materials used for paint clean up shall be placed in a closed-top metal container for disposal. Specific fire prevention precautions are described below.

a. Electrical Equipment. In rooms where extensive paint mixing operations are carried on, electrical equipment shall be installed in accordance with Class I, Group D requirements of the National Electrical Code. Explosion-proof lamps with shatterproof lenses shall be used for lighting.

b. Firefighting. Authorized personnel, duty fire party, and damage control party using the mixing room, shall be informed of the location and instructed in the use of the firefighting equipment to be used on paint or paint-related fires. The firefighting equipment shall be readily accessible and escape routes from the area shall be prominently displayed.

2-11. Personnel Protective Precautions for Paint Mixing. These precautions apply to paints in general. Skin contact, eye contact, ingestion, and breathing mists or vapors in excess of the threshold limit value (TLV) shall be avoided.

a. Personnel Precautions. Personnel with a history of chronic skin diseases, allergies, or asthma shall not be permitted to work with paint compounds and thinners. Personnel who are sensitive to paint compounds and thinners shall be reported to the medical department.

b. Persons handling painting materials shall avoid contact of material with skin and eyes, and inhalation of mists or vapors. No food or drink shall be allowed in the paint area. When painting materials are handled, care shall be exercised to wash hands before eating, drinking, smoking, or using toilets.

c. Accidental Ignition. Extreme care shall be taken by persons mixing solvent-based paints to remove from their person all possible sources of ignition, such as matches, cigarette lighters, and steel buckles. Personnel shall wear nonskid, rubber-soled shoes or canvas boots over their shoes when working in an

enclosed space or where flammable vapors may be present. Plastic clothing shall not be worn. Non-sparking tools shall be used when working in areas where flammable vapors may be present.

d. Alkyd and Oil-Base Paints. This category includes most interior compartment and passageway paints, as well as exterior enamel. Personnel mixing these paints shall wear eye protection and gloves during mixing operations. Personal respiratory protective equipment (NIOSH-approved chemical cartridge or airline respirator) shall be worn if airborne solvent vapor concentrations cannot be controlled by ventilation. Protective cream, Chemical, Chemical Barrier (NSN 6580-00-244-4894), may be used on exposed skin to act as a barrier, and for easier cleaning after painting. Skin that is exposed to these paints shall be promptly cleaned with soap and water (not thinners).

e. Vinyl and Vinyl-Alkyd Paints. Personnel mixing vinyl coatings shall wear protective garments that fit snugly at the ankles, neck, and wrists, and solvent-resistant synthetic rubber or plastic gloves and an apron. NIOSH-approved respiratory protection shall be required when air-sampling data indicates solvent concentrations in excess of the exposure limit values, or when it is reasonable to assume that vapor concentrations cannot be controlled by ventilation and are expected to exceed the TLV for the thinner involved.

f. Epoxy Paints. These include epoxy-polyamide as well as some proprietary paints such as Amercoat, Carboline, Devran, Farbo-Coat, Intergard, Rust-Ban, Sovapon (Mobil) Tarset, and Varni-Lite products which are used for coatings of tanks, bilges, wet spaces, and some exterior surfaces. Personnel mixing epoxy paints shall comply with the precautions given in the paragraph above.

g. Because of the ingredients used in epoxy paint, health hazards such as skin inflammation and allergy reactions are greater. If epoxy coatings contact the skin, prompt skin cleanup is mandatory. Soap and water, not solvents, shall be used, as solvents thin the paint and spread it over the skin, thus increasing the hazard of irritation or allergic reaction. Medical attention should be secured if skin reddening or rash appears.

h. Coal Tar Epoxy Paints. Coal tar epoxy paints are recognized as having cancer-causing properties and shall not be used if acceptable alternatives exist. If coal tar epoxy paints must be used, personnel mixing these paints shall wear protective garments, which fit snugly at the ankles, neck, and wrists; an apron; rubber gloves; chemical worker goggles or a full-face respirator; head covering; canvas boots over their shoes; and an air line respirator. Exposed skin may be covered with a protective cream.

i. Epoxy Thinners and Solvents. Epoxy thinners and solvents used in mixing paints contain ingredients such as ethylene glycol monoethyl ether that are readily absorbed into the body through the skin. Particular attention to skin protection is necessary to prevent skin absorption from adding significantly to overall exposure, especially during cleaning of equipment.

2-12. Health Requirements for Painters.

a. Each command is responsible for ensuring that all painters are included in the installation/activity occupational health medical surveillance program and that they have an appropriate medical evaluation at least annually. This examination shall include all tests specific to the painting profession. Doctor performing examination shall be informed of painter's occupation and chemicals to which he is exposed.

b. Showers provided in the shop shall be used by each work shift after spray painting. In addition, personnel shall wash hands, arms, and face before eating, drinking, smoking, or using the toilet.

2-13. Safety Precautions for Paint Application. Safety precautions for paint mixing apply also to paint application.

a. Danger Area. For each painting operation, the local activity must define and clearly identify, by signs, those areas where there is a possibility that gases or fumes may collect, posing a hazard to painting personnel.

b. Paint Application. Precautions to be observed when paints are applied by brush, roller, or spray are the same as those for mixing paints; in addition, the potential hazards from flammable or toxic solvents are greater. Additional ventilation in confined spaces is needed. Depending upon location of the painting operation and type of paints being used, respirators and protective clothing may also be needed to comply with personnel protective precautions.

c. Ignition Sources. Steps shall be taken to ensure the absence of ignition sources while paint is being applied. Prohibited activities include welding, smoking, hot work, open flame, and the energizing of electrical circuits (except explosion-proof type) in the same and adjacent compartments and exterior work areas. Areas such as fire, engine, and pump rooms shall be in a cold-iron condition before and during paint application and until all paint fumes dissipate.

d. Highly Flammable Paints. Flashpoint labeling is a requirement for all paints and solvents. Personnel shall be instructed to read and understand container labels before using the paint product. The size of posted danger areas, amount of ventilation and degree of other fire and explosion preventive procedures shall be increased prior to use of low-flashpoint paint materials.

e. Epoxy Paints. Epoxy-polyamide paints and most interior and tank paints have a flashpoint of about 37.8ºC (100ºF). Commercial exterior epoxy paints and silicone alkyd surface ship topside enamels generally have flashpoints above 26.7 °C (80 °F). A few paints have lower flashpoints, some below 15.6 °C (60 °F), which present a much greater fire and explosion hazard.

f. Vinyl and Epoxy Paints. Personnel applying these paints by brush or roller should avoid skin contact with the paint and its components by wearing solvent resistant, synthetic rubber or plastic gloves, and an apron. Sleeves shall be kept rolled down. A face shield or chemical safety goggles shall be worn to protect the face and eyes. Protective cream, Chemical Barrier (NSN 6850-00-244-4894) may be used on exposed skin to act as a barrier, and for easier cleaning. Local exhaust or supply ventilation, or both, must be used to control personnel exposure to solvent vapors.

2-14. Application of Paint in a Confined Space. The following precautions shall be observed when painting the interior surfaces of a confined space, such as the inside of a tank.

a. Explosion-Proof Lamps. Explosion-proof lamps with shatterproof lenses, such as Crouse-Hinds Model RCD-6 or equal, shall be installed. Lights shall be completely and properly assembled and in operable condition prior to installation in the danger area. Bulbs shall not be replaced nor shall lights be repaired within the danger area. Portable lights shall be hung using spark proof hooks and not wrapped around nor draped over supports.

b. Gas-Free Testing. Periodic tests shall be conducted to ensure safe, gas-free working conditions. The Marine chemist or competent person should conduct the initial test, with monitors conducting the follow-up tests. During paint operations, gas testing shall continue as necessary to detect dangerous accumulations of hazardous vapors.

c. Ventilation. During painting operations, all tanks and enclosed areas shall be properly ventilated by installing explosion-proof ventilation equipment. There is a possibility that vented paint vapors will create an explosion hazard outside the tank or compartment being painted. Therefore, venting and ventilation shall continue for at least 1 hour after the operation has been completed, and until vapor concentrations remain below 10 percent of the lower explosive limit (LEL).

2-15. Application by Spray. Due to the volume of material applied, the application of paints, varnishes, lacquers, enamels, and other flammable liquids by the spray process is more hazardous than brush application. Potentially harmful mists created by paint spraying operations add to the health hazard. Spraying also deposits a flammable residue, which is subject to spontaneous ignition. The following precautions for paint spraying include those for mixing and paint application.

a. Fire Prevention Precautions. During spray painting, precautions, in addition to those for brushing or mixing, are necessary to prevent static sparking and excessive flammable solvent concentrations. Danger areas shall extend at least 50 feet from the painting operation, and may include an entire dry-dock in cases of extensive painting with highly flammable paints. Rope off and post "DANGER AREA" signs near the painting operation to alert personnel to the hazard. These signs must designate the danger area and prohibit smoking, hot work, and open flame. All electrical leads within the danger area shall be sealed and all equipment requiring grounding shall be grounded. During spray-painting operations, fire-extinguishing equipment shall be in the ready condition.

b. Protective Clothing and Gear. Spray painters shall wear gloves and protective garments that fit snugly at ankles, neck, and wrists. They shall wear filter respirators approved for the operation being performed, i.e., spraying, mixing, or handling materials, which create flammable vapors. Spray gun mists must never be inhaled.

c. Showers. If paint-spraying operations are extensive, showers should be available and operators should shower after every shift.

d. Vinyl and Epoxy Paints. Personnel spray-painting with epoxy paints in other than approved spray booths must wear coveralls, gloves, and NIOSH-approved airline respirators, which provide full-face coverage. The air supplied to the respirator must be approved for use as breathing air. Approved goggles shall be worn except when eye protection is provided by air-supplied respirators or hoods. Exposed skin areas may be covered with protective cream. The same precautions apply to the application of vinyl paints, except that NIOSH-approved organic vapor respirators may be substituted for airline respirators when work is done in open exterior spaces. When these coatings are applied overhead or on surfaces above waist level; approved hoods, which completely protect the head, face, and neck, shall be worn.

2-16. Airless Spray Safety Precautions. Personnel shall receive complete instructions in the proper use of airless spray equipment before being permitted to operate the equipment or to assist the operators. Training shall stress the potential dangers associated with handling of airless spray equipment, as well as the built-in safety features designed to minimize these dangers. The airless spray method uses a pump to deliver high-pressure fluid to the small, spray-tip orifice. This high-pressure (300 lb/in $_2$) system is potentially hazardous. Amputations and deaths have resulted from careless use of this equipment, particularly when spray tips are removed for cleaning. Before a spray tip is removed or adjusted and when spray operations are shut down for an extended period, it is mandatory that electrical pumps be shut OFF, and that the gun trigger is depressed to bleed line pressure.

2-17. Health Hazards and Personnel Exposure Limit Values for Certain Paint Ingredients.

Specific precautions related to hazardous paint ingredients are described in the following paragraphs. Assistance shall be obtained from the Industrial Hygienist or Safety Officer.

a. N-Butyl Alcohol. Exposure to vapors produces irritation of nose, throat, and eyes. The Threshold Limit Value (TLV) is currently set at a ceiling level of 50 ppm (parts per million) by the Committee of the American Conference of Government Industrial Hygienists (AGGIH). Butyl alcohol also causes contact dermatitis. Skin absorption through direct contact with the liquid can add significantly to overall exposure and must be prevented.

b. Dichloromethane. This is volatile solvent, mildly irritating to the skin and eyes. Inhalation of its vapors can produce drunkenness and narcosis. The TLV (ACGIH) for dichloromethane is currently 100 ppm with a Short Term Exposure Limit (STEL) of 500 ppm.

c. Epoxy Resin (Uncured). This is primarily a skin irritant and possible skin sensitizer. Exposure to epoxy resins in the uncured form shall be minimized. Repeated or prolonged skin contact will dry and defat the skin.

d. Ethylene Glycol Monobutyl Ether. This chemical is moderately toxic if taken orally. It is irritating and injurious to the eyes, but is not significantly irritating to the skin. It is readily absorbed through the skin in toxic amounts and is moderately toxic if inhaled. The current TLV is 25 ppm with a STEL of 75 ppm. It is currently under study for its potential for adverse reproductive effects. The low volatility of ethylene glycol monobutyl ether at room temperature considerably reduces the hazard of toxicity from inhalation. Skin absorption through direct contact with the liquid can add significantly to overall exposure and must be prevented.

e. Ethylene Glycol Monoethyl Ether. This chemical is low in oral toxicity and is not significantly irritating to skin. However, it is readily absorbed through the skin. The current TLV is 5 ppm. It is currently under study for its definite potential for adverse reproductive effects. Skin absorption, if not prevented, can add significantly to overall exposure.

f. Formic Acid. This acid produces severe primary damage to skin, eyes, and mucous membranes. It is suspected that the presence of formic acid in paint remover could, through destruction of skin tissue, accelerate the absorption of phenol, and their toxic components. The recommended personnel inhalation TLV (ACGIH) is 5 ppm.

g. Methyl Ethyl Ketone. This chemical can irritate eyes and mucous membranes. Repeated skin contact with the liquid may cause skin dryness and irritation. Exposure to vapor levels above its 200 ppm TLV (ACGIH) may cause narcotic effects.

h. Methyl Isobutyl Ketone. The effects of this chemical are the same as those for methyl ethyl ketone, except that the TLV (ACGIH) is 50 ppm with a STEL of 75 ppm.

i. Methyl Butyl Ketone. The effects of this chemical are the same as those of methyl ethyl ketone, except that it can also cause nervous system damage. Its TLV (ACGIH) is 1 ppm. An industrial hygienist, or NRMC Occupational Health Service, shall be consulted before using methyl normal butyl ketone.

j. Paint Thinner, Mineral spirits, Type II, Grade A, Boiling Range 150° C-210°C (302°F-410°F). Paint thinner vapors are mildly irritating to mucous membranes. Repeated or prolonged skin contact with paint thinner will dry and defat the skin, resulting in irritation and dermatitis. The personnel TLV (ACGIH) for Stoddard Solvent, which is comparable to Type II, Grade A, is 100 p/m.

k. Phenol. This hazardous chemical is highly toxic when ingested, inhaled, or absorbed through open or intact skin. Death has been reported to result from absorption of phenol through a skin area as small as 64 square inches. Death from acute exposure to phenol may occur within 30 minutes. The current TLV is 5 ppm.

l. Polyamide. Polyamide has mild skin irritant and skin sensitizing properties.

m. Super High-Flash Naphtha, Boiling Range 157°C-179°C (153°F-353°F). This chemical contains up to 98 percent aromatic hydrocarbons. Some of the aromatics in high-flash naphtha (for example, mesitylene) are highly toxic by inhalation. However, the low vapor pressure of these components reduces the inhalation hazard when the solvent is used in ventilated areas. Inhalation of the concentrated vapors can cause headache, nausea, and coma.

n. Lead Chromate and Zinc Chromate. These chromates are classified as suspected carcinogens by ACGIH and shall be handled and used accordingly. Whenever possible, materials of lesser toxicity should be substituted. Overexposure to chromates may result in nasal septum ulceration and respiratory tract irritation. The TLV has been set at 0.05 mg/m3 (milligrams per cubic meter of air).

2-18. Safety Precautions and Requirements for Abrasive Blasting. The safety precautions and requirements that shall be taken to prevent introduction of abrasive-blasting materials into ship spaces and unprotected equipment, and to prevent injury and property damage, are described below. These precautions apply to all abrasive blasting operations on and within the vicinity of US Army watercraft.

a. Preoperational Requirements. Abrasive blasting shall not be undertaken until positive steps have been taken to prevent contamination and spread of abrasives and dust to adjacent compartments, machinery, and equipment. Abrasives and dust can enter ships through open sea valves, hatches, ventilation systems, temporary openings, normal entryways, which are frequently opened and closed, and entryways, which must remain open to accommodate other work. If there is any possibility that abrasives can enter a ship or ship's compartment in spite of all possible precautions, critical machinery surfaces and parts, and electric and electronic equipment, shall be positively sealed or otherwise protected. Machinery components, such as reduction gears, open boilers, hot wells, and turbines in various stages of disassembly, are especially subject to damage from contamination.

(1) Prior to blasting operations, the responsible shop shall notify ships force, and all other ships in the vicinity, of time and location of proposed abrasive blasting operations. All shops and ships force shall take the following precautions to protect equipment and structures.

(a) Drop cloths and masking shall be used to prevent damage from the abrasive material.

(b) Temporary shields and other sealing or closing-off measures shall be used to prevent abrasives from entering machinery, pipes, seawater inlets, and pump wells through various openings.

(c) Where remote service connections provide water or ventilation, such as seawater from the auxiliary seawater system while the ship is in dry-dock, the inlet to that connection shall be positioned and measures taken to prevent the entry of blasting contaminants.

(d) Additional precautions shall be taken to the extent necessary to protect adjacent ships, buildings, and stores.

(2) Personnel in or near the blasting area shall be warned of blasting operations. In all circumstances, close cooperation between ship and shipyard personnel is required.

(3) The entire area to be blasted shall be visually inspected. Heavily rusted or corroded areas and damaged metal and holes in the structure or piping shall be checked to determine if technical examination is warranted and for possible repair prior to blasting. Abrasive blasting hoses routed through compartments shall be identified by an appropriately marked sign posted in each compartment, warning against damaging the hoses.

b. Post-Operational Requirements. After any blasting or contamination of ship interior, the equipment or components blasted or contaminated by abrasive dust shall be cleaned and tested prior to being put into service. The entire area shall be visually inspected for pits, scabs, and scars. Suspected wall thickness reductions shall be reported for further technical examination.

c. Blasting Unit Operational and Maintenance Safety Precautions. Commercial facilities will follow OSHA standards.

d. Audio-Visual Operating Signals. The supervisor shall review audio-visual signals, operational procedures, and safety precautions weekly with all personnel directly involved in blasting operations. A signal horn (or buzzer) and a light mounted on the machine shall be used to establish positive communication from each blast operator to the machine operator or pot tender where there is no visual contact. Hand signals may be used when there is visual contact. Audio and visual signals shall be standardized and posted on each blasting unit, including signals for close choke valve, open choke valve, more abrasive, and emergency.

e. Protective Equipment. All blast operators shall wear hoods and airline respirators or air helmets of the positive-pressure type. Other mandatory clothing includes rubber or leather gauntlet gloves, safety shoes, and coveralls. The blast operator shall wear a safety belt or harness when working on staging or other elevated places. Personnel other than blast operators, including machine operators and personnel

engaged in work near abrasive blasting operations, shall wear full eye protection and NIOSH-approved dust respirators. Approved ear protectors shall be worn wherever the airborne noise level is above 85 dBA. Both earplugs and earmuffs (double protection) shall be worn if the noise level exceeds 108 dBA.

f. Staging shall be stable and correctly positioned for the safety, convenience, and comfort of the blast operator.

g. Operating Safety Precautions. The nozzle shall never be pointed in the direction or ricochet line of another person, even with the air and abrasive stream shut off. The blast operator shall always keep hands and other parts of the body away from the discharge and the nozzle, and shall never try to adjust the nozzle while the abrasive stream is flowing.

h. Hose shall be secured, leaving only enough free length to be handled safely by the blast operator. All hoses, fittings, and so forth shall be inspected before blasting begins; worn parts shall be discarded. When couplings are located where sudden parting would be hazardous, both coupled hoses shall be secured to a strong support or to each other.

i. Abrasive blasting equipment shall be properly maintained because operation of damaged or poorly maintained equipment at high pressures is dangerous.

j. Whenever practical, hoppers and hopper tenders should be located on top of dry-dock walls rather than in the basin. This improves housekeeping and permits grit flow to be aided by gravity. Minimizing the number of people who must be in the dock basin reduces the risk of injury if a hose or connection should break, causing the hoses to whip.

2-19. Abrasive Blasting Limitations for Steam Plants. Abrasive blast cleaning of installed (onboard) steam plant components is prohibited. Blast cleaning of installed tanks is allowed; provided the following listed conditions are met, in addition to the other requirements of this section.

a. All piping ends and other tank openings shall be plugged to preclude spread of blasting materials.

b. All internal tank parts must be accessible for hand cleaning (to ensure removal of all blasting material prior to plug removal).

c. When large hull tanks are blasted, sealing the blast operator in the tank may be a practical way, if space permits, to preclude contamination or damage to other equipment or components. When this appears practicable, advance National Maintenance Point (NMP) approval shall be obtained for proposed procedural details, including safety precautions. If this is not practicable, equipment and components must be protected by methods such as those specified in paragraph 2-18 above.

2-20. Safety Precautions for Hydro blasting. Although not considered as hazardous as abrasive blasting, hydro blasting uses water at high pressure that can cut through the body, causing serious injury or death. The abrasive blasting precautions and the special precautions given in the following paragraphs, shall apply when abrasives are injected into the water stream.

2-21. Safety Precautions for Electrically Operated Power Tools. Portable power tools shall be equipped (by manufacturer or modification) with a safety throttle/lock-off device or a protected throttle switch to prevent inadvertent startup caused by tools being dropped, bumped, or stepped on. Precautions for power tools are described below.

a. Inspection. Portable power tools shall be kept cleaned, oiled, and repaired. Tools shall be carefully inspected before use; switches must operate, cords shall be clean and free from defects, and plugs shall be clean and sound. The switch on a tool shall be in the OFF position at the time the tool is plugged into a receptacle. Tools shall be stored in a clean, dry place.

b. Grounds. Metal-cased portable tools shall be fitted with three-pronged plugs. Portable tools with double insulated plastic cases are designed to be electrically safe without the use of a three-pronged plug. A two conductor flexible cable and a two-pronged plug suitable for use with grounded type receptacles may be used for all such equipment. Double-insulated tools with metal gearings and housings with a two-pronged converter are also acceptable.

c. Fire Hazards. Portable electric tools with brushes (sparking) shall not be used where flammable vapors; gases, liquids, or explosives are present.

d. Cord Care. Cords should not be allowed to kink, nor be left where they might be run over. Cords must not encounter sharp edges, hot surfaces, oil, grease, water, or chemicals. A damaged cord shall be replaced, not repaired. Patching cords with tape or any other substance is prohibited. Tools shall be stored with cords loosely coiled.

e. Extension Cords. Only three-wire extension cords with three-pronged plugs and three-slot receptacles shall be used. Because a metal hull ship is a hazardous location, personnel using a portable electric device connected to an extension cord shall plug the device into the extension cord before the extension cord is inserted into a live bulkhead receptacle. Likewise, the extension cord shall be unplugged from the bulkhead receptacle before the device is unplugged from the extension cord.

