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# NAVAL SHIPS TECHNICAL MANUAL

## CHAPTER 9190

## PRESERVATION OF SHIPS IN SERVICE (PAINTS AND CATHODIC PROTECTION)

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NAVAL SHIP SYSTEMS COMMAND, WASHINGTON, D. C. 20360

# NAVAL SHIPS TECHNICAL MANUAL

# CHAPTER 9190—PRESERVATION OF SHIPS IN SERVICE (PAINTS AND CATHODIC PROTECTION)

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## SECTION I. GENERAL INFORMATION

### 9190.1 INTRODUCTION

It is the purpose of