2-22. Safety Precautions for Pneumatic Tools.

a. Personnel. Only authorized and trained personnel shall operate pneumatic tools. Operators using pneumatic tools shall wear and use necessary protective devices, including hearing protection. Personnel with arthritis, neuritis, or circulatory disease shall be examined by a Medical Officer to determine if their medical condition might be aggravated if they were to operate vibrating tools such as pneumatic hammers, chisels, tampers, riveters, or corkers.

b. Inspection. Pneumatic tools shall be thoroughly inspected at regular intervals. These tools shall be kept in good operating condition, and particular attention should be given to valves, hose connections, guide clips on hammers and chucks of reamers and drills during the inspection. All pneumatic tools should be labeled as hazardous noise sources.

c. Disconnection. Pressure shall be shut off and bled from the line before a pneumatic tool is disconnected. The tools shall be fitted with a quick-disconnect fitting and, when the tool is not in use, it shall be disconnected from its supply hose.

d. Air Hose. The air hose shall be rated for the pressure required for the tool. Leaking or defective hoses shall be removed from service. Hoses shall be laid to avoid creating a tripping hazard, particularly on ladders, steps, scaffolds, and walkways. Hoses that are run through doorways shall be protected against damage caused by the door edge. An air hose shall never be pointed at any person.

e. Compressed Air. Compressed air shall not be used to clean clothing being worn, nor shall it be used to blow dust off the body. Compressed air shall never be used as a power source for a projectile or to clean the deck or space where the pneumatic tool was used.

2-23. Safety Lock-Off Devices.

a. Definition. A safety lock-off device is any operating control, which requires positive action by the operator before the tool can be turned on. The lock-off device shall automatically lock the throttle in the OFF position when the throttle is released. Two consecutive operations by the same hand shall be required, first to disengage the lock-off device and then to turn on the throttle. The lock-off device shall be integral with the tool, shall not adversely affect the safety or operating characteristics of the tool, and shall not be easily removed. Devices such as a deadman control or quick-disconnect, which do not automatically and positively lock the throttle in the OFF position when the throttle is released, are not safety lock-off devices.

b. Action. Shore activities shall establish a program to replace the existing inventory of portable pneumatic grinders and reciprocating saws with grinders and saws equipped with safety lock-off devices. This conversion shall be accomplished by purchasing such tools equipped with safety lock-off devices to replace existing grinders and saws as they are retired, except as prescribed below.

(1) Initiate immediate procurement to obtain a supply of new grinders and saws with safety lock-off devices to be used on high-value work where inadvertent tool activation could cause significant material damage.

(2) Issue directives, which specify that only portable pneumatic grinders and reciprocating saws equipped with safety lock-off devices, shall be used on high-value work.

(3) Prohibit purchase of portable pneumatic grinders and reciprocating saws lacking safety lock-off devices.

2-24. Safety Precautions for Solvent and Chemical Cleaning. These safety precautions apply to chemicals used to clean painted areas. Paint removers or strippers have additional special precautions, which are listed in paragraph 2-25.

a. Solvent Cleaning. Personnel protection, fire prevention, and ventilation requirements for solvent cleaning are the same as those specified for mixing and applying paint (see paragraph 2-13).

b. Chemical Cleaning. Chemical cleaning ferrous metal surfaces of surface ship bilges is approved for use only on surface ships at shipyards and shall not be used at any other location. This method shall not be used on or near aluminum.

c. Chemical Cleaning Materials. Chemical cleaning materials include sodium hydroxide (lye), sodium gluconate, and detergent. Alkaline powders and solutions constitute an extreme personnel hazard if improperly handled. Concentrating or heating solutions is ordinarily prohibited because it compounds the danger. These solutions may permanently damage or burn the eyes, severely burn skin and damage tissue, and cause death or severe injury if swallowed. Mists and dusts may severely irritate the eyes, nose, and throat.

d. Caustic Solutions. Caustic solutions shall not be prepared or stored in wide-open steel tanks. The tanks used for storage shall have a small tank opening and shall be closed during storage. Caustic solutions shall be transferred through alkali-resistant pumps and lines. Entry into bilges containing caustic solutions is prohibited. If entry is imperative, the caustic solution shall first be removed. Personnel shall consult an Industrial Hygienist or Safety Personnel for safe entry measures, if entry is necessary.

e. Personnel Safety Precautions. Personnel shall be thoroughly instructed regarding the hazards of using chemical cleaning materials. Personnel working in areas where chemical solutions are being used, prepared, or transferred shall be dressed in clothing impervious to the chemicals. This includes splash goggles or face shields. Treadle-actuated, whole-body showers and eyewashes shall be provided near work areas where caustic solutions are prepared, used, or stored.

2-25. Safety Precautions for Paint Strippers and Removers. Paint strippers and removers present one or more of the following hazards: fire, anesthetic, toxic, or caustic. Accident investigation results indicate that extreme handling precautions are required because of these hazards and the number of different formulations involved.

a. Paint Strippers and Removers. Paint strippers containing phenol are considerably more toxic than most shipboard paints or solvents. Phenol is readily absorbed through the skin and may cause serious illness, or even death, if not washed off promptly. In the case of phenol-containing paint removers (manufacturers recommendations for safety equipment shall be observed by personnel using these products), personnel protection includes, as a minimum, solvent-resistant synthetic rubber gloves and

boots, solvent-resistant suits or coveralls, and rubber-framed goggles and face shields. Full eye protection with respirators or air-supplies hoods is mandatory whenever the atmospheric limits for the air contaminants are exceeded. Personnel not essential to the paint stripping operation should be evacuated.

b. Accidental Contact. Clothing wetted with paint remover shall be removed immediately and not reworn until laundered. If paint remover contacts the skin, flush off immediately with large quantities of water. If remover enters the eyes, flush with running water for at least 15 minutes with the eyelids held open. Medical attention must immediately be obtained. Personnel using paint removers must have ready access to a safety shower and eyewash fountain.

c. Prohibited Use. Paint strippers or removers shall not be used on fiberglass-reinforced plastic laminates, other plastics, electrical insulators (other than ceramic), or other materials, which may be damaged by the stripper. Caustic strippers shall not be used on aluminum, magnesium, or zinc.

d. Personnel Protective Procedures. Paint strippers or removers shall not be used until personnel protective guidance for the specific proposed use has been obtained from an Occupational Health Service. Other paint removal methods shall be used (see paragraphs 2-17 through 2-24 for applicable precautions) if personnel protective guidance cannot be practicably implemented.

2-26. Safety Precautions for Polyurethane Coatings. Once cured, polyurethane coatings present no special health hazards but do present special problems during mixing, application, and curing because of the possibility of free isocyanate vapors being liberated.

WARNING

Vapor

These isocyanate vapors can cause irritation of the skin, eyes, and respiratory tract. Isocyanate vapors can cause severe allergic reactions in sensitized individuals and may produce asthma-type symptoms. The material safety data sheet shall be reviewed prior to using this product.

SECTION 3. SURFACE PREPARATION

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3-1. General. The best quality paint will perform effectively only if applied to a surface, which has been properly prepared. The initial cost of adequate surface preparation is justified because of the increase in durability, and the achievement of the maximum coating life with minimum repairs and repainting.

3-2. Surface Preparation. Preparation will be performed in accordinance with the manufactures recommendations

3-3. Painted Surfaces. Preparation of painted surfaces includes the removal of surface contaminants, corrosion, old paint, moisture, blending (touchup paint), and roughening the surface (old paint in good condition). Personnel working on surface preparation shall wear approved hearing protective devices and given periodic audiometric examinations. All noise hazard areas will be marked with appropriate warning signs.

WARNING

Ear protection

Flying particles

All personnel must wear eye and ear protection during surface preparation.

3-4. Removing Surface Contaminants. Surface contaminants must be removed to ensure proper coating adhesion and minimize the possibility of defects such as blistering, peeling, flaking, and under film rusting. Surfaces to be painted for preservation must be completely free of mill scale, rust, loose paint, dirt, oil, grease, salt deposits, and moisture. To prevent embedding contaminants during surface preparation, oil or grease must be removed before using power tool or abrasive-blast surface preparation. Rusted surfaces shall be freshwater rinsed, where practicable, to remove water-soluble contaminants before abrasive blasting or additional surface preparation by other means. Weld spatters and flux compounds should be removed by grinding or chipping.

a. All exterior hull surfaces and floodable tanks shall be pressure washed 1500 to 2500 PSI prior to mechanical cleaning or blasting to remove salts and chlorides. This will prevent contamination of the new paint system.

b. Removing Old Paints. In touchup painting for preservation, when only localized areas or spots need attention, removal of old paint must go beyond the visibly defective areas until an area of intact and adhering paint film is attained, with no rust or blisters underneath. The edges of tightly adherent old paint remaining around the area must be tapered (feathered) to allow proper blending and prevent laying new paint over loose or cracked paint. When painted surfaces show evidence of corrosion, peeling, blistering checking, scaling, or general disintegration, the paint is to be removed down to the bare surfaces.

c. Preparing Old Paint in Good Condition. Old paint in good condition provides an excellent base for repainting. When a surface is to be repainted and the old paint is not to be removed, the surface shall be roughened with an abrasive, cleaned, and dried before new paint is applied. Roughening may be omitted when hydro blasting of underwater hull areas results in clean vinyl anti-fouling paint showing the original red or black color. Roughening may also be omitted where painting is being done for appearance, rather than preservation, and some peeling or flaking can be tolerated.

3-5. Metallic Surfaces. Blast cleaning is the most effective and the preferred method of preparing metallic surfaces for painting. If abrasive blasting is not specified or permitted, mechanical means shall be used. If the surface to be painted is subject to flash rusting, blast-clean only the area that can be coated with paint immediately, before flash rusting can occur.

a. Steel Surfaces. When blasting to bare steel is specified or required, surfaces shall be cleaned to near-white condition, as prescribed in paragraph 3-17.b. Near White Metal Blast.

b. Aluminum Surfaces. Aluminum surfaces shall be cleaned free of corrosion products, dirt, and other contaminants by light abrasive blasting. Use of 80-grit aluminum oxide or garnet abrasive at 65 lb/in^2 pressures has resulted in satisfactory aluminum surface preparation, with minimum metal removal.

NOTE

The abrasive sanding discs used on aluminum must not have been used previously on other metals or to remove copper or mercury pigmented paints.

c. Spot Cleaning. Spot cleaning after blasting can be done by power brushing or orbital sanding. For cleaning aluminum, only use clean dry sand, stainless steel wire brushes, stainless steel pads, or abrasive sanding discs. If the cleaned aluminum surface is not painted immediately or becomes contaminated with oil or grease, the surface shall be washed with a liquid detergent cleaner, rinsed with fresh water, and allowed to become completely dry before paint is applied.

3-6. Plastic Surfaces. Plastic surfaces requiring painting shall be lightly roughened. All extraneous matter shall be removed by washing with detergent, rinsing, wiping with a solvent, or by other suitable means. Glazed surfaces shall be sanded to promote adhesion.

3-7. Surface Cleaning Methods. The goal of surface cleaning is to provide a roughened surface, which is free of contamination and gouges or sharp projections. Roughening is necessary to attain the

necessary anchor pattern for good paint adhesion. Surface cleaning methods vary with the type of surface preparation needed, location, and size of the area being cleaned. Cleaning standards listed below conform to the standards established by the Steel Surfaces Painting Council. Standards are identified by the prefix SP followed by the standard number.

3-8. Solvent Cleaning SP-1. Solvent cleaning prepares surfaces by removing oil, grease, dirt, chemical paint stripper residues, and other foreign matter prior to painting or mechanical treatment. Solvents clean by dissolving and diluting to permit contaminants to be wiped or washed off the surface.

a. Solvent Cleaning Procedures. The simplest procedure is to first remove soil and dry materials with a wire brush. The surface is then scrubbed with brushes or rags saturated with solvent, and clean rags are used to rinse and wipe dry. Immersing the work in the solvent or spraying solvent over the surface is a more effective method. With either method, the solvent quickly becomes contaminated, so it is essential that several clean solvent rinses be applied. Under normal conditions mineral spirits is an effective solvent for cleaning.

b. Solvent Safety Precautions. Toxic solvents and solvents with low flashpoints present serious hazards to health and safety. Solvents shall not be used for cleaning if their flashpoints are below 37.8°C (100°F), or their maximum allowable concentrations (MAC) are less than 100 p/m. Safety precautions to be followed are described in paragraph 2-24. Safety Precautions for Solvent and Chemical Cleaning.

c. Recommended Solvents. Solvents recommended for cleaning surfaces prior to painting are:
Mineral spirits, NSN 8010-00-558-7026 (5 gallons).

3-9. Hand Cleaning SP-2. Hand cleaning will remove only loose or loosely adhering surface contaminants, including loose mill scale, loose rust, and loosely adhering paint. Hand cleaning is not to be considered an appropriate procedure for removing tight mill scale and all traces of rust; it is primarily recommended for spot cleaning in areas where corrosion is not a serious factor.

CAUTION

Removal of contaminants by hand cleaning must be done carefully to avoid deep tool marks or gouges on the surface.

a. Before hand cleaning, the surface must be free of oil, grease, dirt, chemicals and water-soluble contaminants, all of which can be removed with solvent cleaners and freshwater rinsing. Impact tools, such as chipping hammers, chisels, and scalers shall be used to remove rust scale and any heavy buildup of old coatings. Use vacuum or other removal methods to clean the area of dust and debris. Start painting as soon as possible after cleaning.

b. In those situations where areas are not accessible to power tools, hand-cleaning methods may have to be used. Since hand cleaning will remove only the loosest contamination, careful application of primers is required; preferably by brushing to thoroughly wet the surface. To achieve satisfactory results, all applied coats must be capable of overcoming the interference of contaminants left behind after hand cleaning.

3-10. Power Tool Cleaning SP-3.

a. Cleaning. Power tool cleaning methods will prepare surfaces faster and better than hand tool methods. Power tools are used for removing small amounts of tightly adhering contaminants that hand tools cannot remove; but compared with blasting, they are uneconomical and time consuming for removal of tight mill scale, rust, or old coatings from large areas. Power tools are driven either electrically or pneumatically and the basic units include a variety of attachments. Before power tool cleaning, the surface must be free of oil, grease, dirt, chemicals, and water-soluble contaminants, all of which can be removed with solvent cleaners and fresh water rinsing. If oily residue is detected after power tool

cleaning, solvent cleaning should be repeated. Painting must be started and completed as soon as possible after power cleaning.

b. Types of Power Tools. Chipping hammers are used to remove tight rust, mill scale, and old paint from large metallic and masonry areas. Wire brushes (cup or radial) are used to remove loose mill scale, old paint, weld flux, slag, and dirt deposits. Grinders and sanders are used to smooth excessively rough surfaces. As with hand tools, care must be exercised with power impact and grinding tools so they do not cut too deeply into the surface, resulting in burrs that are difficult to cover and protect satisfactorily. Care must be taken when using wire brushes to avoid polishing metal surfaces, which would prevent adequate adhesion of subsequent coatings.

3-11. Safety Precautions and Requirements for Power Tool Cleaning. Goggles face shields, or similar protection against flying particles should be worn. In addition, gloves, aprons, and leggings may be advisable if there is a problem with hot sparks. Respiratory protection filter masks should be provided for prolonged exposure. These tools should not be used near readily ignitable materials or within 50 feet of volatile flammable liquids, such as those used in cleaning and painting. In addition, operations should not be conducted where there is the possibility of the presence of combustible gases.

3-12. Abrasive Blasting. Abrasive blasting is the preferred method for preparing metal surfaces. Blast cleaning abrades and cleans through high-velocity impact on the surface with sand, metal shot, metal and synthetic grit, or other abrasive particles. The abrasive is discharged, either wet or dry, under pressure. The wet system differs from the dry in that a solution of water and rust inhibitor is incorporated with the blast abrasive. The rust-inhibiting solution either is mixed with the abrasive in the pressure tank or is introduced into the blast stream just behind, or just in front, of the blast nozzle. All blasted metal surfaces require that prime painting be started and completed the same day to prevent new rust from forming. Blast-cleaned surfaces are subject to rapid rusting if not coated.

3-13. Safety Precautions and Requirements for Abrasive Blasting. The safety precautions and requirements that shall be taken to prevent introduction of abrasive-blasting materials into ship spaces and unprotected equipment, and to prevent injury and property damage, are described in paragraph 2-18. These precautions apply to all abrasive blasting operations on and within the vicinity of US Army Watercraft.

a. Preoperational Requirements. Abrasive blasting shall not be undertaken until positive steps have been taken to prevent contamination and spread of abrasives and dust to adjacent compartments, machinery, and equipment. Abrasives and dust can enter ships through open sea valves, hatches, Ventilation systems, temporary openings, normal entryways, which are frequently opened and closed, and entryways, which must remain open to accommodate other work. If there is any possibility that abrasives can enter a ship or ship's compartment in spite of all possible precautions, critical machinery surfaces and parts, and electric and electronic equipment, shall be positively sealed or otherwise protected. Machinery components, such as reduction gears, open boilers, hot wells, and turbines in various stages of disassembly are especially subject to damage from contamination.

(1) Prior to blasting operations, the responsible shop shall notify all other ships in the vicinity, of time and location of proposed abrasive blasting operations. All shops and the ships force shall take the following precautions to protect equipment and structures:

(a) Drop cloths and masking shall be used to prevent damage from the abrasive material.

(b) Temporary shields and other sealing or closing-off measures shall be used to prevent abrasives from entering machinery, pipes, seawater inlets, and pump wells through various openings.

(c) Where remote service connections provide water or ventilation, such as seawater from the auxiliary seawater system while the ship is in dry-dock, the inlet to that connection shall be positioned and measures taken to prevent the entry of blasting contaminations.

(d) Additional precautions shall be taken to the extent necessary to protect adjacent ships, buildings, and stores.

(2) Personnel in or near the blasting area shall be warned of blasting operations. In all circumstances, close cooperation between ship and shipyard personnel is required.

(3) The entire area to be blasted shall be visually inspected. Heavily rusted or corroded areas, damaged metal, and holes in the structure or piping shall be checked to determine if technical examination is warranted, and for possible repair prior to blasting.

b. Protective Equipment. All blast operators shall wear hoods and airline respirators or air helmets of the positive-pressure type. Other mandatory clothing includes rubber or leather gauntlet gloves, safety shoes, and coveralls. The blast operator shall wear a safety belt or harness when working on staging or other elevated places. Staging shall be stable and correctly positioned for the safety, convenience, and comfort of the blast operator. Personnel other than blast operators, including machine operators and personnel engaged in work near abrasive blasting operations, shall wear full eye protection and NIOSH-approved dust respirators. Approved ear protection shall be worn wherever the airborne noise level is above 85 dBA. Both earplugs and earmuffs (double protection) shall be worn if the noise level exceeds 108 dBA.

c. Operating Safety Precautions. The nozzle shall never be pointed in the direction or ricochet line of another person, even with the air and abrasive stream shut off. The blast operator shall always keep hands and other parts of the body away from the discharge and the nozzle, and shall never try to adjust the nozzle while the abrasive stream is flowing.

(1) Hoses will be secured, leaving only enough free length to be handled safely by the blast operator. All hoses, fittings, and so forth shall be inspected before blasting begins; worn parts shall be discarded. When couplings are located where sudden parting would be hazardous, both coupled hoses shall be secured to a strong support or to each other.

(2) Abrasive-blasting equipment shall be properly maintained because operation of damaged or poorly maintained equipment at high pressures is dangerous.

(3) Whenever practical, hoppers and hopper tenders should be located on top of dry-dock walls rather than in the basin. This improves housekeeping and permits grit flow to be aided by gravity. Minimizing the number of people who must be in the dock basin reduces the risk of injury if a hose or connection should break, causing the hoses to whip.

3-14. Abrasive Materials. Metal or synthetic shot, grit, or similar abrasives are used where recovery of the abrasive is possible. Sand or other low-cost materials are used when the abrasive agent is expendable, but the use of sand is costly. The abrasive grit must be of a size sufficient to remove surface contamination without working the surface to excess. Overworking creates extreme peaks and valleys on the surface, which require an additional buildup of the applied paint film for adequate protection. The peaks, if too high, represent possible areas of premature failure in coating systems with less than five mils dry film thickness.

3-15. Dry Blasting. The two dry blasting methods of surface cleaning are described below.

a. Conventional Blasting. Conventional blast cleaning is a term used to designate the usual method of field blasting, in which no effort is made to alleviate the dust hazard or recycle the blasting abrasive. Conventional blasting does not require special rinsing, as is required for wet blasting, but it does require that health precautions be taken to protect the operator and other personnel in the area from the fine, abrasive dust. Machinery in the vicinity must also be shielded from the dust. After blasting, the surface must be brushed, vacuumed, or air cleaned to remove residues or trapped grit.

b. Vacuum Blasting. Vacuum blasting is a surface cleaning method, which minimizes the dust hazard and reclaims the blast abrasive. Vacuum blasting allows practically no dust to escape to contaminate the atmosphere. On highly irregular surfaces; the vacuum method of blasting is less efficient than conventional blasting methods because of the poor vacuum on such surfaces. When the blasting cone is held firmly against the surface to prevent abrasive loss and the surface is heavily contaminated with rust, algae, or other foreign matter, the machine may become clogged after operating for only a short time. When clogging occurs, the vacuum blaster is used as a semi-open blasting device and the cone containing the nozzle is held at a slight distance away from the surface. A considerable amount of dust is created (workers must wear respirators), but not as much as is created by conventional blasting. Vacuum blasting is efficient and economical for cleaning repetitive, small-scale surfaces in a shop. The process results in considerable savings in abrasive costs and reduces the dust and the health hazard.

3-16. Wet Blasting. Wet blasting reduces the dust associated with blasting to a minimum, but is not suitable for certain types of work as described below.

a. Wet Blasting Disadvantages. When blasting is used on steel structures having many ledges, formed by upturned angles or on horizontal girders, a considerable amount of cleanup work is required. Wet sand and other blast residues trapped on these ledges are more difficult to remove than dry materials. Some sludge will adhere to wet-blasted surfaces, requiring removal by rinsing, brushing or compressed air. The blasted surface shall be thoroughly dry before coatings are applied.

WARNING

. **Vapor**

On standing, the rust-inhibiting solution decomposes to form gases. Stock solutions of the inhibitor must not be used.

b. Rust Inhibitor. When wet blasting, a rust inhibitor is used in the blasting unit, followed by a rust-inhibiting wash. For galvanized surfaces, the rust inhibitor is omitted.

(1) For wet blasting, 2 pounds of the rust inhibitor solution are dissolved in 15 gallons of water. This resulting solution can be added to 300 pounds of abrasive in the blasting machine or it can be pumped directly into the discharge line.

(2) For washing down spent abrasives, 2 pounds of prepared rust inhibitor solution are dissolved in 40 gallons of water.

3-17. Degrees of Blast Cleaning. Five degrees of blast cleaning are defined below.

NOTE

All new materials used in hull repairs shall be blasted to white metal to remove rust and mill scale.

a. White-metal Blast SP-5. Blast cleaning to white metal is the highest degree of blast cleaning and is used for coatings, which must withstand exposure to very corrosive atmospheres where the high cost of surface preparation is considered to be warranted. Blast cleaning to white metal completely removes all rust, mill scale, and other contaminants from the surface, and assists in maximum paint system performance.

b. Near-white Metal Blast SP-10. When blast cleaning to near-white metal, the blasted surface will show shadows, streaks, or discolorations, but they will appear across the general surface area and not be concentrated in spots. Evaluation of the completed-cleaning job with near-white metal blast must be by visual judgment. This surface preparation results in a 10 to 35 percent savings over white metal blasting and has proved to be adequate for many of the special coatings developed for long-term protection in

moderately severe environments. Near-white metal blast is the most cost-effective standard for most ship surface preparation where abrasive blasting to bare metal is specified.

c. Commercial Blast SP-6 is not an acceptable method of blasting on Army watercraft.

d. Brush-Off Blasting SP-7 is not an acceptable method of blasting on Army watercraft.

e. High and Ultrahigh Pressure Waterjetting SP-12. Waterjetting is defined as achieving surface cleanliness using high pressure or ultrahigh-pressure waterjets to remove paint, rust, scale or other surface contaminants. Waterjetting is suitable for cleaning plating surfaces only. Waterjetting is not suitable or authorized for cleaning framing, structural members or other sharply angled surfaces. When waterjetting hull surfaces, all framing, structural members, and other sharply angled surfaces shall be cleaned by abrasive blasting.

(1) Standards for waterjetting

a. Low-Pressure Water Cleaning (LP WC). Cleaning performed at pressures less than 5,000 psi. Suitable for washing down surfaces and peeling loose paint from surfaces prior to Hand, SP-2 or Power Tool, SP-3 Cleaning.

b. High-Pressure Water Cleaning (HP WC). Cleaning performed at pressures from 5,000 psi to 10,000 psi.

c. High-Pressure Waterjetting (HP WJ). Cleaning performed at pressures from 10,000 to 25,000 psi. Suitable for removal of paint to near-white metal; normally used on thin or easily damaged surfaces.

d. Ultrahigh-Pressure Waterjetting (UHP WJ). Cleaning performed in excess of 25,000 psi. Normal method of removing paint, rust, scale, and other debris from hull surfaces.

(2) Waterjetting Surface Preparation Standards.

a. Waterjetting is not an acceptable method of cleaning new materials for installation. Waterjetting will not remove all mill scale and provide an adequate surface profile for paint adhesion on new material. All new material must be cleaned to White-Metal Blast standard SP-5 by abrasive blast prior to installation.

b. WJ-1. Surface shall be free of all previously existing visible rust, coatings, mill scale, and foreign matter and have a matte metal finish. Equivalent to White Metal Blast, SP-5.

c. WJ-2. Surface shall be cleaned to a matte finish with at least 95% of the surface area free of all previously existing visible residues with the remaining 5% containing only randomly dispersed stains of rust, coatings, and foreign matter. Equivalent to Near-White Metal Blast, SP-10.

d. WJ-3. 66% removal of previously existing coatings. Not an acceptable method of blasting on Army watercraft.

e. WJ-4. Surface shall have all loose rust, loose mill scale, and loose coatings uniformly removed. May be used to remove loose coatings and matter prior to Hand Tool Cleaning, SP-2 or Power Tool Cleaning, SP-3.

(3) Safety. Waterjetting is capable of cutting through steel. Extreme caution must be exercised to ensure that personnel performing cleaning operations are not exposed to the waterjet. Waterjetting can be destructive to non-metallic surfaces, electrical installations, and other watercraft components. Extreme care must be used to protect components from damage due to high-pressure pulsations or water intrusion.

(4) Paint Systems. Waterjetting is not compatible with epoxy-polyamide paint systems. Therefore, surfaces cleaned by waterjetting shall be coated with one of the alternatively approved epoxy paint system listed in Appendix B.

WARNING

Vapor

Although nonflammable paint strippers and removers eliminate fire hazards, they are toxic and can be hazardous to personnel.

3-18. Paint Remover Cleaning.

a. Paint Remover Uses. Removers are available in flammable and nonflammable types and as a liquid or semi-paste. While most paint removers require scraping or use of steel wool to physically remove the softened paint, types of paint removers are available that allow the loosened finish to be flushed off with steam or hot water. Many of the flammable and nonflammable removers contain paraffin wax to retard evaporation. It is essential that any wax residue be removed from the surface prior to painting to prevent loss of adhesion of the applied coating. In such instances, follow the manufacturer's label directions or use mineral spirits to remove any wax residue.

b. Paint Removers Safety Precautions. Safety precautions and special requirements, such as proper ventilation, which shall be observed when working with these substances, are described in paragraph 2-25. Safety Precautions for Paint Strippers and Removers.

3-19. Steam Cleaning.

a. The steam cleaning method of preparing surfaces for painting involves using steam or hot water under pressure. Steam cleaning compound can be included for added effectiveness. The steam or hot water removes oil and grease by liquefying these contaminants (because of the high temperature), then emulsifying and diluting them with water. When steam cleaning is used on some types of old paint, the old paint becomes swollen and loosened. Steam cleaning is commonly used to remove heavy dirt deposits, soot, and grime. Wire brushing or brush-off blast cleaning may be necessary to complete the residue removal.

b. The workman should be provided with proper head cover, a face shield, a heavy rubber apron, oilskin or rubber trousers, knee-length boots drawn under the trouser legs, a heavy rubber coat, and rubber gloves covering canvas gloves. If the air temperature is excessive causing the worker to suffer excessively from heat, equipment could be limited to knee boots worn under the trousers, an oiled (or plastic) apron, gloves, and face shield. During steam cleaning operations, adequate ventilation, natural or forced, should be provided.

3-20. Removal of Thin Film Rust-Preventive Compound. Steam should be used to remove thin-film rust preventive compound where large surface areas are involved, or where the rust preventive compound hardened with age. For small areas, it can be effectively removed with an aromatic hydrocarbon solvent of petroleum naphtha or coal tar naphtha.

3-21. Removal of Metal Conditioning and Thin Film Rust-Preventive Compounds. Use steam to remove any mixture of grade one thin-film rust preventive compound and metal conditioning compound. If straight steam is not an effective removal method, the procedures described in the paragraphs below are recommended. Health hazards are described in paragraph 2-17, Health Hazards and Personnel Exposure Limit Values for Certain Paint Ingredients.

a. Naphtha-Rosin Soap. Mix Hercules Powder Dresinate 87 (a liquid sodium rosin soap) and high-flash coal tar naphtha in 1:2 weight ratios. Stir until a homogenous mixture is obtained. Brush this cleaning

compound on approximately 30 square feet of area. Allow the material to penetrate into the preservative film for about 5 minutes. If the cleaner appears to be drying, reapply a small amount. Rinse the surface with a stream of hot water at about 90 to 100 pounds pressure. Naphtha-rosin-soap mixtures have a flashpoint of 40.6° C (105° F) and its use requires fire precautions equivalent to those observed when spray painting.

b. Methylene Chloride (Dichlord-Methane) Paint Remover. The use of methylene chloride-type paint removers, containing a minimum of 70 percent by weight methylene chloride, followed by steaming, has been found effective for removing thin-film rust-preventive compounds, especially if the mixture has been applied over paint.

(1) Brush the cleaning compound liberally on the preventive-coated surface. Allow the material to penetrate into the preservative film for about 15 minutes. If the cleaner appears to be drying, reapply. Direct a jet of steam to the area to be cleaned, holding the gun top 1 to 2 inches from the surface. The steam gun should have a 1/2-inch nozzle (approximately).

(2) If any preservative compounds or loose paint remain, brush more cleaning material onto the surface, allow it to soak again for 15 minutes, and steam the area. In extreme cases, this cycle may have to be repeated once more.

3-22. Hand Cleaning of Ships' Bilges.

a. Hand Cleaning Use. The hand-cleaning method is used solely to prepare bilge surfaces for repainting, as some routine methods of cleaning bilges for other purposes are inadequate for paint preparation. Follow precautions described in paragraph 3-8.

b. Hand-Cleaning Procedures. When hand-cleaning procedures are implemented work sections no larger than 200 to 300 square feet should be cleaned at a time. Longitudinal and transverse structural members may be used as boundaries to define the work sections. Clean and prime each section before starting work on the next section. The procedure is essentially hand cleaning, with the assistance of detergent solutions to aid in soil removal

3-23. Cleaning Aged, Inorganic Zinc-Coated Surfaces. When cleaning an aged, inorganic zinc-coated surface for recoating, the cleaning methods described in this paragraph must be used, depending upon the conditions to which the inorganic zinc coating has been subjected. If the inorganic zinc has had heavy traffic and physical wear, or if the existing top coating has been worn away to the inorganic zinc, the zinc-coating should be thoroughly scrubbed with a cleaning solution prepared by mixing 8 pounds of sodium metasilicate and 1 gallon of detergent with sufficient water to make 30 gallons of solution. Flush the cleaned surface with fresh water to remove loosened grime and cleaning solution and allow to dry. Lightly roughen the surface either by mechanical means or by abrasive brush blasting.

3-24. Tank Surface Preparations. When cleaning tanks you must always comply with the requirements for gas freeing, safety, and oxygen sufficiency. Install explosion-proof ventilation equipment and ventilate tank.

a. Tank Interior Cleaning. Install fresh water hose lines. Ensure that the hoses extend to the tank bottom, continue ventilation, enter tank, and wash down all interior surfaces with a high-velocity stream of freshwater. Remove the sludge to the sludge tank and muck out as necessary. Ventilate to dry tank surfaces. Remove residual water and oil from the tank bottom.

(1) Portable tank cleaning machines are readily available from the commercial industry. They use a rotating nozzle and a high-pressure stream of water to remove sludge, rust, loose paint, and scale. Normally they are used to clean cargo tanks on larger vessels.

(2) Using non-sparking power tools (or hand scrapers if power tools are unavailable), remove all adhering sludge or deposits, rust, loose mill scale, and loose paint. Tightly adhering paint may be retained

if the surface is subsequently roughened by sanding or hand wire brushing. Burnishing or polishing of any of the surfaces shall be avoided

b. Repeat steps given in paragraphs above until all the sludge, dirt, deposits, rust, and loose mil scale or paint have been removed. Wash the cleaned area with cleaning solvent until a solvent-wet rag remains dean.

SECTION 4. PAINT EQUIPMENT, GAGES, AND MATERIALS

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4-1. Introduction. The selection of the proper equipment and materials for any painting job requires a general knowledge of the equipment and materials needed to do the job correctly. The different tools that are available for the application of paints and for testing are described in this section. Also given in this section is information on the requisition, storage, and testing of paints.

4-2. Paint Equipment. Tools used for the application of paint shall be of first quality and maintained in perfect working condition at all times. The types of tools and their care and maintenance are described below.

a. Paintbrushes. Brushes are identified by the type of bristle used; natural, synthetic, or a mixture of each.

(1) Chinese Hog Bristles. Chinese hog bristles are the finest of the natural bristles because of their length, durability, and resiliency. Hog bristle has a unique characteristic in that the bristle end forks out (flags) like a tree branch and permits more paint to be carried on the brush. In addition, the hog bristle flagging leaves finer brush marks, which flow together readily and result in a smooth finish.

(2) Horsehair Bristles. Horsehair bristles are used in inexpensive brushes and are an unsatisfactory substitute for hog bristles. The ends of the horsehair bristles do not flag and quickly become limp. They also hold far less paint and do not spread the paint as well. Brush marks left in the applied coating tend to be coarse and do not level as smoothly.

NOTE

Some brushes contain a mixture of hog bristle and horsehair and their quality depends upon the percentage of each type used.

(3) Other Animal Hair Brushes. Animal hair is used in fine brushes for special purposes. Badger hair, for example, is used for a particularly good varnish brush. Squirrel and sable are ideal for striping, lining, lettering, and freehand art brushed.

(4) Nylon Brushes. Nylon is the most common synthetic used in paint brushes. By artificially exploding the ends and kinking the fibers, manufacturers have increased the paint load nylon can carry and have reduced the coarseness of nylon brush marks. Nylon is usually superior to horsehair. Nylon brushes are recommended for use with latex paint because water does not cause any appreciable swelling of nylon bristles. The fact that nylon is a synthetic substance makes nylon brushes unsuitable for applying lacquer, shellac, many creosote products, and any other coating that would soften or dissolve nylon bristles.

4-3. Brush Care and Maintenance.

a. Before using, rinse brushes with paint thinner. Brushes that are to be reused the following day need to be marked for white light colors, or dark colors. Brushes should be suspended by the handle in a closed container, with the bristles immersed in paint thinner or linseed oil to just below the bottom ferrule. The weight of the brush should not rest upon the bristles.

b. Brushes that are not to be reused immediately shall be cleaned with thinner or some other solvent (at least three cleanings), and then washed with detergent and water. Brushes shall be stored suspended from racks by the handle or wrapped in paper and stored in a flat position.

4-4. Paint Rollers. The selection of a paint roller for a job depends upon the type of paint being used and the surface to be coated.

a. Roller Description. A paint roller is a cylindrical sleeve or cover, which slips onto a rotatable cage. The inside diameter of the cover is 1 1/2 to 2 1/4 inches. In length, covers are 3, 4, 7 and 9 inches. Special rollers are available in lengths from 1 1/2 to 18 inches.

b. Types of Roller Covers. Proper paint application depends upon the selection of a cover with the desired fabric and fabric thickness (nap length). Selection is based on the type of paint to be used and the smoothness or roughness of the surface to be painted. The fabrics used in roller covers are:

(1) Lambs Wool (Pelt) is the most solvent-resistant type of material used and is available in nap length up to 1 1/4 inches. Lambs wool is recommended for application on semi-smooth and rough surfaces; it mats badly in water and is not recommended for water-base paints.

(2) Mohair is made primarily of angora hair. It is solvent-resistant and is supplied in 3/16 to 1/4-inch nap lengths. Mohair is recommended for synthetic enamels and for use on smooth surfaces, and can be used with water-base paints.

(3) Dynel is modified acrylic fiber which has excellent resistant to water. It is best for application of conventional water-base paints and solvent-base paints, except those, which contain strong solvents such as ketones. Dynel is available in a range of nap lengths from 1/4 to 1 1/4 inches.

(4) Dacron is a synthetic fiber, which is somewhat softer than Dynel. It is best suited for exterior oil or latex paints. Dacron is available in nap lengths ranging from 5/16 to 1/2-inch.

(5) Rayon roller covers are not recommended. Rayon mats badly in water and generally produces poor coating results.

4-5. Paint Thickness Gages. Paint thickness is measured in terms of wet film thickness (WFT) and dry film thickness (DFT). The WFT measurements are useful in monitoring on site paint applications. The DFT measurements determine the final barrier film obtained for preservation. The gages used for the measurements of WFT and DFT are described below.

a. Minimum Film Thickness Requirements: When a measurement of paint thickness is specified, a minimum of five DFT measurements shall be recorded for every 1,000 square feet of painted surface. The average of these readings shall be the official recorded value.

b. Wet Measurements. WFT gages are used to check freshly applied coatings. The WFT multiplied by the decimal equivalent of the percentage of solids by volume gives an estimate of the DFT, which will remain after the solvent has evaporated. Wet film gages to be used are described below.

(1) Interchemical WFT Gage. The interchemical WFT consists of an eccentric center wheel attached to two concentric running wheels. Rolling of the gage results in the central measuring wheel dipping into the coating. The point at which the film touches the center wheel measures the thickness of the film, which can be read on the mil scale provided on one of the running wheels. The range of the particular

gage selected for use should be one in which the measured film thickness falls within the middle 80 percent of each scale. The gage is available in the ranges given in table 4-1.

(2) Nordson WFT Gage. The Nordson WFT gage has several legs, with each of the inner legs somewhat shorter than the outer legs. The two end legs define the plane of application and penetrate through the wet film to the substrate. Consequently, some of the legs will dip into the coating while others will not touch it. The leg, which is just wetted by the coating, indicates the WFT.

c. DFT Measurements. Minimum DFT for the coatings should be determined with one of the DFT gages (or equal) described below.

(1) General Electric Type B Thickness Gage. The General Electric Type B thickness gage is a rugged, reasonably portable instrument operating from a 115-volt, 60-Hz power supply. The gage operates on a magnetic principle and can be used to measure coatings only on a magnetic surface. The instrument is fast and easy to use, and can be used on slightly curved surfaces as well as on flat surfaces. Due to the fact that different surfaces will give different readings, it is necessary to standardize the scale with a foil of known thickness on a bare area of the same thickness and type of surface as the one on which the measurement is being made. To prevent variances in readings, measurements shall not be made close to edges and corners. The accuracy of the readings varies with the thickness of foil used to standardize the instrument. For best results, the standardizing foil shall be close to the actual thickness of the paint film being measured.

(2) Elcometer Thickness Gage. The Elcometer thickness gage has different ranges available and is a light, portable instrument that fits into a coat pocket. This gage is operated by means of the variation in magnetic force between the metal surface and a self-contained permanent magnet. No outside power source is necessary. Measurements can be made on slightly curved surfaces. To operate the Elcometer thickness gage, it is necessary to first standardize the dial over a bare area of the same type and thickness of metal as that on which the coating is to be measured. It is important for accuracy to hold the meter in the same plane when taking the measurements, as the gage is then set to zero. The results obtained will be satisfactory for most purposes for which field measurements are made, providing the necessary precautions for use are taken.

(3) General Electric Permanent Magnet Thickness Gage. The General Electric permanent magnet thickness gage is a portable, self-contained gage with a dual scale. The low scale ranges from 0 to 7 mils and the high scale ranges from 1 to 60 mils. The gage is also provided with a go-no-go feature, which can be set for a minimum and maximum paint thickness.

(4) Mikrotest Thickness Gage. In the Mikrotest thickness portable gage, a small magnet is attached to one end of a balance, which is at equilibrium; the magnet is connected through a spiral spring with a micrometer screw. To measure DFT, the spiral spring of the gage is stretched by turning the micrometer screw until the magnet is pulled away from the coated surface. The coating thickness can then be read from the calibrated disk or obtained from a calibration curve.

(5) Dermitron Electromagnetic Thickness Gage. The dermitron electromagnetic thickness gage and other eddy-current type thickness gages are electronic instruments that measure variations in impedance of an eddy-current-inducing coil by paint coating thickness variations. Gages of this type can be used only if the electrical conductivity of a coating differs significantly from that of the substrate. Typical measurement applications involve an organic coating over aluminum or corrosion-resistant steel (CRES).

(6) Tooke Coating Inspection Gage. The Tooke coating inspection gage is an optical thickness gage. It is used to measure the thickness of different colored individual paint coats or can be used when nondestructive gages cannot be used. A cut is scribed through the film and measurements are made by means of a calibrated microscope eyepiece. After the measurements, the scribed marks shall be repainted.

(7) PosiTector coating thickness gauge. The PosiTector thickness gauge is a fixed probe dry film thickness gauge used to non-destructively measure the thickness of non-magnetic coatings applied to ferrous metal substrates. Measurement depends on changes in magnetic flux within the probe. The magnitude of these changes is a function of the distance between the probe and substrate under the paint.

Table 4-1. INTERCHEMICAL WET FILM THICKNESS GAGE

Range Graduations (mils)	Smallest (mils)
0 to 0.4	0.02
0 to 10	.05
0 to 2	0.1
0 to 4	0.2
2 to 12	0.5
10 to 30	1.0
20 to 60	2.0

4-6. Paints and Paint Materials. Only paints and paint materials that are in accordance with this manual shall be used on board Army watercraft unless deviation has been authorized by Commander, US Army Tank-Automotive and Armaments Command, Troop Support Group, Army watercraft, ATTN: AMSTA-LC-CJA, 6501 East 11 Mile Rd, Warren, MI 48397-5000.

4-7. Paint Requisition. Paint requisitions shall be submitted only for paints listed in Appendix A or Appendix B. The formula or specification numbers of the paints to be ordered must be stated on the requisition. If only the formula number is given, the publication date of this TB shall also be given.

SECTION 5. PAINTING APPLICATION REQUIREMENTS

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5-1. General. There are basic requirements that shall be met whenever significant painting is accomplished aboard a US Army watercraft. Section 1 contains guidelines on when to paint. This section covers basic paint application techniques that shall be followed.

5-2. Painting Guidance. When painting schedules conflict with the requirements given in this section, guidance on paint compatibility and touchup procedures shall be obtained from Commander, US Army Tank-Automotive and Armaments Command, Troop Support Group, Watercraft Inspection Branch, ATTN: AMSTA-LC-CJWW, BLDG 2796, Fort Eustis, Virginia 23604-5286. Faxes can be sent to (757) 878-5109.

5-3. Painting Schedules and Dry-Docking Reports. DA Form 5587-R shall be kept aboard the vessel at all times. A report of vessel dry-docking, painting and condition of vessel bottom will be submitted to the NMP. This report must be submitted within 90 days of refloat. The report will be mailed to Commander, US Army Tank-Automotive and Armaments Command, Troop Support Group, Watercraft Inspection Branch, ATTN: AMSTA-LC-CJWW, BLDG 2796, Fort Eustis, Virginia 23604-5286. Faxes can be sent to (757) 878-5109.

5-4. Basic Preparations. To obtain optimum performance from a coating, certain basic procedures must be followed, regardless of the type of equipment selected for paint application. Always refer to manufacturing instructions for exact minimum and maximum temperatures, humidity, and application requirements.

a. Temperature, Wind, and Humidity Requirements. It is essential for surface and surrounding temperatures to be between 10° C and 32.2° C (50° F and 90° F) for water-thinned coatings, and 1.6° C and 35. °C (35° F and 95° F) for other coatings, unless the manufacturer specifies otherwise. Paint should be applied only when surfaces are completely dry and surface temperature is at least 2.8° C (5° F) above the dew point. The paint material should be maintained at a temperature of 18.3° C to 29.4° C (65° F to 85° F) at all times. Paint shall not be applied when the temperature is expected to drop to freezing before the paint has dried. Wind velocity should be less than 15 miles per hour and relative humidity less than 80 percent.

b. Relative Humidity, Dew Point, and Dew Point Spread.

(1) A factor that plays an important part in painting is humidity, that is, the amount of water vapor (water in a gaseous state) in the air. Any given volume of atmosphere at a given temperature can hold

only a certain amount of water vapor. If more and more water vapor is added to the air, the saturation point eventually will be reached and some of the water vapor will condense, or become liquid. The condensation takes the form of dew, rain, or other precipitation. Relative humidity is the ratio of the amount of water vapor in the air to the total amount that the air can hold at the saturation point, or 100 percent humidity.

(2) The warmer the air is, the more water vapor it will hold. Consequently, cooling a volume of air will reduce its capacity to hold water vapor. If the cooling is continued, the dew point (the temperature at which moisture suspended in the atmosphere will begin to form dew) will be reached, and the water vapor will condense. Readings taken from a psychrometer are used to compute relative humidity and dew point.

(3) There are two types of instruments used aboard ship to determine relative humidity and the dew point. These two instruments look different, and a different method is used to get a reading, but both instruments will give you the same results.

(a) A hygrometer consists of two thermometers mounted vertically in a ventilated case or box. One thermometer, known as the dry bulb, has a mercury bulb exposed directly to the air. The other thermometer, known as the wet bulb, has a bulb covered with muslin. In use, the muslin is stretched tightly around the bulb and kept moist by a wick immersed in a small cup filled with water. The wick consists of a few threads of cotton long enough to allow 2 or 3 inches of it to be coiled in the cup. The muslin is kept thoroughly moist, but not dripping, at all times.

(b) A sling psychrometer also consists of two thermometers. They are mounted together on a single strip of material and fitted with a swivel link and handle.

1 One thermometer is mounted a little lower than the other is, and has its bulb covered with muslin. When the muslin covering is thoroughly moistened and the thermometer well ventilated, evaporation will cool the bulb of the thermometer, causing it to show a lower reading than the other thermometer. With the sling psychrometer, ventilation is caused by twirling the thermometers by using the handle and swivel link. The dry-bulb temperature is the reading shown by the uncovered thermometer, and the wet bulb temperature is shown by the muslin-covered thermometer.

2 The dry-bulb thermometer records the temperature of the free air. The wet-bulb thermometer records what is known as the *temperature of evaporation, which* is always less than the temperature of free air.

NOTE

The difference between the temperature readings of the dry-bulb and the wet-bulb shows how near the air is to a state of saturation.

(4) When the wet and dry-bulb temperatures are known, the *relative humidity* of the atmosphere may be found by referring to the table for determining relative humidity. The table may be readily understood by reviewing the following example.

Assume the temperature of the air (dry-bulb) is 60° and the temperature of evaporation (wet-bulb) is 56°; the difference is 4°. Look in the column headed “Temperatures of the air;" find 60° and follow the same horizontal line across to the column headed "4° ." Here the figure "78" will be found. This means that the air is 78 percent saturated with water vapor. The amount of water vapor present in the atmosphere is 78 percent of the total amount it could carry at the given temperature (60°). The total amount, or saturation, is represented by 100. Any increase in the amount of vapor beyond this point would show in the form of mist or rain. The relative humidity over the ocean's surface is generally about 90 percent. Because of this increased moisture, the relative humidity at sea level is normally higher than that cited in the above example.

Table 5-1. **TABLE FOR DETERMINING RELATIVE HUMIDITY**

TEMPERATURE OF THE AIR, DRY-BULB THERMOMETER	DIFFERENCE BETWEEN DRY-BULB AND WET-BULB READINGS (PERCENT)									
	1	2	3	4	5	6	7	8	9	10
24	87	75	62	50	38	26				
26	88	76	65	53	42	30				
28	89	78	67	56	45	43	24			
30	90	79	68	58	48	38	28			
32	90	80	70	61	51	41	32	23		
34	90	81	72	63	53	44	35	27		
36	91	82	73	64	55	47	38	30	22	
38	92	83	75	66	57	59	42	34	26	
40	92	84	76	68	59	52	44	37	30	22
42	92	84	77	69	61	54	47	40	33	26
44	92	85	78	70	63	58	49	43	36	29
46	93	85	79	72	65	58	51	45	38	32
48	93	86	79	73	66	58	51	45	38	32
50	93	87	80	74	67	61	55	49	43	37
52	94	87	81	75	69	63	57	51	46	40
54	94	88	82	76	70	64	59	53	48	42
56	94	88	82	77	71	65	60	55	50	44
58	94	89	83	78	72	67	61	56	51	46
60	94	89	84	78	73	68	63	58	53	48
62	95	89	84	79	74	69	64	59	54	50
64	95	90	85	79	74	70	65	60	56	51
66	95	90	85	80	75	71	66	61	57	53
68	95	90	85	81	76	71	67	63	58	54
70	95	90	86	81	77	72	68	64	60	55
72	95	91	86	82	77	73	69	65	61	57
74	95	91	86	82	78	74	70	66	62	58
76	95	91	87	82	78	74	70	66	63	59
78	96	91	87	83	79	75	71	67	63	60
80	96	92	87	83	79	75	72	68	64	61
82	96	92	88	84	80	76	72	69	65	62
84	96	92	88	84	80	77	73	69	66	63
86	96	92	88	84	81	77	73	70	67	63
88	96	92	88	85	81	78	74	71	68	65
90	96	92	88	85	81	78	74	71	68	65

(5) The dew point spread is the number of degrees between the actual temperature (dry-bulb) and the dew point. To find the temperature at which dew will begin to form, you can use the table below. Example: the dry-bulb temperature is 60 °, the wet-bulb reads 56°, the spread between the dry-bulb, and wet-bulb reading is 4°. Using Table 5-2 read down for the value of 4° and across to the columns for 60° and you finds a value of seven. This 7° tells you that there is a 7° dew point spread. This 7° spread is subtracted from the dry-bulb temperature of 60°, and that tells you that 53° is the dew point temperature.

CAUTION

The surface temperature of the material to be painted must be at least 5° above the dew point.

Table 5-2. AIR TEMPERATURE: DEW POINT SPREAD TABLE

(All figures are in degrees Fahrenheit at 30-inch pressure.)

DIFFERENCE DRY-BULB MINUS WET BULB	AIR TEMPERATURE SHOWN BY DRY-BULB THERMOMETER												
	35	40	45	50	55	60	65	70	75	80	85	90	95
1	2	2	2	2	2	2	2	1	1	1	1	1	1
2	5	5	4	4	4	3	3	3	3	3	3	3	2
3	7	7	7	6	5	5	5	4	4	4	4	4	4
4	10	10	9	8	7	7	6	6	6	6	5	5	5
5	14	12	11	10	10	9	8	8	7	7	7	7	6
6	18	15	14	13	12	11	10	9	9	8	8	8	8
7	22	19	17	16	14	13	12	11	11	10	10	9	9
8	28	22	20	18	17	15	14	13	12	12	11	11	10
9	35	27	23	21	19	17	16	15	14	13	13	12	12
10		33	27	24	22	20	18	17	16	15	14	14	13
11		40	32	28	25	22	20	19	18	17	16	15	15
12			38	32	28	25	23	21	20	18	17	16	16
13			45	37	31	28	25	23	21	20	19	18	17
14				42	35	31	28	26	24	22	21	20	19
15				50	40	35	31	28	26	24	23	21	21

c. Paint Mixing. Paints shall not be used until they are thoroughly mixed. Improper mixing is considered to be one of the principal reasons for poor paint performance. Tinting pastes, if used, must be mixed in a similar manner before they are added to the paint. Pastes shall be measured carefully, and stirred in until no streaking occurs and the desired color is obtained.

(1) Mixing Procedures. Mechanical paint agitators (shakers) shall be used whenever possible. If a shaker is not available, the paint must be stirred until all lumps, cakes, and sediments are completely dispersed. Stirring should be done in accordance with the following procedures:

(a) Open the paint can. If a skin has formed on the paint surface, it should be carefully removed and properly discarded in accordance with specific waste disposal policies.

(b) Pour the top 2/3 of the paint into another can.

(c) Stir the pigment and liquid left in the first can until the paint is smooth; a paint mixing attachment for use with an electric or pneumatic drill is suitable. See section 2 for applicable safety precautions.

(d) Gradually, add contents of the second can to the first can, continuing to stir.

(e) Continue to mix by pouring the paint back and forth from one can to the other (boxing) until uniformly smooth.

(2) Paint Straining. Strain the paint through a wire screen or cheesecloth to remove any particles or skins that remain undissolved after stirring.

5-5. Multicoating Applications. When successive coats of the same paint are used, and tinting is permitted, each coat should be tinted differently to aid in determining proper application and to ensure complete coverage. Sufficient time must be allowed for each coat to dry thoroughly before top coating or subjecting the painted surface to service conditions such as immersion.

5-6. Basic Painting Procedures. The basic techniques, procedures, and methods used in the application of paints are described in Sections 5, 6, and 7.

NOTE

Before starting any painting job, ensure that surface preparation has been completed as directed in Section 3. Apply the first coat of paint as soon as practicable after surface preparation has been accomplished.

5 7. Paintbrush Techniques. The techniques used in the application of paint with a brush are as follows:

a. Painting Procedures. Start major work on overhead areas first, and then work downward. Begin painting at a corner or some other logical vertical division. Cover only the areas, which can be easily reached without moving ladders. Work downward, painting progressive sections to the deck level then start at the top of the adjacent area and work down again. Paint trim, doors, or similar areas after bulkheads and other major surfaces are completed.

b. Coating Application. Dip the brush into the paint up to 1/2 the bristle length Withdraw the brush and tap it against the inside of the bucket to remove excess paint. Hold the brush at an angle of 45° to the work. Make several light strokes in the areas to be painted. This will transfer much of the paint to the surface. Then spread the paint evenly and uniformly. Do not bear down on the brush.

(1) When one section of the surface is painted, adjacent areas should be painted so that the brush strokes are completed by sweeping the brush into the wet edge of the paint previously applied. This helps eliminate lap marks and provides a more even coating.

(2) Finally, cross-brush lightly to smooth the painted surface and to eliminate brush or sag marks. Very fast-drying finishes will not permit much brushing and cross lapping; in such cases, the paint shall be applied, spread rapidly, and then allowed to dry undisturbed. Going back over a fast-drying paint will cause piling up of the coating.

5-8. Paint Roller Technique. The techniques used in the application of paint with a roller are as follows:

a. Paint to Roller Procedures. To apply paint with a roller, pour the premixed paint into the tray to about 1/2 the tray depth. Immerse the roller completely, and then roll it back and forth along the ramp to coat the cover completely. Remove any excess paint. As an alternative to using the tray, place the specially designed galvanized wire screen (grid) into a 5- gallon can of the paint. This screen attaches to the can and remains at the correct angle to load and spread paint onto the roller. The first load of paint on a roller should be worked out on newspaper to remove entrapped air from the roller cover; it is then ready to apply to a surface.

b. Paint Application:

(1) When a roller is passed over a surface, thousands of tiny fibers continually compress and expand, releasing the coating and wetting the surface. This application of paint is in sharp contrast to other application methods, which depend upon the skill and technique of the painter. The uniformity of application by roller is less susceptible to variance because of painter ability than other methods.

(2) Always roll paint onto the surface, working from the dry area into the just painted area. Never roll completely in the same or one direction. One good technique is to roll the paint onto the surface in a W pattern and then fill in the area inside the W using horizontal or vertical strokes. Don't roll too fast. Avoid spinning the roller at the end of the stroke. Always feather out final strokes to pick up any excess paint on the surface. Feathering is done by rolling out the final stroke with minimal pressure.

5-9. Conventional Spray Painting Techniques. Conventional spray painting techniques are as follows:

a. Spray Painting Preparation. Before spray painting starts, ensure that the following steps are completed.

(1) Mix the paint thoroughly. Strain the paint through a wire screen or cloth to remove skin and coarse or foreign particles.

(2) Ensure that the air filter is connected to the main air supply line to prevent moisture and oil particles from mixing with the paint.

(3) Spray Pattern Adjustment. After making initial adjustments to the air and liquid pressures, make the final spray gun adjustment by observing the spray pattern.

b. Spray Gun Paint Application:

(1) The spray gun shall be held 6 to 8 inches from the surface being painted. Begin the strokes before pulling the trigger and release the trigger before ending the stroke. This prevents piling up paint at the beginning and end of each stroke. Always keep the gun at a right angle to the surface being painted. Swinging the gun in an arc will result in uneven application and excessive overspray at the end of the stroke.

(2) When painting corners, first spray within 1 inch of the corner. Then holding the gun sideways, spray the corner so that both sides of the corner are sprayed at the same time. Speed of application depends upon the material being sprayed, rate of paint flow, and surface to be coated.

5-10. Common Spray Paint Defects.

a. Some of the common causes of an orange peel finish are:

(1) Too high or too low air pressure on the spray gun.

(2) Paint viscosity too high or incorrect thinners used.

(3) Inadequate surface preparation.

(4) Holding the gun so close to the surface that air ripples result.

b. Another common defect in spraying is mist or fog. These defects are caused by the following:

(1) Over atomization caused by:

(a) Air pressure too high.

(b) Fluid pressure too low.

(c) Wrong air cap for material used.

(d) Wrong fluid tip for material used.

(2) Improper use of gun caused by:

(a) Incorrect stroking.

(b) Gun too far from surface

5-11. Paint Failures. The types of paint failures to look for when inspecting a surface before or after an application of paint are described below.

a. Alligatoring or Checking. Alligatoring, or checking, exists when the outer layer of paint is broken and underlying paint coats are visible, often presenting an appearance similar to alligator hide. This may be caused by applying paint:

(1) To unseasoned wood.

(2) Over a relatively soft undercoat.

(3) Over previous coats before they have dried.

(4) Of a hard drying nonelastic type over a more elastic paint.

b. Cracking. Cracking exists when a break extends through to the painted surface. Paints, which lack elasticity because of aging or other causes, can no longer contract or expand with moisture and temperature changes and, therefore, crack.

c. Flaking, Scaling, and Peeling. Flaking, scaling, and peeling are characterized by the detachment of pieces of paint, generally irregular in shape. When pieces are small, it is termed flaking; when pieces average over 1/4 inch, it is termed scaling; when pieces are larger (over 1 inch), it is termed peeling. Flaking and scaling usually follow cracking and have the same causes. Peeling is often caused by the presence of moisture behind the film or by incompatibility of paint film.

d. Bleeding. Bleeding exists when the color of a previous coat is absorbed into the topcoat. Bleeding is usually caused by the solubility of the color ingredient of the undercoat in the vehicle of the new coat.

e. Blistering. Blistering occurs when the topcoat detaches from the underlying surface in unbroken areas because of gases or liquid (usually water) forming beneath the coating.

f. Chalking. Chalking is characterized by the presence of a loose powder evolved from the paint film, at or just beneath the surface. Chalking may be detected by rubbing the film under the fingertips. Slight chalking is desirable for some applications because the surface becomes self-cleaning. The degree of chalking is determined by the composition of the paint.

g. Discoloration. Discoloration is an alteration in the original color and includes yellowing, darkening, fading, and mottling.

SECTION 6. PAINT APPLICATION PROCEDURES

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6-1. General. Detailed paint application procedures are frequently presented in specialty manuals, military or federal specifications and standards.

6-2. Epoxy-Polyamide Coatings.

a. Description. Epoxy-polyamide coatings are similar to other epoxy coatings in that they consist of a two-component system that includes a pigmented polyamide resin (A component) and an epoxy resin (B component). Once they are mixed together and applied as a paint film, the coating cures to a hard film by chemical conversion. During this curing period, the solvents used to maintain the composition in liquid form are released by evaporation.

b. Epoxy Coating Hazards:

(1) Epoxy-polyamides have a minimum flashpoint of 34° C (95° F) and do not require the type of precautions against fire that are essential to vinyl paints. Since solvent fumes epoxy paint systems are potentially hazardous, suitable precautions shall be taken to prevent fires and to protect personnel from fumes and fume inhalation (particularly in confined spaces). Precautions against such hazards must be exercised at all times.

(2) In addition to fire and vapor hazards, these epoxy coatings can cause allergic reactions when allowed to be exposed to the skin. Prompt skin cleanup is recommended using soap and water, not solvent. Solvent will thin and spread the paint over the skin increasing the hazard of a delayed allergic reaction.

c. Surface Preparation. The single factor most affecting the performance of the epoxy primer coatings is the preparation of the surface to be coated, both as to method and to degree of care. Surfaces to be coated should be completely free from rust, loose paint, dirt, scale, oil, grease, salt deposits, moisture, and other contaminants. Surface preparation procedures detailed in section 3 apply and are supplemented by requirements given in this section.

(1) Bare Surfaces. When painted surfaces show evidence of corrosion, peeling, blistering, checking, general disintegration or changing to a new paint system, the old system should be removed down to bare metal prior to repainting. Surfaces to be painted with the epoxy primer system should be abrasive-blasted to near-white metal. In areas where abrasive blasting is not permitted, the surfaces should be cleaned by mechanical means (disk sanding, chipping tools, or pneumatic descaler (needle gun), to remove all loose paint film and foreign matter. Since abrasive blasting will not adequately clean surfaces contaminated with oil or grease, such areas should be cleaned with solvent.

(2) Galvanized Steel. Galvanized steel should be roughened by a light abrasive blast or by mechanical means to provide a suitable painting surface.

(3) Aluminum Surfaces. Aluminum should be cleaned by light abrasive blasting, power wire brushing, or orbital sanding. Only stainless steel wire brushes, scouring pads, or aluminum oxide abrasive sanding disks shall be used. None of these materials shall have been previously used on other metal, or for the removal of copper-pigmented paint, prior to being used on aluminum.

(4) Surface Preparation of Coated Metal. Brush blasting may be used instead of blasting to bare metal in those instances where an epoxy coating is in good condition and has been applied over a well-prepared surface. This method should result in a surface retaining all paint films, but free from all rust, scale, and foreign matter.

(5) Touchup painting. When only localized areas or spots requiring painting, it is essential that removal of the old paint be carried back to an area of intact and adhering paint film. The edges of the tightly adhering paint remaining around the area to be recoated shall be sanded to a smooth slope (feathered) to allow proper blending and prevent laying new paint over loose or cracked paint. Areas of intact paint to be over coated shall first be roughened. A tack coat shall then be applied prior to final coating.

(6) Bilges and Sumps. Structures and fittings below floor plates in machinery spaces (bilges, bilge wells, and sumps) may require special cleaning methods. Bilges on surface ships will be cleaned at shipyards using the hand cleaning method (or equivalent) described in paragraph 3-22, Hand Cleaning of Ships' Bilges.

(7) Wet Spaces. In wet spaces, remove corrosion products and cracked or loose paint by mechanical means. Retain tightly adhering paint. Edges of paint film around the area to be recoated must be tapered (feathered). Remove stains on old paint by solvent cleaning, detergent cleaning, or both. Rinse with clean freshwater and dry before repainting. Apply primer to the bare metal areas so it overlaps the intact paint. Apply topcoats over the spot-primed areas and the remaining intact painted surfaces. Intact painted areas do not require priming.

d. Mixing Epoxy-Polyamide Coatings.

(1) Mixing ratios of epoxy coatings are 1:1 by volume; for example, 5 gallons of component 'A' mixed together with 5 gallons of component 'B'.

(2) Mixing Procedures. Each individual component shall be thoroughly stirred prior to mixing the components together. After mixing equal volumes of the two components, this mixture shall again be thoroughly stirred until well blended. The induction or stand-in time shall be adhered to. Induction time is defined as that time immediately following the mixing of components A and B during which the critical chemical reaction period of these components is initiated. This reaction period is essential to ensure the complete curing of the coating.

(3) Epoxy Primer Induction Times. The approximate temperature of the paint components in storage should be estimated to judge the amount of induction time and the pot life that might be expected. The job site application temperature will affect the time required for the paint to cure, and must be considered in estimating induction time, cure time, and the effect of batch size on these functions.

(a) To ensure that the reaction proceeds uniformly, the paint should be stirred periodically during its induction period. This action prevents localized overheating or hot spots within the paint mixture.

e. Epoxy-Polyamide Coating Application. Epoxy-polyamide coatings may be applied by brushing, spraying, and rolling or dip coating. Application is described below.

(1) Thinning. Up to 1 pint of ethylene glycol monoethyl (EGM) ether for each gallon of mixed paint may be added if the paint has thickened appreciably during cold temperature application, or when necessary to improve application characteristics. When applied at the proper thickness, without thinning, these paints have no tendency to sag.

(2) Application Thickness. Unless otherwise specified, apply each coat of paint to produce approximately three mils dry film thickness (DFT). Coating applications in excess of 4.0 mils DFT should be avoided. Brush Application. During maintenance painting, brush application is recommended for the first coat of paint over mechanically cleaned surfaces and hand-cleaned bilges. The brushing effort forces the paint into the surface profile and displaces any traces of surface contaminants

(3) Tack Coat for Topcoat Paints. If more than 7 days elapse between preservation coats of the epoxy, the surface should be cleaned with water, detergent, and rinsed clean with freshwater. If required, use solvents for grease and oil removal. Then a tack coat (1 to 2 mils WFT) of the last coat applied is applied to the hard epoxy coat. It is allowed to dry approximately 4 hours before application of the next full wet coat of the system. This same procedure applies to aged epoxy paint systems after service, except that surface preparation methods specified in paragraphs 3-4.a.and 3-4.b apply. Epoxy primer should be used as the tack coat when applying epoxy paints over proprietary epoxy coatings.

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(4) Equipment Cleanup. Since epoxy paints cure with time, due to an internal chemical reaction, the paint should not be allowed to remain in spray equipment for an extended period, especially in the sun or in a warm area. Paint cures more rapidly at higher temperatures. When components A and B are mixed together, the pot life of the mixture (including the induction time) is 6 hours at 21.1°C (70°F). Pot life is longer at lower temperatures and shorter at temperatures above 21.1°C (70°F). After use, spray equipment should be cleaned by flushing and washing with EGM ether solvent. General cleanup is also done by using EGM ether solvent. Brushes and rollers should be given a final cleaning in warm soapy water, rinsed clean with warm freshwater, and hung to dry.

6-3. Vinyl Paint Coatings. The procedures and precautionary highlights for the preparation and application of vinyl paints are described below. Refer to section 2 for a more detailed listing of precautions.

a. Safety Precautions:

(1) The solvents used in the vinyl systems component formulations are more flammable than the solvents in most other shipboard paints. The vapors can produce physiological and toxic effects if breathed continuously for long periods. All precautions and safety measures pertaining to flammable materials such as no smoking, welding, burning in the immediate areas, grounding of spray equipment, and elimination of chipping and other spark producing operations shall be enforced. Respirators for spray painters and explosion-proof ventilation shall be used.

b. Surface Preparation. A clean dry surface, free of contaminants, is especially critical in the application of vinyl paints improper surface preparation will result in unsatisfactory paint performance.

(1) Prior to the application of vinyl paints, the removal of scale, corrosion, dirt, grease, oil, marine fouling, and other foreign matter from the surface shall be completed. The method of cleaning depends upon the amount and the type of cleaning required. For metal surfaces, abrasive blasting is the most effective method for surface preparation. A solvent wash and light blasting or mechanical roughening may be used to rid new-galvanized steel of fatty material and flux components, as well as to provide a suitable anchor pattern. This is required for satisfactory adhesion of pretreatment primer.

(2) Cleanup. During cleaning operations, considerable dust or debris will collect on otherwise clean surfaces. Depending upon weather conditions, some rusting may occur. Any contaminants on the surface to be painted must be removed prior to coating application.

(3) Touchup Surface Preparation.

(a) For vinyl bottom paint touchup, surfaces shall be washed down with streams of high-pressure water after docking to remove mud, slime, scum, and loose marine fouling. Light blasting may be used for removing adherent marine life from intact paint. Prior to touchup, deteriorated areas of old paint and

corrosion products should be removed, and surfaces prepared as specified above. Oil and grease may be removed with suitable solvents.

(b) To avoid after-corrosion or surface contamination, each shift shall clean only the areas that can be coated in the same shift. All cleaned surfaces shall be coated as soon as practical, including those that were cleaned of oil and grease as well as corrosive products.

d. Vinyl Paint Mixing. Vinyl paints are best mixed by using a mechanical shaker or high-speed stirrer. Mixing is very important because the copper pigment in antifouling paint settles to the bottom of the containers during storage. All of the pigment must be thoroughly dispersed in the paint to achieve optimum antifouling properties. After agitation, the paint should be examined with a hand paddle to be sure that the contents of the container are properly mixed. The paint should be restirred as necessary to keep the pigment in suspension.

e. Vinyl Paint Application. Vinyl paints may be applied through any paint application method. They should not be applied over conventional paint films because of the softening effect of the ketone ingredient used in vinyl paints. When vinyl antifouling paints are applied over cured epoxy paints, a mist coat of the epoxy paint must be applied before the vinyl paint to assure adhesion. Depending upon the thickness of the wet film and weather conditions, vinyl paints may be recoated within 1 hour. A minimum drying period of 24 hours, preferably longer, is necessary between the final coats and undocking to ensure solvent release.

(1) Hot and Airless Spray Application. Hot and airless sprays require special techniques that should be developed by the shipyard.

(2) Conventional Spray Application. The actual application of vinyl coatings by spray requires more technique and a better understanding of spray equipment than is usually exercised with other types of finishes. Since vinyl paints are comparatively low in non-volatile film-forming materials, the operator must make slow steady passes with the spray gun. The speed of the passes has a direct relation to the DFT, which, in turn, influences the ultimate performance of the system.

(3) There are many variables in spraying vinyl paints, some of which are influenced by the painter's experience. These factors include: atomizing, fluid pressures, and the necessity for thinning the paints. These factors are, in turn, influenced by:

(a) Paint viscosity.

(b) Ambient temperature during application.

(c) Type of spray equipment.

(d) Length and diameter of the paint lines.

(e) Height between paint pot and spray gun.

(4) Ensure that the spray equipment is clean, in good working order, and correctly assembled. Obviously worn parts, particularly the air cap, fluid tip, and needle, shall be replaced. These parts shall be examined for clogging and shall be cleaned during the application whenever it is apparent that the gun is spraying improperly.

(5) Vinyl Paint Thinner. Methyl isobutyl ketene, or a 50-50 mixture of methyl isobutyl ketone and xylene, should be used for thinning paints when required to obtain a suitable spray pattern or when cleaning the equipment. A mixture of l/2 to 1 gallon of ketone to 5 gallons of paint has been found to sufficiently thin most vinyl paints.

(6) Vinyl Paint Viscosity Reduction. Reduce vinyl paint viscosity by warming cans in a steam box located at the job site. Temperatures shall be maintained below 48.3°C (110°F).

(7) Spray Gun Adjustments. For each application or new paint shipment, the spraying conditions may differ, requiring spray adjustments. Adjust the spray gun to wide fan position and the paint fluid valve to 1/2 the fully open position. Adjust the atomizing air on the gun to 60 pounds and the paint fluid pressure to 30 pounds and sample the spray pattern. If the spray pattern is not suitable, and no further adjustment or combination of adjustments of fan width and paint fluid valve will correct the pattern, increase the paint fluid pressure in increments of 10 pounds, up to 60 pounds. If the spray pattern is still not suitable, the vinyl paints need to be thinned (paragraph (5) above).

(8) Adjust the spray gun pressure to obtain a uniform fan with proper atomization. A spray pattern that produces too dry a spray will result in a powdery surface with a considerable deposit of spray dust on it. To correct the dry spray, reduce the air pressure and increase the paint pressure. A fan pattern created by too wet a spray may result in a film that is splotchy or that sags. To correct the excessively wet spray, reduce the paint pressure and increase the air pressure. Spray pattern should be kept wet and the film continuous as the area is covered. If the fan narrows down or the paint starts to spit out of the gun, the nozzle should be removed and cleaned.

(9) Vinyl Spray Coating Techniques. Vinyl paint shall be applied with continuous parallel strokes overlapping the preceding stroke by at least 2 inches. The painter should not pause at the end of the stroke, because paint will pile up at the laps, resulting in an uneven appearance and sagging. The correct gun-to-surface distance should be maintained wherever practical and should not exceed 16 inches. A spray coat consists of the maximum amount of paint that can be applied at one time (in one or more passes) without sagging.

(10) Three-Pass Cross Technique. To produce uniform films of proper thickness, a three-pass cross technique has been found particularly suitable for vinyl primer application to large areas. Cover an area with horizontally-oriented spray gun passes, moving the gun at a speed that will keep the spray pattern wet and the film continuous as the area is covered. Next, cross the same area with vertical passes of the gun. Lastly, horizontally re-cross the area. These three passes of the gun are considered one spray coat.

(11) Confined Area Techniques. In confined areas, such as crown frames and other welded structural members, it is usually not practical to cross-stroke each spray pass. In such areas, the spray passes should be made back and forth in the same direction and the painter should reduce the middle of the spray pattern to fit the structural member. To cover tight corners and weld areas, the pattern should be reduced to a small oval.

6-4. Polyurethane Coatings:

a. Description. Polyurethane coatings are a two-component coatings system that consists of part A and part B. Once they are mixed together and applied as a paint film, the coating cures to a hard film by chemical conversion.

b. Coating Hazards.

(1) Once cured, polyurethane coatings present no special health hazards but do present special problems during mixing, application, and curing because of the possibility of free isocyanate vapors being liberated. These isocyanate vapors can cause irritation of the skin, eyes, and respiratory tract. Isocyanate vapors can cause severe allergic reaction in sensitized individuals and may produce asthma-type symptoms.

(2). The material safety data sheet shall be reviewed prior to using this product.

c. Surface preparation. Surface must be clean, dry, and in sound condition. Remove all oil, dust, grease, dirt, loose rust, and other foreign material to ensure adequate adhesion. For best performance

use near white metal blast cleaning per SSPC-SP10. Prime any bare steel the same day as it's cleaned before flash rusting occurs.

d. Paint application. Always apply polyurethane according to the manufacturer's instructions.

e. Touchup painting. Touchup painting shall be performed in localized areas or spots requiring painting. It is essential that removal of the old paint be carried back to an area of intact and adhering paint film. The edges of the tightly adhering paint remaining around the area to be recoated shall be sanded to a smooth slope (tapered/feathered) to allow proper blending and prevent laying new paint over loose or cracked paint. Areas of intact paint to be over coated shall first be roughened.

SECTION 7. SHIPBOARD PAINT APPLICATION

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7-1. General. This section covers the application of paints to shipboard equipment, bilges, tanks, and interior and exterior surfaces of US Army Watercraft.

7-2. Pretreating, Priming, and Insulating Metal Surfaces. Metal surfaces should be primed as soon as practical after surface preparation. This prevents corrosion and maintains the state of preservation until the finish coat can be applied. To prevent bimetallic corrosion, dissimilar metal surfaces must be kept separate from each other. The preservation of metal surfaces is described below.

a. Steel Surfaces. Except when otherwise specified steel should be painted with at least one coat as soon as practical after surface preparation. See the painting instructions pertaining to the end use of the steel to determine the proper primer for final painting. Apply one priming coat to interior surfaces and two coats to exterior surfaces. Give all edges, welding, rivet heads, and other protruding objects an additional coat of primer. Clean and touch up areas that become bare or show rust.

b. Galvanized Steel:

(1) Paint all galvanized steel unless painting is specifically excluded elsewhere in this TB. Apply epoxy paints where specified; otherwise, apply one coat of epoxy primer to surfaces that are to be painted.

(2) Paint welds and damaged areas of galvanized surfaces as required for the surrounding galvanized area. Apply paint only to surfaces that have been cleaned (preferably by abrasive blasting). Where painting is not required, apply two coats of galvanizing repair paint to the welds and damaged areas.

c. Miscellaneous Metals:

(1) In interior compartments, corrosion-resisting steel, brass, nickel-copper alloy, and copper-nickel alloy are not required to be painted except to improve appearance. Camouflage painted exterior areas must be coated with an epoxy primer prior to application of the finish paint.

(2) In seawater tanks and fuel tanks, completely paint corrosion-resistant steel (CRES) and copper alloy piping to minimize the effect of galvanic corrosion on the coated tank surfaces. Copper-bearing piping and components shall be painted only after adequate masking of rubber items, gaskets, filters, heat exchange surfaces, and critical sealing surfaces.

e. Dissimilar Metal Surfaces:

(1) The most effective methods for preventing bimetallic corrosion are careful design and correct assembly. Excellent workmanship is required to insulate dissimilar metals effectively. Properly applied films of specified paints and insulation tapes will increase durability and prevent corrosion.

(2) For insulation material to function effectively it must be installed so that all joints are closed; this ensures that water cannot collect and form a bridge between steel and aluminum. For ships in service where no insulating tape appears to have been used, or where existing tape has deteriorated, horizontal joints exposed to the weather shall be sealed with calking compound.

7-3. Shipbottom Epoxy Anticorrosive Coatings. Commercial epoxy anticorrosive coatings that have been approved for use on shipbottoms are listed in Appendix A. These proprietary coatings shall be applied as recommended by the manufacturer except for minimum film thickness.

a. Surface Preparation. Minimum surface preparation standards for epoxy coatings, as stated in paragraph 6-2.c, shall be followed if they are more stringent than the manufacturer's instructions.

b. Final Coats. The antifouling topcoat for shipbottoms shall be self-cleaning/polishing.

c. Approved Coatings from Proprietary Sources. Proprietary coatings are to be purchased on a competitive basis. Coating selection shall be made based on factors that contribute to total application cost and time available for application. Paint thickness requirements specified in Appendix B shall be used for estimating total cost. The factors to be considered are:

(1) Total coating material cost (that is, cost per square foot for required total film thickness, rather than cost per gallon).

(2) Equipment available for coating application, and ease of application.

(3) Ambient temperature, pot life, stand-in or induction time, drying time required between coats, and curing time.

(4) Safety precautions required.

(5) Colors of coating system as an aid to application and inspection of the surface during application and in service.

(6) Availability of technical services.

(7) Past performance of coating.

(8) Whether or not the coating is approved for use by the Environmental Protection Agency (EPA).

(9) Procurement activities should solicit invitations for bid and comply with Defense Federal Acquisition Regulations (DFARs) on each requisition for proprietary coatings.

d. Aluminum Boats Shipbottom Paint System:

(1) Antifouling paint need not be applied to aluminum boats. Aluminum boats are dry-berthed or subject to frequent beaching. The NMP has the responsibility for deciding whether to apply antifouling paint under these conditions.

(2) The NMP has the responsibility for specifying the desired antifouling paint colors for aluminum ships or crafts and for new aluminum ships or crafts scheduled to join their Commands.

(3) The proprietary products approved for use on aluminum boat shipbottoms and aluminum boat boot toppings are listed in Appendix B.

7-4. Coating for Bilges and Tanks (Except Potable Water Tanks). Approved paint coating systems for saltwater ballast tanks are listed in Table B-10. Surface preparation by abrasive blasting to near-white metal is required for maximum adhesion and performance. Coatings shall be applied as recommended by the manufacturer.

7-5. Potable Water Tank Coating Systems. Excessively applied or inadequately cured potable (fresh) water tank coatings have a potential impact on crew health, well-being, and morale because they make food and beverages unpalatable. Ship operating schedules can also be adversely affected, with worst cases requiring unanticipated/additional time at an industrial activity for coating replacement. Therefore, it is recommended that all potable water tanks be painted at each overhaul by a depot-level activity to maximize compliance with these procedures and to minimize the extent of potable water tank preservation required outside of overhaul. This policy will ensure for sufficient paint curing times.

a. Approved Coating Systems. The commercial products listed in table B-9 are approved for use in potable water tanks.

b. Proprietary Coatings. Proprietary coatings listed in Appendix A, Table A-2 shall be mixed and applied in accordance with the manufacturer's instructions and as specified in this TB. If ambiguity exists, requirements of the TB shall govern. Any unresolved conflicts shall be reported to the NMP for guidance. Deteriorated epoxy-polyamide coatings shall be removed and replaced with an approved proprietary coating system.

c. Coating Requirements.

(1) The following requirements apply to all coatings used in potable water tanks:

(a) Drying time between coats shall be no less than 48 hours at a minimum temperature of 21°C (70°F). Heated air shall be used if necessary to maintain the proper temperature.

(b) Ventilation shall be a continuous airflow (See Section 2).

(c) Fully coated tanks shall be cured for a minimum of 7 days under the same conditions mentioned above prior to being filled.

(d) Refer to paragraph 2-14. Application of Paint in a Confined Space for ventilation requirements guidance.

(e) Freshly painted potable water tanks shall be rinsed at least twice with freshwater before being disinfected and put into service.

(2) It is recognized that situations arise where very limited touchup is required, and specified drying times would have an adverse impact on the ships schedule. There is no approved procedure for accelerating drying or curing of these paints. Any situations requiring accelerated paint drying or curing should be referred to the NMP for approval, including a proposed resolution such as using heat to shorten drying and curing times.

d. Film Thickness Requirements:

(1) WFT to DFT thickness ratios should be locally determined for the selected coating. Use the same mixing and application procedures used for ship tank painting. Painters should be instructed to apply paint within a WFT range that will result in the required DFT. All potable water tank painters should be supplied with WFT gages.

(2) Procedures shall be instituted to ensure that for at least 98% of the tank surface area, the total thickness of the applied paint system is no greater than the total number of coats applied multiplied by the maximum allowable per-cost thickness.

(3) Adequate painting for preservation may result in excessive thickness near angular shapes. In isolated areas, near stiffeners for example, the maximum DFT may be exceeded by up to 2 mils per coat, provided that the total non-complying area is less than 2 percent of the total tank surface. For touchup or over coating intact aged paint in good condition, the same requirements apply. The total film thickness requirement may be corrected to allow for the thickness of underlying paint. The requirement is to avoid excess thickness in individual coats. High DFT resulting from properly applied extra coats is not considered a problem below 35 mils total.

e. Quality Assurance. Minimum quality assurance inspections for potable water tank coatings shall include:

(1) Surface preparation (to ensure freedom from surface dirt, moisture, or other contaminants).

(2) DFT of any remaining aged coating.

(3) DFT after application of each coat, recording at least five measurements per 1,000 square feet of surface.

(4) Hardness of paint (to ensure that each coat has cured thoroughly).

7-6. Electric and Electronic Equipment.

a. Electric and electronic equipment will usually be supplied, painted, and preserved as required by either the individual purchase specifications or the operating manual. Painting and preservation may be necessary if the equipment is received in an unpainted condition or if the coating has been damaged during shipment. In addition, painting and preservation are necessary for finishing and installation.

b. Except as otherwise specified, the painting and preservation of electric and electronic equipment shall comprise: One coat of epoxy primer applied to bare metal surfaces only

7-7. Motors and Generators. Motors and generators shall be painted in accordance with specifications given in the following.

a. Exterior Parts. Except for shafts and identification plates, paint exterior parts in accordance with paragraph 7-6.b above.

b. Interior Parts. Electrical insulation of all types, surfaces in contact with lubricating oil or grease, commutators, collector rings, brushes, bearings, and bearing surfaces shall not be painted. Do not paint peripheries of armatures and rotors or any other rotating part of a machine from which centrifugal force may cause the paint to be thrown on to the windings when the machine is operated at rated load and rated ambient temperature. Insulation varnish, instead of paint, may be applied to such parts. Paint other corrosion-resistant parts in accordance with paragraph 7-6.b. above.

c. Apply one coat of epoxy primer followed by one coat of white enamel to the inside of both ends of the enclosure of water or air-cooled motors and generators.

d. To reduce wear of carbon brushes, paints that contain silicone resins shall not be used on or in close proximity to motors and generators.

7-8. Switchboards and Panels. Switchboards and dead-front type panels for control, power, lighting applications, and for electric propulsion, shall be given an additional finish coat only if cleaning and touchup will not give the desired result.

7-9. Electric Cables. Do not paint electric cables.

7-10. Metal Enclosures.

a. Enclosures for motor controllers, electric panels, wiring boxes, fittings, fixtures and enclosures for electric equipment in general (except electronic, interior communication, and fire control equipment) for which painting is not otherwise specified in purchase specifications, shall be painted in accordance with appendix B. For equipment received with pretreatment and primer only, apply finish coats as appropriate. Finish-paint that matches the surrounding structure may be applied over the epoxy primer to avoid having to mask enclosures when painting the surrounding structure. Touch up any damaged coatings as required. Epoxy primer pretreatment is not required over intact primer or in confined spaces where necessary safety precautions cannot be followed.

b. Brass, Corrosion-Resistant Steel (CRES), and nonferrous metals other than aluminum shall not be coated except where painting is desirable for appearance or camouflage.

7-11. Miscellaneous Equipment. The painting specifications for the miscellaneous shipboard equipment are given in Appendix B.

7-12. Shipboard Items not to be painted. The following shipboard items are not to be painted:

a. CRES decks, CRES galley equipment, and CRES bulkheads in wet spaces.

b. Decorative plastic surfaces such as those on bulkheads and tabletops.

c. Hatch and door rubber gaskets and rubber window moldings.

d. Sight glasses, gage faces, and identification plates and other markings, which, if painted, would be illegible.

e. Insulators.

f. Knife edges of watertight doors and hatches.

g. Porcelainized surfaces.

h. Threaded parts, such as adjusting threads and take up threads which, if painted, would not function properly.

i Anodes and Cathodic protection.

j. The following interior aluminum surfaces:

(1) Bins, shelves, dressers, cabinets, battens, and fittings.

(2) Interior gratings, handrails, and floor plates.

(3) Internal ventilation duct surfaces.

k. Electrical outlet, terminals, activating mechanisms of electrical safety devices, and control switchboards on machinery elevators.

l. Bell pulls, sheaves, annunciator chains, and other mechanical communication devices.

m. Within magazines, dry sprinkling piping with holes drilled in the pipe top.

n. Exposed composition metal part of any machinery.

o. Glads, stems, yokes, toggle gear, and all machined external valve parts.

p. Heat exchange surfaces of heating or cooling equipment.

q. Joint faces of gaskets and packing surfaces.

r. Lubricating gear, such as oil holes, oil or grease cups, and lubricators and surfaces in contact with lubricating oil.

s. Lubricating oil reservoirs.

t. Machined metal surfaces of reciprocating engines or pumps and oil-wetted surfaces of internal combustion engines.

u. Metal lagging.

v. Rods, gears, universal joints, and couplings of valve operating gear.

w. Expansion joints, nonferrous parts of pipe hangers, flexible hose connections, and items particularly fabricated of rubber, and resilient elements of isolation mounts.

x. Springs.

y. Strainers.

z. Working surfaces.

aa. Deck fitting and joiner hardware on plastic boats.

ab. Light-reflecting and light-transmitting surfaces of items such as light fixtures, ports, and windows.

7-13. Preservation and Coating for Interior and Exterior Surfaces.

a. Exterior Surfaces. Metal exterior surfaces of all surface ships are to be coated in accordance with the requirements in Appendix B.

b. Interior Compartments. Interior painting (except in tanks, voids, and bilges) is not necessary when existing paints meet the requirements of this TB and can be cleaned to the satisfaction of the ship's Vessel Master.

NOTE

Use a minimum number of thin coats when painting for appearance instead of preservation.

c. Interior Color Schemes. The choice of colors for living, messing, recreation, commissary, sanitary spaces, and adjacent passageways must be restricted to those specified for decks, bulkheads, and overheads in Appendix B.

d. Surface Preparation and Coatings. If the existing coatings show significant defects such as cracking, peeling, and flaking, the entire surface should be cleaned to bare metal and repainted using the appropriate procedure.

(1) Apply one coat of epoxy primer. Use two finish-coats of chlorinated alkyd-base paint on bulkheads and overheads. Chlorinated alkyd-base paints are applied in the same ways as conventional alkyd-base paints.

(2) Apply one coat of epoxy primer and two finish-coats on decks.

(3) Both sides of uninsulated fire zone bulkheads shall receive two coats of thermal insulating coating compound. Apply the coating compound to the minimum approved DFT over properly prepared and primed surfaces. Epoxy primers are acceptable primers.

(4) Apply one coat of epoxy primer and one coat of white epoxy topcoat to wet spaces such as washrooms, water closets, bath and shower spaces, sculleries, and vegetable preparation spaces. Apply as specified in paragraphs 6-2.a through 6-2.e to achieve at least 5 mils DFT.

e. Bulkheads and Overheads.

(1) Use non-flaming chlorinated alkyd-base paints for the overheads and bulkheads of living, messing, and recreation spaces, and their connecting passageways. Paint fibrous glass board to match surrounding structure. Finish-paint all other compartments in accordance with Appendix B.

(2) Interior deck colors may be carried up onto the bulkhead adjacent to the deck to a height of approximately 6 inches. Paints listed in Appendix B may also be used for deck boarders in spaces where rugs are installed. Interiors of weather doors may be finish-painted to match the surrounding bulkhead.

f. Painting Behind Equipment. Before installation of front-serviced electronics equipment, the bulkhead and deck area should be painted with two coats of epoxy primer and finish-painted in accordance with Appendix B.

g. Decks and Walking Surfaces. Decks for which coverings are specified require painting where the deck covering consists of false decking, gratings, rugs, or portable material. Do not paint surfaces of aluminum or CRES. Deck Plates in main and auxiliary machinery spaces shall be painted in accordance with Appendix B.

h. Acoustical-Absorptive Treated Surfaces. Surfaces treated with acoustical absorptive material shall be painted with one coat of paint (unless two coats are required to achieve hiding) to match surrounding structure. The paint shall be sprayed in thin coats and care shall be taken to prevent the paint from bridging or sealing the perforations in the acoustical treatment.

i. Tanks, Bilges, and Voids. Tanks, bilges, and voids shall be painted in accordance with Appendix B.

(1) CRES, copper-nickel, Monel, bronze, and other copper-bearing metals are frequently used for piping and for components placed in coated tanks. The metals act as strong cathodes in immersion conditions, causing galvanic corrosion to take place at gaps (holidays) in the painted tank surface (anode). Deep pits occur at paint holidays since small anodic steel surfaces are exposed to relatively large cathodes of corrosion-resistant bearing metal. To protect against galvanic corrosion in immersion conditions, both the pipes and the components should be completely coated with the specified tank or bilge coating system, except where prohibited.

(2) Proprietary approved coatings shall be applied as recommended by the manufacturer or as stated in the paint specification. The minimum surface preparation standards for epoxy coatings shall govern when they conflict with less thorough requirements in the manufacturer's instructions.

APPENDIX A

Paint Materials

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Table A-1 MATERIALS COVERED BY FORMULA DESIGNATIONS

Formula No.	NSNs and Container Size
49 Stain, oil, wood, interior, cherry	8010-00-165-4422(1 qt)
50 Stain, oil, wood, interior, dark mahogany	8010-00-281-2075(1 gal)
51 Stain, oil, wood, interior, dark oak	8010-00-281-2072(1 gal)
52 Stain, oil, wood, interior, light oak	8010-00-597-8226(1 qt)
54 Stain, oil, wood, interior, walnut	8010-00-597-8225(1 gal)
67 Putty, slate color	8030-00-275-8097(1 gal)
124 Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semi Gloss	8010-00-577-47381(gal)
Color 27880 White	8010-00-577-4739(5 gal)
125 Enamel, Interior, Nonflaming (Dry), Chlorinated Alkyd Resin, Semi Gloss	8010-00-577-4734(1 gal)
Color 24585 Pastel Green	8010-00-577-4735(5 gal)
126 Enamel, Interior, Nonflaming (Dry)	8010-00-577-4736(1 gal)
Chlorinated Alkyd Resin, Semi Gloss Color 26307 Bulkhead Gray	8010-00-577-4737(5 gal)

Table A-2 MATERIALS NOT COVERED BY FORMULA DESIGNATIONS

Aluminum Paste	Filler, Crack and Seam (for wood metal or concrete and cement mortar)	8010-00-247-4347(1 lb) 8010-00-247-4338(10lb)
Antisweat Compound	Coating Compound, Paint, Antisweat	8010-00-965-2507(1 gal)
Asphalt Varnish	Varnish, Asphalt	8010-00-160-5856 (5 gal)
Caulking Compound	Compound, Caulking, knife or gun application (metal and wood)	8030-00-160-6899 (1/2 pint) 8030-00-577-4740 (1/2 gal) 8030-00-243-0956 (1 gal)
Caulking Compound	Compound, Caulking, knife and caulking iron application (metal only)	8030-00-753-4982 (RO) 8030-00-297-0600 (1 qt)
Canvas Preservative	Preservative Coating, Canvas	
	Haze Gray	8030-00-550-5906 (1 gal)
	Deck Gray	8030-00-281-2347 (1 gal)
	Olive Drab	8030-00-281-2346 (5 gal)
	White	8030-00-550-8017 (1 gal)
Cleaning Compound	Cleaning Compound, Fuel Tank and Bilge	6850-00292-9700 (5 gal) 6850-00-292-9701 (55 gal)
Cleaning Compound, Steam	Cleaning Compound, High Pressure (Steam) Cleaner	6850-00-256-0157 (125 lb)
Clear epoxy	Coating, Epoxy, high solids	8010-00-959-4661 (1 kit)
Coating Bituminous	Coating Compound, Bituminous Solvent Type, Black (For Ammunition)	8030-00-290-5141 (1 gal)
Corrosion Preventative Compounds		
	Solvent Cutback, Cold Application	
Grade 1 (Hard Film)		8030-00-231-2345 (1 gal) 8030-00-244-1299 (5 gal) 8030-00-244-1300 (55 gal)
Grade 2 (Soft Film)		8030-00-244-1297 (1 gal) 8030-00-244-1298 (5 gal) 8030-00-244-1295 (55 gal)
Grade 3 (Soft Film, Water Displacing)		8030-00-244-1296 (1 gal) 8030-00-244-1293 (5 gal) 8030-00-244-1294 (55 gal)
Grade 4 (Transparent, Non Tacky Film)		8030-00-526-1605 (5 gal) 8030-00-526-1604 (55 gal)
Class 1 (Hard Film)		8030-00-231-2354 (5 lb) 8030-00-597-3288 (35 lb)

Table A-2 MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (CONT)

Class 1A (Hard Film, Non Stick)		8030-00-514-1843 (400 lb)
Corrosion Preventative oil, nonstaining		8030-00-255-4447 (5 gal)
Detergent	Detergent, General Purpose Water Soluble	7930-00-282-9699 (1gal)
Diammonium Phosphate	Tech, Grade	6810-00-174-1821 (100lb)
Linseed Oil	Linseed Oil (raw)	8010-00-656-1639 (5 gal)

Enamel (Gloss) Enamel, Silicone Alkyd, Copolymer

Color	Code
Brown	10055
Brown	30279
Red	11105
Red	31136
International Orange	12197
Orange	12246
Yellow	13538
High-light Buff	13578
Dark Green	14062
Green	34424
Olive Drab	14064
Medium Green	14110
Dark Blue	15044
Clear Blue	15177
Dark Gray	16081
Light Gray	16376
Black	17038
Off White	17875
Off White	17886
White	17925
Enamel,	Enamel, Silicone Alkyd, Copolymer

Table A-3 JOB SITE AMBIENT TEMPERATURE AND INDUCTION TIME

Ambient Temperature °C (°F)	Induction Time (in hours)
1.6 to 10 (35 to 60)	2 at 21.1°C (70°F)
10.0 to 15.6 (50 to 60)	2
15.6 to 21.1 (60 to 70)	1 to 1 1/2
21.1 and above (70 and above)	1/2 to 1

APPENDIX B

Painting Systems

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NOTE

This appendix lists all paint systems approved for use on Army watercraft. You must use one of these systems or one equivalent to it. Please contact the Watercraft Inspection Branch to verify your current paint system. Special operational requirements may warrant a change in your paint system. Contact Commander, US Army Tank-Automotive and Armaments Command, Troop Support Group, Watercraft Inspection Branch, ATTN: AMSTA-LC-CJWW, BLDG 2796, Fort Eustis, Virginia 23604-5286 for guidance. Faxes can be sent to (757) 878-5109. These paint systems do not apply to leased vessels; they shall be painted/touchup in accordance with the contract agreement.

Peacetime and Mobilization

Table B-1 U/W HULL to BOTTOM of RUB RAIL

	1st coat	2nd coat	3rd coat	DFT/coat
Ameron	Bar-Rust 238 Red	Bar-Rust 238 Lt Gray	NA	10/5
International	Intershield KZ Red	Intershield KZ Gray	NA	5
Sherwin Williams	Seaguard 5001 Red	Seaguard 5001 Gray	NA	5
Hempel USA	Hempadur 4514U Red	Hempadur 4514U Gray	NA	5-8
	Hempadur 4515 Red	Hempadur 4515 Gray	NA	5-8
	Hempadur 4514	Hempadur 4514	Hempadur 4518	5/5/3

Table B-1 U/W HULL to BOTTOM of RUB RAIL (continued)

	1st coat	2nd coat	3rd coat	DFT/coat
DuPont Industrial	Corlar 25P 71125P Red	Corlar 25P 63325P Gray	NA	5-8
CMP Coatings, Inc.	Bannoh 500	Bannoh 500R	NA	5
	Bannoh 500 Red	Bannoh 500R Black		5/5
F&H	822 UW Epoxy Red	822 UW Epoxy Gray	NA	5

Table B-2 ANTIFOULING

Note

Dry Stored Vessels are Painted with Hempel Globic or Equal, Ablative AF will Dry and Flake Off.

Ameron	ABC #3 Blue	ABC #3 Red	ABC #3 Black	
International	Interviron A/F Blue	Interviron A/F Red	Interviron A/F Black	5
Sherwin Williams (Seaguard)	Ablative A/F Blue	Ablative A/F Red	Ablative A/F Black	5
Hempel USA	Olympic A/F 7660 Black	Olympic A/F Red	Olympic A/F Black	5
	Globic 81920 Black	Globic 81820 red	Globic 8192 Black	4
	Olympic 86951	Olympic 86951	Olympic 86951	5
	Globic 8190 reddish/brown	Globic 8190 red	Globic 8190 Black	4
	Globic 81900 Red 51110	Globic 8190 Black		4
CMP Coatings Inc.	Sea Grandprix 500/700 Red	Sea Grandprix 500/700 Black		5
.	TFA10-A	TFA10-A	TFA10-A	5
	Sea Tender Blue	Sea Tender Red	Seatender Black	5
F&H	Inducote A/F Black	Inducote A/F Red	Inducote A/F Black	5

Table B-3 FREEBOARD, MAIN DECK, AND ABOVE VENTILATION DUCTS

Ameron	Dimetcote 302H	Amercoat 385 Pearl Gray	Amercoat 450H	3/5/3
International	Interzinc EPA 075	Intertuf KH Lt Gray	Interthane PH Haze Gray	3/5/3
Sherwin Williams	Zinc Clad IV	Fast Clad DTM Haze Gray	NA	4/5
Hempel USA	HempaduR 1736 zinc-rich	Hempadur 4588 Lt gray	Hempa 5595 Haze	2/8/2
UK Equivalent (Dry Abrasive Blast)	Hempadur 1736 zinc rich	Hempadur 4514	Hempa 5521semi gloss	5/5/2
Hydro Blasting Only	Hempadur 4514	Hempadur 4514	" "	5/5/2
Hempel	Hempadur 1555 Red	Hempadur 4514 Lt Gray	Hempa 5521 Haze Gray	2/5/2
Dupont Industrial	Ganicin 347-912 zinc	25P 63725P Lt gray	Urethane 333 Haze Gray	3/5/2

Table B-3 FREEBOARD, MAIN DECK, AND ABOVE VENTILATION DUCTS (Except Decks) (continued)

	1st coat	2nd coat	3rd coat	DFT/coat
CMP Coatings, Inc.	Epicon Zinc HB-2	Umeguard SX	Unymarine Haze Grey	3/5/2
CMP	Epicon Zinc HB-2	Umeguard SX	Unymarine Finish	3/5/2
F&H	885 ZF	235 Epoxy Gray	890 AU Haze Gray	3/5/3

Table B-4 STACK PIPES

Hempel	Silicone Topcoat 5690 Black 2 coats	1.5
CMP Coatings, Inc.	Silcon No. 400 Black	1-2

Table B-5 ALUMINUM PRIMER

Hempel	Hempadur 1530V	Same	Same	4

Table B-6 WELL DECK, RAMP TOP PLATE, DECK BORDERS

Note
Apply to bow ramp top plate surfaces two coats 10 mils each

Ameron	Dimetcote 302H	Amercoat 385 Pearl Gray	Amercoat 450H	3/5/3
International	Interzinc EPA 075	Intertuf KH Lt Gray	Interthane PH Haze Gray	3/5/3
Sherwin Williams	Zinc Clad IV	Fast Clad DTM Haze Gray	NA	4/5
Hempel USA	HempaduR 1736 zinc-rich	Hempadur 4588 Lt gray	Hempathane 5595 Haze	2/8/2
UK Equivalent (Dry Abrasive Blast)	Hempadur 1736 zinc rich	Hempadur 4514	Hempathane 5521semi gloss	5/5/2
Hydro Blasting Only	Hempadur 4514	Hempadur 4514	" "	5/5/2
Hempel	Hempadur 1555 Red	Hempadur 4514 Lt Gray	Hempa 5521 Haze Gray	2/5/2
Dupont Industrial	Ganicin 347-912 zinc	25P 63725P Lt gray	Urethane 333 Haze Gray	3/5/2
CMP Coatings, Inc.	Epicon Zinc HB-2	Umeguard SX	Unymarine Haze Grey	3/5/2
CMP	Epicon Zinc HB-2	Umeguard SX	Unymarine Finish	3/5/2
F&H	885 ZF	235 Epoxy Gray	890 AU Haze Gray	3/5/3

Table B-7 NON-SKID AREAS of DECKS

Ameron	Amercoat 137	Amercoat 138HR Haze Gray	NA	3/NA
Sherwin Williams	Zinc Clad IV	Dura Skid 460 Haze Gray	NA	3/NA
Hempel USA	Hempadur 4588	Hempadur 493US Haze Gray		
Hempel	Hempadur 4514	Hempadur Non-Skid 4534 Haze Gray 11480		5/NA
CMP Coatings, Inc.	Bannoh 500	Maxtop Non-Skid Haze Gray		3/NA
F&H	885 ZF	868 Non-Skid Haze Gray		3/5

Table B-8 INTERIOR PAINT SYSTEMS

	1st coat	2nd coat	3rd coat	DFT/coat
Ameron	Amercoat 385 Buff			
International	Intertuf KH Buff			
Sherwin Williams	Macropoxy 646 Buff			
Hempel USA	Hempadur 4588 Hempadur 45143	Wet Areas 4858 W/B Epoxy Dry Areas 5810 W/B Acrylic		
DuPont Industrial	Corlar 26P HB DTM		2 coats	
CMP Coatings, Inc.	Umeguard SX – color as spec.		2 coats	
F&H	825 RC	825 RC		

Table B-9 POTABLE WATER TANKS COATINGS

Ameron	Amercoat 233ER Buff	Amercoat 233ER White	NA	4
International	Interline 925	Interline 925	NA	5
Sherwin Williams	Tankguard#1 Green	Tankguard#3 White	NA	4
Hempel USA	Hempadur 85671 L.Red Hempadur 3553 L.Red	Hempadur 85671 White Hempadur 3553 L/Gray	NA	6
DuPont Industrial	Corlar TL NSF (Beige)	Corlar TL NSF (White)		6
CMP Coatings, Inc.	Cleankeep 5000 off white – one coat Or Clean Keep 5000	Clean Keep 5000		12 6/ct.

Table B-10 BALLAST TANKS, VOIDS and COFFERDAMS

Ameron	233 ER Buff	233ER White	NA	
International	Intergard KB Buff	Intergard KB White	NA	5
Sherwin Williams	Dura Plate 235 Buff	Dura Plate 235 White	NA	5
Hempel USA	Hempadur 1763 L.RED	Hempadur 1763 Buff	NA	6
Hempel	Hempadur 4514 Power tool clean and spot paint Hempadur 1763 L.Red Full Blast and Paint	Hempadur 4514 Hempadur 1763 Buff	NA NA	6 6

Table B-10 BALLAST TANKS, VOIDS and COFFERDAMS (continued)

	1st coat	2nd coat	3rd coat	DFT/coat
Dupont Industrial	Corlar 25P 71125P Red	Corlar 25P 63325P Buff	NA	6
CMP Coatings, Inc.	Nova 1000 Cream	Nova 1000 Grey	NA	5
F&H	235 Epoxy Buff	235 Epoxy White	NA	5

Table B-11 MACHINERY SPACES

Ameron	233 ER Buff	233ER White	NA	
International	Intergard KB Buff	Intergard KB White	NA	5
Sherwin Williams	Dura Plate 235 Buff	Dura Plate 235 White	NA	5
Hempel USA	Hempadur 1763 L.RED	Hempadur 1763 Buff	NA	6
Hempel	Hempadur 4514	Hempadur 4514	NA	6
	Power tool clean and spot paint Hempadur 1763 L.Red Full Blast and Paint	Hempadur 1763 Buff	NA	6
Dupont Industrial	Corlar 25P 71125P Red	Corlar 25P 63325P Buff	NA	6
CMP Coatings, Inc.	Nova 1000 Cream	Nova 1000 Grey	NA	5
F&H	235 Epoxy Buff	235 Epoxy White	NA	5

Table B-12 CHAIN LOCKERS

Ameron	Bar-Rust 235 Buff	Bar-Rust 235 White	NA	
International	Intertuf KH Buff	Intertuf KH White	NA	5
Sherwin Williams	Dura Plate 235 Buff	Dura Plate 235 White	NA	5
Hempel USA	Hempadur 4588	Hempadur 4588	NA	5
Hempel	Hempadur 4514	Hempadur 4514	NA	5
Dupont Industrial	Corlar 26P HB DTM	Corlar 26P HB DTM	NA	5
CMP Coatings, Inc.	Umeguard SX Red/Brown	Umeguard SX White	NA	5
F&H	235 Epoxy Buff	235 Epoxy White	NA	5

Table B-13 ANCHOR and CHAINS

Ameron	Amercoat 385 Black	Amercoat 450H colors for marking	5/3
International	Intertuf KH Black	Interthane PH colors for marking	4/2
Sherwin Williams	Macropoxy 646	Black Macropoxy 646 colors for marking	5

Table B-13 ANCHOR and CHAINS (CONT)

	1st coat	2nd coat	3rd coat	DFT/coat
Hempel USA	Hempadur 4588	Hempadur 4588 colors for marking		5
Hempel	Hempadur 4514 Black	Hempadur 4514 Colors for marking		5
DuPont Industrial	Corlar 25P 64025P Black	Corlar 25P Mastic (color)		5
CMP Coatings, Inc.	Umeguard SX Black	Unymarine colors for marking		5/2
F&H	235 Epoxy Black	235 Epoxy Colors for Marking		5

Table B-14 FINISH PAINT FOR MISCELLANEOUS EQUIPMENT

Area	**Color**
Airports and deadlight frames	Same as adjacent surface
Blocks	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Boat falls tube	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Boat Hooks	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Booby hatch exterior	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Bulwark, inboard side	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Bulwark cap	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Canvas items, equipment covers, etc.	Canvas Preservative, Haze Gray
Capstans	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Cargo battens, exterior	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Chests, deck	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Coaming, hatch	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Compass stand	Enamel, Silicone Alkyd, Copolymer, Light Gray, Color 16376
Davits	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Deck fittings, bits, cleats, chocks, etc	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270

Table B-14 FINISH PAINT FOR MISCELLANEOUS EQUIPMENT (CONTINUED)

Area	Color
Deck machinery and controls	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Deck pads	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Doors and hatches	Same as adjacent surfaces
Draft markings: Light background Dark background	 Enamel, Silicone, Alkyd, Copolymer, Black, Color 27038 Enamel, Silicone, Alkyd, Copolymer, White, Color 27886
Electrical fittings and	Same as adjacent surface.
Exhaust through transom or side	Heat resistant Aluminum, Black 650 deg Low emissivity 0.40 or less
Firefighting equipment	Enamel. Silicone, Alkyd, Copolymer, Red, Color 11105
Fittings on doors and hatches	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Furniture, installed	Same as adjacent surfaces
Galley smoke pipe Lower two-thirds Upper one-third	 Enamel, Silicone, Alkyd, Copolymer, Haze Grey, Color 26270 Enamel, Silicone, Alkyd, Copolymer, Black, Color 27038
Gangways and boarding ladders	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Gratings, wood	Same as adjacent surfaces
Guards, fenders, and chaffing strips	Same as adjacent deck
Handrails, pipe, chain and	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Hawser pipes Hawser rack	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270 Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Hose rack, fire	Enamel, Silicone, Alkyd, Copolymer, Red Color 11105
Ladder Non-walking surfaces Walking surfaces	 Same as adjacent surface Deck Covering Compound, Non-Skid, Rollable
Lifeboats, motor launch, exterior	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270

Table B-14 FINISH PAINT FOR MISCELLANEOUS EQUIPMENT (continued)

Area	Color
Life preserver boxes Exterior Interior	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Life preserver racks	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Life raft, supports	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Light screens, port	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Light screens, starboard	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Machinery and accessories interior of vessel Under 300°F Over 300 °F	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 16376
Manholes and deck plates	Same as adjacent surface
Mast, spars, kingport	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Mast and attachments aft of stack, upper one-third	Enamel, Silicone, Alkyd, Copolymer, Black, Color 27038
Mast collars	Enamel, Silicone, Alkyd, Copolymer, Black, Color 27038
Piping	Same as adjacent surfaces Same as adjacent surfaces
Piping interior of vessel: Under 300°F Over 300 °F	Same as adjacent surfaces Same as adjacent surfaces
Quadrant, rudder exposed Wire rope lubricant,	Enamel, Silicone Alkyd, Copolymer, Haze Gray, Color 26270
Rigging-running	Wire rope lubricants
Searchlight	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270
Spanner wrench-stowed	Enamel, Silicone Alkyd, Copolymer, Red, Color 11105
Stack interior	Aluminum, Paint , Heat resisting 1200 deg
Stair treads	Deck Covering Compound, Non-Skid, Rollable
Switchboard, front panel	Enamel, Silicone, Alkyd, Copolymer, Light Gray, Color 16376
Thresholds	Enamel, Silicone, Alkyd, Copolymer, Haze Gray, Color 26270

Table B-14 FINISH PAINT FOR MISCELLANEOUS EQUIPMENT (continued)

Area	Color
Winches	Enamel, Silicone Alkyd, Copolymer, Haze Gray, Color 26270
Wind and spray shields	Enamel, Silicone Alkyd, Copolymer, Haze Gray, Color 26270

Table B-15 Ship Machinery and Engine Room Parts

Color	Color No	Coating	Uses
Brilliant Yellow	13538	Enamel, silicone Alkyd, Copolymer	Pulleys, machinery guard
Vivid Orange	12246	Enamel, silicone Alkyd, Copolymer	Exposed hazards
Clear Blue	15177	Enamel, silicone Alkyd, Copolymer	Switch Box control panels
Highlight buff	13578	Enamel, silicone Alkyd, Copolymer	Highlighted areas to concentrate attention
Machinery Gray	16376	Enamel, silicone Alkyd, Copolymer	Body of Machinery

Table B–16 ACCEPTABLE COLORS AND USES

NOTE

All vessels shall be painted one color; the decks, hull structure, and topside surfaces shall be painted with Haze gray (26270).

Navy standard topside colors		
Haze Gray	26270	Decks, Hull structure and topside surfaces
Deck Gray	26008	
Additional colors		
White	17925	Chain and hull markings
Red	11105	Chain markings, fire system
Yellow	13538	Chain markings and fuel system
Light Blue	15177	Chain markings, potable water system
Dark Grey	16081	High pressure air system
Tan	10342	Low Pressure air system
Gold	17043	Sanitation System

Table B–16 ACCEPTABLE COLORS AND USES (CONTINUED)

International Orange	12197	Safety Equipment
Orange	12246	Lube oil systems
Dark Blue	15044	Fresh water systems
Dark Green	14062	Sea water systems
Off White	27880	F 124, Interior bulkheads
Pastel Green	24585	F 125, Staterooms and pilot house bulkheads
High-speed diesel engines and generators		
Cummins Beige	27769	
Caterpillar Yellow	23540	
Alpine Green	24325	
Machinery Gray	26376	

APPENDIX C

MARKINGS

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NOTE

Each shot of chain is joined together with a detachable link.
One fathom equals 6 feet. There are 15 fathoms (90 feet) in a shot of anchor chain.
This method is used through the entire marking procedure alternating red, white and blue for detachable links as appropriate.

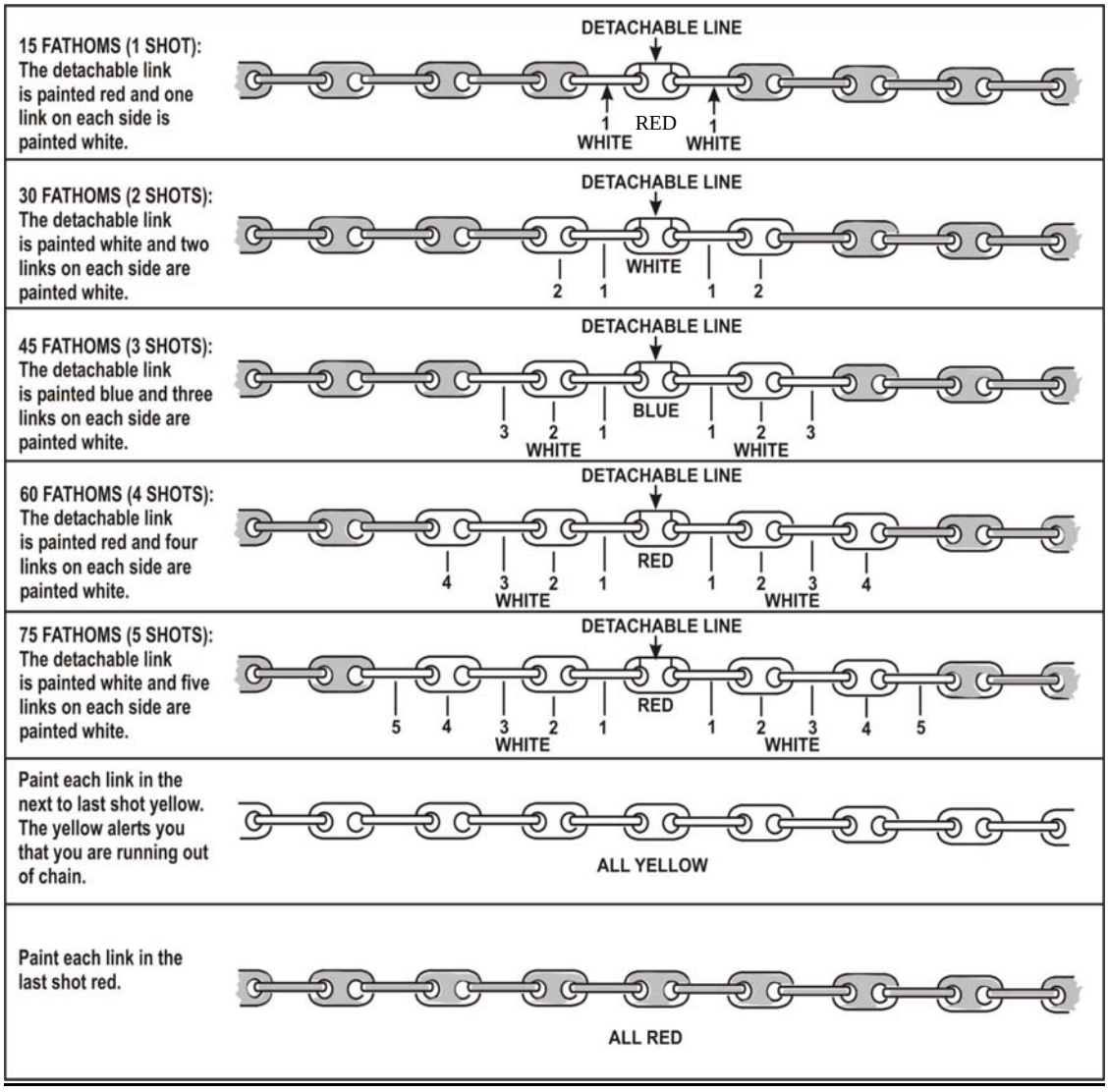

Figure C-1. Standard Anchor Chain Markings.

NOTES

1. All dimensions are decimal fractions of the height "H."

2. Width of bars used for letters and numerals is .17of the height "'H."

3. Except where otherwise shown, all outside corner bevels shall be as follows:

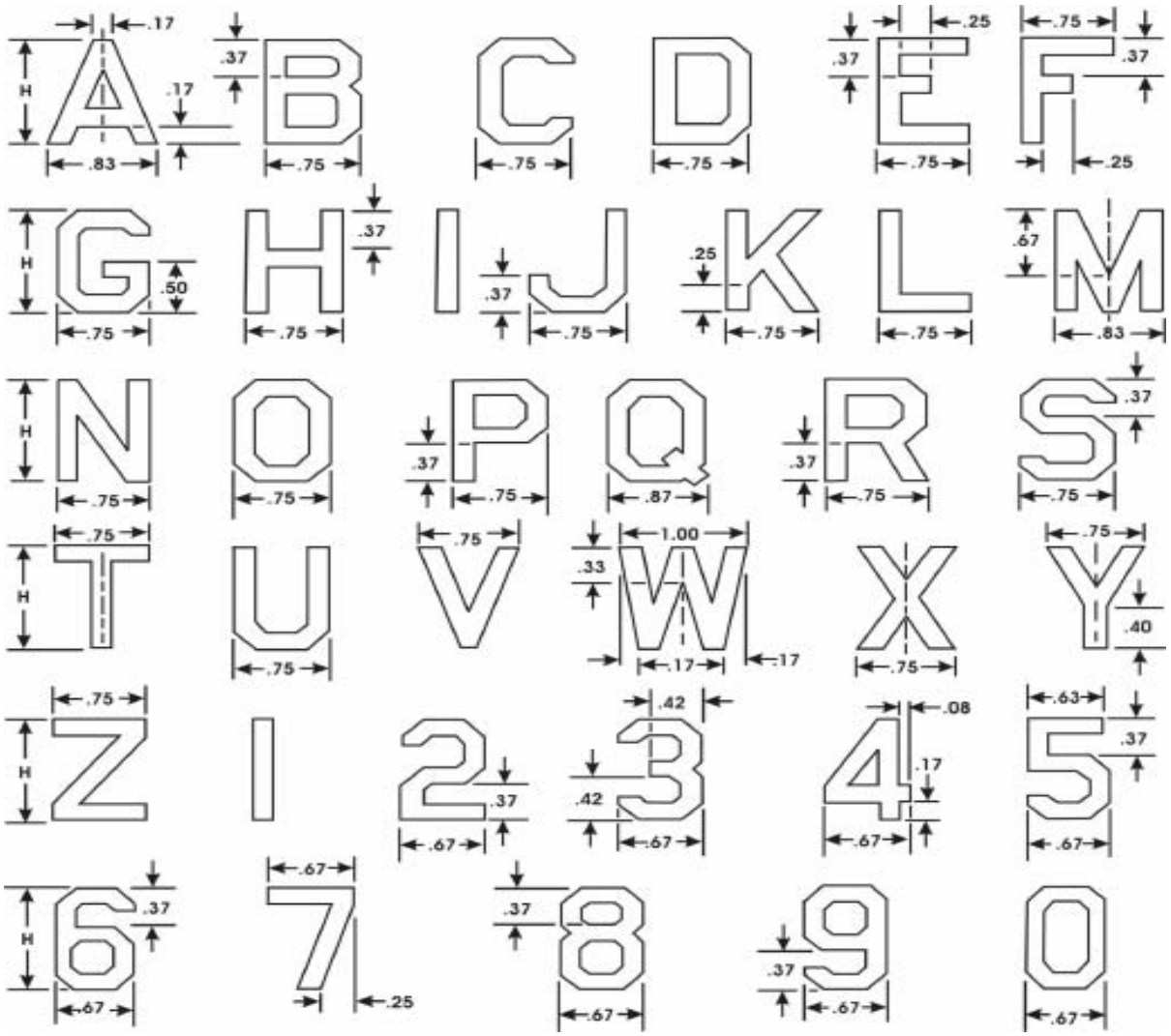

Figure C-2. Block Letters and Numerals.

BOW MARKINGS

STERN MARKINGS

NAME BOARD

Figure C-3. Designation Arrangements.

Table C-1. DIMENSIONS FOR DESIGNATIONS

SIZE OF WATERCRAFT (LOAD WATER LINE LENGTH)	DIMENSIONS IN INCHES (CM)		
	A	B	C
LESS THAN 20'	3(7.62)	4(10.2)	2(5.1)
20' TO LESS THAN 40'	4.5(11.4)	6(15.2)	3(7.6)
40' TO LESS THAN 70'	6(15.2)	8(20.3)	4(10.2)
70' TO LESS THAN 150'	7.5(19.1)	10(25.4)	5(12.7)
150'AND OVER	9(22.9)	12(30.5)	6(15.2)

Table C-2. WATERCRAFT COLOR CODES

Color	Application
DARK GREEN	BILGE SYSTEM, SEA WATER SYSTEM
PURPLE	REFRIGERANT SYSTEM
DARK GRAY	HIGH PRESSURE AIR SYSTEM
TAN	LOW PRESSURE AIR SYSTEM (Control Air/Service Air)
YELLOW	DIESEL FUEL SYSTEMS CONTAINERS-PAINT ENTIRE
	NAPHTHA CONTAINERS-CONTAINER
ORANGE	LUBRICATING OIL HYDRAULIC OIL
RED	FIRE EXTINGUISHING SYSTEM
BLACK	STEAM AND HOT WATER HEATING SYSTEM
DARK BLUE	NON-POTABLE FRESH WATER SYSTEM
LIGHT BLUE	POTABLE WATER SYSTEM
GOLD	SEWAGE
YELLOW	OIL WATER SEPARTER SUCTION

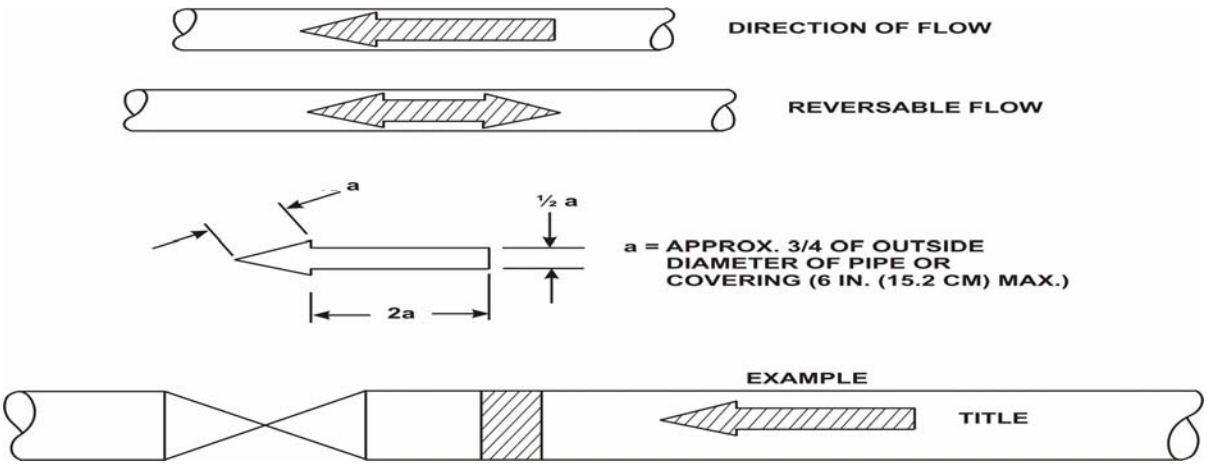

Figure C-4. Piping Systems.

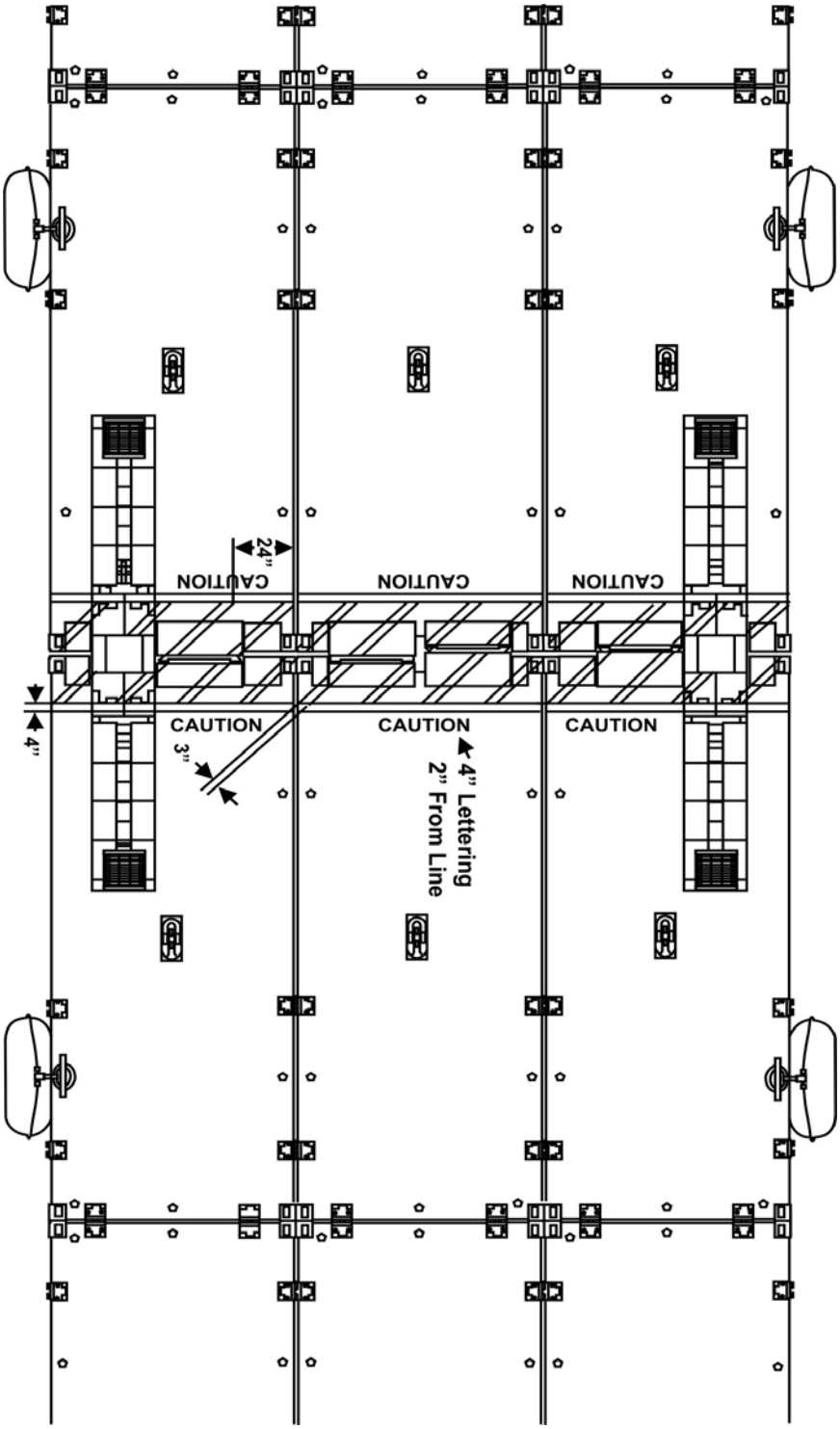

Figure C-5 MCS Safety Markings

APPENDIX D

DECK COVERINGS

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SECTION I GENERAL INFORMATION

D-1. Scope. This appendix contains information on the installation and maintenance of deck coverings.

D-2. Requirements.

a. Satisfactory deck coverings for watercraft are lightweight, wear and skid-resistant, nonflammable, possess the ability to protect the deck from corrosion, present an attractive appearance, and are easily maintained. Simple installation and low cost are also important considerations. Since no single material is able to meet all these requirements, each material approved for use is the result of compromise.

b. Deck coverings are classified based on use aboard watercraft. If a material is restricted to a particular class of watercraft, this also is indicated.

c. Space in which no deck covering is installed shall be painted in accordance with instructions in this TB.

D-3. Approval. New and experimental deck coverings shall be approved for evaluation on an individual case basis Authorization for the installation of experimental deck coverings shall be obtained from the Watercraft Inspection Branch. When approval is granted, full installation data and later follow up reports, shall be required.

D-4. Installation Criteria. In general, if the existing deck covering is functional it should not be replaced, even if it does not agree with the materials listed for the specific space. New deck coverings should be installed only where none are now present, or where existing authorized deck coverings are beyond economical repair. When repairs are required, local repairs should be made, if possible, rather than complete removal and reinstallation of a new deck covering. Where replacement is made the deck covering specified herein shall be installed.

D-5. General Safety Precautions.

a. Potential hazards are encountered in most deck covering applications. Therefore, a continuing safety program during installation is mandatory. Adherence to prescribed safety procedures will provide protection against major hazards such as fire, explosion, and toxicity.

b. Liquids, adhesives, and deck covering compounds containing volatile flammable solvents evaporate to form vapors which, if not removed or reduced in concentration by adequate ventilation, may form explosive or flammable mixtures. Every precaution shall be taken to ensure the elimination of ignition sources, such as, open flames from smoking, lighters, welding, and other operations involving sparks that can be generated from electrical equipment. A continuous fire watch shall be maintained during application of these materials to ensure that all safety precautions are observed.

c. Vapors from some of the solvents used may have a harmful or irritating effect on the human system, particularly in confined spaces. Air respirators and eye protectors shall be worn, depending on the application. Container labels shall be read and followed for specific safety instructions concerning flammability and toxicity.

D-6. Slip Resistant Coverings. Since all compounds used for installation of skid-resistant deck covering contain volatile solvents, which may be flammable, adequate safety measures must be taken during application.

a. Certain sensitive individuals handling the materials may develop a skin rash; therefore, gloves shall be worn. Any materials spilled on the body shall be wiped off and the skin washed with soap and water. In case of contact with the eyes, flush the eyes immediately with clear water and contact a physician. Clothing and gloves contaminated with the uncured resins shall not be worn again until they have been thoroughly cleaned. Because some formulations may use materials that fume when in contact with air, adequate exhaust ventilation is necessary in closed spaces. If the proper precautions are taken to ensure cleanliness, ventilation, and protective clothing, no difficulty should be encountered in using or handling epoxy, resins, hardeners, or solvents.

b. The following safety precautions shall be observed for interior areas where non-skid materials are rolled, trowled, or sprayed for a minimum of one hour after the non-skid has cured.

(1) Ensure absence of ignition sources; all welding, smoking, hot work, open flames, energizing and deenergizing of electrical circuits in the compartment and adjacent areas shall be prohibited. Only explosion-proof lights shall be used and all portable electrical wiring shall be inspected for cracks and wear prior to use.

(2) Use exhaust ventilation, preferably air-driven, to open air to reduce the solvent vapor concentration below the lower explosive limit. Ship's exhaust ventilation in the area shall be secured and masked, supply left open. If it is necessary to use electrical motor-driven exhaust fans, only explosion-proof equipment shall be used. Ground all exhaust ventilation for electrostatic discharge using AWG20 cable (or equivalent) with metal clips for attaching equipment to ground.

(3) Portable dry chemical fire extinguishers shall be readily available.

D-7. Slip-Resistant Self-Adhesive Treads.

General. Slip-resistant self-adhesive treads have pressure-sensitive adhesive on their backs and can be installed satisfactorily over bare steel, wood, well-dried (minimum 48 hours air dry) paint and primers, deck tile, and all other deck coverings that are well adhered to the deck. All rust, grease, oil, and dirt must be removed prior to installation. In addition, deck tile should be cleaned free of residual wax. Three treads with no space between should be installed at the head and foot of ladders, on each side of doors used for continuous traffic, and at both sides of doors in crew messing space (install over deck tile if present). This will protect the deck tile from excessive wear on either side of doors. Slip-resistant treads should not be

painted or waxed as this drastically reduces their slip-resistant properties. To increase the traction on sheet or deck tile covering, slip-resistant treads should be cemented directly over the basic deck covering. Required materials are: silicon carbide treads, 6 inches by 24 inches, black, NSN 7220-00-205-0389; or, 24- inch roll, NSN 7220-00-205-0390; and a beading sealer, NSN 8030-00-264-3886.

b. Installation. This deck covering does not require a separate adhesive because the back has a pressure sensitive adhesive protected by a plastic liner. To facilitate liner removal, rub the rough surface of a piece of the deck covering against the edge of the liner in the direction of removal. This will lift the edge, and the liner can then be removed easily. Apply the tread or sheet to the deck and roll with a weighted roller. To waterproof the edges, seal with beading sealer. When installing sheet material, leave a 1/16-inch expansion space between adjoining sheets and between sheets and bulkheads of coamings. Traffic can be permitted over the area after the sealer has dried hard.

c. Repair. Replace damaged treads as follows:

(1) Over steel or aluminum, remove the damaged sections by scraping or chipping and mechanically abrade the deck to shiny metal. Reprime the deck and replace the treads as soon as surface is dry.

(2) Over deck tile or resilient sheet, remove as much of the tread as possible without damaging the existing tile or sheet material. Replace with new treads.

D-8. Slip-Resistant Deck Covering.

a. General. Slip-resistant (nonskid) deck coverings are used aboard ship to provide safe footing for personnel and a slip-resistant surface for vehicles and aircraft.

b. General purpose use interior and exterior types.

(1) General Purpose Use. A general purpose, abrasive-type nonskid coating is normally satisfactory for most shipboard applications.

(a) The majority of nonskid premature coating failures are caused by either improper application or application over a poorly prepared surface. Adhesion of nonskid materials, just as for other coatings, is dependent upon the degree of surface preparation and the environmental conditions under which they are applied. Application over a hot or cold surface will dramatically affect the cure time and workability of the nonskid material. When this covering is applied on a hot surface (over 37.8°C (100°F)) the cure time can be significantly decreased; on a cold surface (below 10.0°C) (50°F)) on the other hand, the cure time will be significantly increased. Ideally, the nonskid system should be applied over a white or near-white metal, abrasive-blasted surface, free from oil, grease, or other contaminants, and applied on a day when the relative humidity does not exceed 60 percent and the surface temperature ranges between 18°C and 29°C (65°F and 85°F).

(b) In addition, the nonskid coating should be applied over an approved primer. For steel an epoxy primer must be applied beneath the nonskid topcoat. The primer not only improves the adhesion of the nonskid coating but also prevents rapid failure or undermining of the nonskid topcoat if it becomes cut, pierced, or otherwise mechanically damaged.

(2) Deck Areas (Metal-Interior and Exterior). For metal deck areas, apply one of the following nonskid systems:

(a) Sprayable type, Deck Covering Spray on, Non slip intended for use aboard ship where a slip-resistant surface is needed, and on exterior walkways and weather decks. See Appendix B-7 for a listing of non-skid.

c. Deck Preparation (Metal Decks). Many cases of nonskid coating failures have been the result of improper surface preparation or application. The degree of adhesion of a nonskid coating is directly

proportional to the degree of surface preparation and cleaning. Reduction in the degree of surface preparation is usually accompanied by a proportionate reduction in performance. Various degrees of surface preparation specifically relating to gradations in performance have not been established, nor can they be assessed with any degree of confidence. There are also certain trade-offs, such as, cost, time, abrasive equipment availability, grit disposal, dust, and machinery contamination that must be considered. Therefore, every effort should be made to achieve or approach the optimum surface within the constraints encountered in each situation. Ideally, the non-skid coating system should be applied over a metal surface, which is free of corrosion products, and other contaminants, degreased, and coated with the approved metal primer.

(1) Steel surfaces should be finished to a white metal finish (SSPC-SP5), or to a near-white metal finish (SSPC-SP10), as defined in the Steel Structures Painting Manual volume 2.

(a) Blast cleaning to white metal (SSPC-SP5) is the ultimate, and is used to prepare surfaces where the coatings must withstand exposure to very corrosive atmospheres and where a high cost of surface preparation is warranted. Blast cleaning to white metal requires the complete removal of all rust, mill scale, and other contaminants from the surface.

(b) In a near-white metal blast (SSPC-SP10), there may be shadows, streaks, discolorations, and blemishes across the blasted surface area, but not concentrated in spots. (Evaluation of cleaning results is based on visual examination.) Near-white metal preparation provides a 10 to 35 percent savings over white metal blasting and has proven to be adequate for many of the special coatings developed for long-term protection in moderately severe environments.

(2) Aluminum surfaces shall be cleaned free of corrosion products, dirt, and other contaminants by light abrasive blasting with 80 grit aluminum oxide or garnet abrasive. A pressure of 65 psig has resulted in satisfactory surface preparation with minimal metal removal. The surface can be spot cleaned after blasting by power brushing or orbital sanding. Aluminum shall be cleaned only with clean, dry sand, stainless steel wire brushes, stainless steel pads, or 1PD-455 specification abrasive sanding discs not used previously for cleaning other metals or for removal of copper or mercury pigmented paints. If not painted immediately or if contaminated with oil or grease, the aluminum should be washed with a liquid detergent cleaner, thoroughly rinsed with freshwater, and allowed to dry completely.

d. Renewal and Reapplication. Nonskid surfaces must be renewed when operations indicate that slip resistance has become unsatisfactory as a result of wear or coating failure. Surfaces may be renewed by over coating the existing coating; the decision to recoat should be based on a thorough examination. If the existing coating is worn but otherwise sound (intact), it can be successfully over coated. Wear is shown by loss of nonskid characteristic (grit is worn flush with coating film); a sound surface condition is shown by relatively few bare areas, no significant rusting, no corrosive undercutting (indicated by easily removable nonskid flakes or sheets), and by good adhesion (indicated by difficulty in removing a test patch by chipping or scraping). If examination reveals large bare areas, significant corrosion, or poor adhesion, the old nonskid coating should be removed and the surface properly prepared before reapplication of nonskid Coating. The degree of adhesion of the new coating will depend on the quality of cleaning and surface preparation.

(1) A section of the deck should be roped off to eliminate nonessential traffic. The deck must be cleaned free from rust, oil, loose paint, and other contaminants by either mechanical or chemical means or, as a combination of the two, degreased and then coated with epoxy polyamide.

(2) In view of the time and effort required for surface preparation, care should be exercised to protect the surface by priming immediately (within 1 hour) after it is cleaned and dried in order to prevent rust and other surface contamination. Although priming within 1 hour is generally recommended, the priming of steel can often be delayed for longer periods without serious effects under favorable conditions; that is, conditions of low humidity and freedom from surface contamination, or when the surface can be certified to conform to a near-white metal blast, SSPC-SPC-10.

e. Recoating. Sound, intact, nonskid coatings may be recoated if the surface is lightly sanded or roughened, cleaned, and degreased. On areas where machinery is used, the surface may be degreased by scrubbing with a cleaning solution to remove oil, grease, fuel, and hydraulic fluids.

f. Complete Removal of Nonskid System. A portion of deteriorated nonskid coating or the complete nonskid coating system can be removed and the surface prepared for recoating by the methods described below.

(1) Surface Priming Metal. An anticorrosive primer is normally required over metal surfaces beneath the nonskid topcoat. Primer not only improves the adhesion of the nonskid topcoat, but enhances the total performance of the nonskid system. An epoxy primer is preferred and is recommended for use under all epoxy nonskid topcoats applied over steel or aluminum surfaces. Only use primers specified by non-skid manufacturers for types of metal other than steel and aluminum. On steel, the primer should be applied IAW with the manufacturers requirements for surface preparation, temperature, humidity, and recoat intervals.

(2) Rollable Nonskid Coating Application. Follow all manufacturers' requirements. Prior to applying an application of rollable nonskid material, prepare the deck surface and prime with an epoxy primer. Ensure that the primer coat is cured and clean prior to application of nonskid.

(a) Use a long-handled roller applicator with a free-rolling, hard-phenolic roller core (napless), 9 inches long, 1 7/16,-inch diameter, 3/32,-inch thick, slip-off design.

(b) On smooth deck surfaces, 5 gallons of material should normally cover 175 to 200 square feet (approximately 35-40 square feet per gallon).

(c) Take into account the following factors:

1 Working life of mixed material varies with temperature and is approximately 4 hours at 24°C (75°F).

2 The pot life is 4 hours at 24°C (75°F) (when mixed with accelerator).

3 Hard Dry is reached after 24 hours at 21°C (70°F) to a foot-traffic stage and to a heavier traffic stage after 48 hours at 21°C (70°F).

4 Minimum cure time is 4 days at 21°C (70°F) (complete cure, heavy-duty vehicular traffic, aircraft movements).

5 The strength of the ridge formation should be tested before allowing foot traffic on newly applied coatings.

6 Cure times of nonskid coatings is a function of the surface temperature. The higher the temperature, the sooner the cure hard condition will be reached. Conversely, the cooler the surface temperature, the longer it will take to reach a cure hard condition. The surface temperature can be considerably higher or lower than the air temperature depending on the time of day and the amount of direct sun exposure. Excessively hot surfaces may cause nonskid coating defects. Excessively thick coatings will require longer cure times and result in defects, especially on hot surfaces.

(a) Cleaning. Clean tools and equipment immediately after application is completed by using solvents recommended by the manufacturer (such as toluol, xylol and alcohols). Observe proper handling precautions.

(b) Appearance of Cured Material (Surface Profile). When nonskid coatings have dried and cured, the surface profile will show a hard ridge pattern with a textured appearance of roughly parallel rows of raised coating peaks or ridges. The aggregate shall present a uniformly coarse, rough appearance over the entire surface. The overall surface appearance shall present a wave-like ridge pattern with raised

peaks. The peaks of the waves shall be approximately ½ to 1 inch apart and approximately 1/16 to 3/32 inch high.

(6) Specific Application Guidelines. The following specific guidelines have proved successful under fleet and service conditions and are recommended for use when rollable nonskid coatings are applied.

(a) Keep a lid on all opened nonskid coating containers when not in use in order to minimize solvent losses.

(b) Over stirring nonskid coatings may cause breakdown of chemical thickening agents as well as introduce excess air that may inhibit or accelerate coating reactions.

(c) Do not apply nonskid coatings when deck temperatures are above 49°C (120°F) or below 4°C (40°F).

(d) Base material components from one manufacturer are not necessarily compatible with another manufacturer's accelerator components. Do not mismatch components; they are not interchangeable.

(e) Epoxy polyamide paint primer should be mist sprayed or solvent wiped if more than 24 hours elapses between primer application and nonskid coating application.

(f) Nonskid deck coatings are high-performance, organic coatings that are designed to be applied over epoxy polyamide.

(g) When nonskid coatings are mixed and not immediately applied, they should be remixed for a period of 1 to 2 minutes before application.

(h) Nonskid coatings must be thoroughly mixed to disperse components. Mix only that amount that can be applied during the working life of the coating. Never mix more than can be used in an 8-hour workday. All coating that is mixed shall be applied.

(i) Nonskid coatings are best applied in one continuous operation.

(j) Condition the roller core before applying the nonskid coating by wetting its surface with some freshly prepared mix. Do not allow the coating to dry or build up on the roller applicator.

D-9. Safety Precautions. All the compounds mentioned in the discussion of slip-resistant deck coverings contain volatile solvents, which may be flammable. Adequate safety precautions must be observed during application.

a. It should be noted that some individuals are more sensitive than others to the materials and may develop a skin rash. To prevent this possibility, gloves shall be worn. If materials are spilled on the hands or other parts of the body, they should be wiped off and the skin washed with soap and water. In case of accidental contact with the eyes, flush the eyes immediately with clear water and contact a physician. Clothing and gloves contaminated with uncured resins shall not be worn again until they have been thoroughly cleaned. Adequate exhaust ventilation is necessary where these materials are used in closed spaces to prevent hazards due to solvent entrapment. If the proper precautions are taken to insure cleanliness, ventilation, and protective clothing, no difficulty should be encountered during the use or handling of epoxy resins, hardeners, or solvents.

b. Where non-skid materials are rolled, troweled, or sprayed, the following safety precautions shall be observed for a minimum of 1 hour after the nonskid has cured.

(1) Insure absence of any ignition sources; all welding, hot work, open flames, energizing and de-energizing electrical circuits in the compartment and adjacent areas shall be prohibited. Only explosion-proof lights shall be used and all portable electrical wiring shall be inspected for cracks and wear prior to

use.

(2) Use exhaust ventilation, preferably air-driven, to open air to reduce the solvent vapor concentration below the lower explosive limit. Ship's exhaust ventilation in the area shall be secured and masked; air supply shall be left open. If it is necessary to use electrical motor-driven exhaust fans, only explosion-proof equipment shall be used. Ground all exhaust ventilation for electrostatic discharge using AWG20 cable (or equivalent) with metal clips for attaching equipment to ground.

(3) Portable dry chemical fire extinguishers shall be readily available.

(4) The requirements of certification by a Marine Chemist or Competent person shall be followed with regard to maintaining a safe atmosphere.

(5) Proper personnel protective clothing and eye protection shall be worn.

(6) Where the foregoing safety precautions cannot be implemented, install 6-inch by 24-inch slip-resistant treads, deck covering, light weight, non slip, abrasive particle (NSN 7220-00-205-0389), approximately 3 inches apart over entire work and traffic areas or cut and install sections from a 24-inch wide slip-resistant roll (NSN 7220-00-205-0390).

GLOSSARY

Active Service Craft Craft, which have been assigned to an installation, activity, or unit for operational use.

After-Corrosion A continual process of corroding.

Anode A piece of metal fixed to steel to provide cathodic protection. Anodes must be fixed so that they are in electrical contact with the steel they have to protect, and must not be greased or painted.

Antifouling For underwater use on hulls; contains agents which prevent the adhesion and growth of organisms on the hull. Antifouling are formulated so that the control agents migrate into water closest to the hull, making it repel organisms.

Atomization Term used in spraying. Proper atomization is obtained when the spray pattern is kept wet and the film is continuous as the area is covered.

Abrasive Blasting Cleaning A common means of producing a surface suitable for painting. It removes rust, mill scale, old paints and other contaminants more thoroughly than is possible by manual or power tool methods.

Competent Person A person who is capable of recognizing and evaluating employee exposure to hazardous substances or to other unsafe conditions and is capable of specifying the necessary protection and precautions to be taken to ensure the safety of employees as required by the particular regulation under the condition to which it applies. For the purposes of Subparts B, C, D of this part, except for 1915.35(b) (8) and 1915.36(a) (5), to which the above definition applies, the competent person must also meet the additional requirements of 1915.7.

Confined Space A compartment of small size and limited access such as a double bottom tank, cofferdam, or other space which by its small size and confined nature can readily create or aggravate a hazardous exposure.

Conventional Paints Linseed oil, alkyd, phenolic, coal tar, and other common resin paint for purposes of this bulletin; vinyl, epoxy, and urethane are not considered conventional paints.

Dew Point The temperature at which the water vapor in the air will condense into a liquid.

Dry-Stored Craft Craft, which are not stored in contact with water.

Faying Surfaces Joined or fitted closely to a surface.

Finish Paint The topcoat of a paint system

Flash Point The temperature at which the vapor of a material will be ignited by a spark or open flame.

Gas Freeing Operations performed in testing, evaluating, removing, or controlling hazardous materials or conditions, within or related to a confined or enclosed spaces, which may present hazards to personnel entering or working in, on or adjacent to the space.

Hand Tool Clean Clean surfaces to Steel Structure Painting Council (SSPC), Swedish St 2 standard, free of loose paint, scale, rust and debris, utilizing power tools.

Hull The main body of a watercraft below the main outside deck.

Lower Explosive Limit (LEL) The minimum concentration of vapor in air below which propagation of a flame does not occur in the presence of an ignition source.

GLOSSARY (CONT)

Major Area The boot top region, topsides, superstructure, deck, cabin, bulkheads, large hull area or other surface of considerable dimension.

Major Painting The renewal of a paint surface or paint system on a major area

Marine Chemist An individual who possesses a current Marine Chemist Certificate issued by the National Fire Protection Association (NFPA)

Maximum Allowable Concentration (MAC) Exposure Concentration of a drug or chemical not to be exceeded under any circumstances.

Mil Thickness Used to measure the dry film thickness (DFT) of a paint coat or system to insure sufficient application of the protective coating. A mil equals one thousandth of an inch.

Oxygen-Deficient Atmosphere An atmosphere having an oxygen concentration of less than 19.5% by volume.

Paint Coat. The dry film thickness of paint applied in one coat.

Paint Surface The painted surface of a structure consisting of the topmost layer of protective paint.

Paint System The protective paint barrier that covers a painted structure, which may consist of pretreatment coat, primer coats, intermediate coats, and finish or topcoats.

Pretreatment Coat The wash primer or preprimer paint film applied under the regular primer paint coat. Used for better bonding and corrosion control.

Primer The undercoats of paint, generally containing corrosion inhibiting pigments, which react chemically with the steel to form a corrosion resistant surface.

Proprietary Coatings Commercially available epoxy anticorrosive coating used as an acceptable alternative to epoxy-polyamide.

Safety Lock-off Device A safety lock-off device is any operating control, which requires positive action by the operator before the tool can be turned on.

Scantling In shipbuilding, dimensions of structural parts, including frames, beams, girders, and plating, which must be adhered to according to specifications. Minimum scantling is prescribed for the various types and sizes of watercraft by classification societies. Also generally, soft wood timber measuring less than 5" X 5".

Short Term Exposure Limit (STEL) The maximum Exposure limit to a substance based on a 15 minute time weighted average.

Solvent Cleaning The process of cleaning surfaces using chemical solvents, which remove oil and grease.

Spray Coat A spray coat consists of one or more passes, depending on the paint, and should be considered as that amount of paint applied at one time just short of sagging, running, wrinkling, and peeling.

Surface Preparation This is the process of cleaning a surface prior to applying paint.

GLOSSARY (CONT)

Surface Treatment The application of a pretreatment coating to a cleaned and bare metal surface, to provide initial corrosion protection and adhesive bonding of the primer coats to the metal surface.

Tack Coat When a coat of paint cure to when a finger tip pressed lightly against the film leaves only a slight impression and none of the film sticks to the finger.

Tapering Becoming gradually narrower

Threshold Limit Value (TLV) The airborne concentration of a potentially toxic substance to which it is believed that healthy working adults may be exposed safely through a 40 hour working week and a full working life. This concentration is measured as a time weighted average concentration. They are developed only as guidelines to assist in the control of health hazards and are not developed for use as legal standards

Touchup Painting The process of repairing a damaged paint system to prevent the undercutting of existing paint by corrosion.

Undercoats The underlying layers of paint below the finish coat.

Underbody The exterior hull surfaces normally under water when craft is afloat.

Upper Explosive Limit (UEL) The maximum concentration of flammable vapor in air above which propagation of flame does not occur on contact with a source of ignition.

Vinyl Paints A plastic resin coating that has outstanding durability.

Watercraft A term that includes all marine equipment used by the Army. TM 55-500 provides characteristics of the equipment currently in use.

Zinc Protectors High purity zinc anodes attached to metal surfaces to provide corrosion protection by galvanic action in a water environment.

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	0019 00 4	4	1	1		Step No. 19 states to remove locking bars, pins or hooks from where to what? The bars, pins or hooks are not identified. Where are they stored?

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PART II - REPAIR PARTS AND SPECIAL TOOL LISTS AND SUPPLY CATALOGS/SUPPLY MANUALS

PUBLICATION NUMBER	DATE	TITLE
TB 43-0144	**30 November 2005**	**Painting of Watercraft**

PAGE NO.	COLM NO.	LINE NO.	NATIONAL STOCK NUMBER	REFERENCE NO.	FIGURE NO.	ITEM NO.	TOTAL NO. OF MAJOR ITEMS SUPPORTED	RECOMMENDED ACTION

PART III - REMARKS *(Any general remarks or recommendations, or suggestions for improvement of publications and blank forms. Additional blank sheets may be used if more space is needed.)*

TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

RECOMMENDED CHANGES TO PUBLICATIONS AND BLANK FORMS For use of this form, see AR 25-30; the proponent agency is OAASA	Use Part II *(reverse)* for Repair Parts and Special Tool Lists (RPSTL) and Supply Catalogs/Supply Manuals (SC/SM).	DATE
TO: *(Forward to proponent of publication or form) (Include ZIP Code)*	**FROM:** *(Activity and location) (Include ZIP Code)*	

PART I - ALL PUBLICATIONS (EXCEPT RPSTL AND SC/SM) AND BLANK FORMS

PUBLICATION/FORM NUMBER	DATE	TITLE
TB 43-0144	**30 November 2005**	**Painting of Watercraft**

ITEM	PAGE	PARA-GRAPH	LINE	FIGURE NO.	TABLE	RECOMMENDED CHANGES AND REASON

** Reference to line numbers within the paragraph or subparagraph.*

TYPED NAME, GRADE OR TITLE PLUS	TELEPHONE EXCHANGE/AUTOVON, EXTENSION	SIGNATURE

TO: *(Forward direct to addressee listed in publication)*	**FROM:** *(Activity and location) (Include ZIP Code)*	DATE

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TYPED NAME, GRADE OR TITLE	TELEPHONE EXCHANGE/AUTOVON, PLUS EXTENSION	SIGNATURE

THE METRIC SYSTEM AND EQUIVALENTS

Linear Measure

1 centimeter = 10 millimeters = .39 inch
1 decimeter = 10 centimeters = 3.94 inches
1 meter = 10 decimeters = 39.37 inches
1 dekameter = 10 meters = 32.8 feet
1 hectometer = 10 dekameters = 328.08 feet
1 kilometer = 10 hectometers = 3.2808.8 feet

Weights

1 centigram = 10 *milligrams* = .15 *grain*
1 decigram = 10 centigrams = 1.54 grains
1 gram = 10 decigram = .035 ounce
1 dekagram = 10 grams = .35 ounce
1 hectogram = 10 dekagrams = 3.52 ounces
1 kilogram = 10 hectograms = 2.2 pounds
1 quintal = 100 kilograms = 220.46 pounds
1 metric ton = 10 quintals = 1.1 short tons

Cubic Measure

1 cu. centimeter = 1000 cu. millimeters = .06 cu. inch
1 cu. decimeter = 1000 cu. centimeters = 61.02 cu in.
1 cu. meter = 1000 cu. decimeters = 35.31 cu. feet

Square measure

1 sq. centimeter = 100 sq. millimeters = .155 sq. in.
1 sq. decimeter = 100 sq. centimeters = 15.5 inches
1 sq. meter (centare) = 100 sq. decimeters = 10.76 feet
1 sq. dekameter (are) = 100 sq. meters = 1.076.4 sq. ft.
1 sq. hectometer (hectare) = 100 sq. dekameters = 2.47 acres
1 sq. kilometer = 100 hectometers = .386 sq. miles

Liquid Measure

1 dekaliter = 10 liters = 2.64 gallons
1 hectoliter = 10 dekaliters = 26.42 gallons
1 kiloliter = 10 hectoliters = 264.18 gallons
1 liter = 10 deciliters = 33.81 fl. ounces
1 centiliter = 10 milliliters = .34 fl. ounce
1 deciliter = 10 centiliters = 3 38 ft. ounces
1 metric ton = 10 quintals = 1.1 short tons

Approximate Conversion Factors

To change	To	Multiply by
inches	centimeters	2.540
feet	meters	.305
yards	meters	.914
miles	kilometers	1.609
sq. inches	sq. centimeters	6.451
sq. feet	sq. meters	.093
sq. yards	sq. meters	.836
sq. miles	sq. kilometers	2.590
acres	sq. hectometers	.405
cubic feet	cubic meters	.028
cubic yards	cubic meters	.765
fluid ounces	milliliters	29.573
pints	liters	.472
quarts	liters	.946
gallons	liters	3.785
ounces	grams	28.349
pounds	kilograms	.454
short tons	metric tons	.907
pound inches	newton-meters	.11296
ounce inches	newton-meters	.0070062
centimeters	inches	.394
meters	feet	3.280
meters	yards	1.094
kilometers	miles	.621
sq. centimeters	sq. inches	.155
sq. meters	sq. yards	10.764
sq. kilometers	sq. miles	1.196
sq. hectometers	acres	2.471
cubic meters	cubic feet	35.315
milliliters	fluid ounces	.034
liters	pints	2.113
liters	quarts	1.057
grams	ounces	.035
kilograms	pounds	2.205
metric tons	short tons	1.102
pound-feet	newton-meters	1.356

Temperature (Exact)

°F Fahrenheit temperature — 5/9 (after subtracting 32) — Celsius Temperature °C

PIN: 020132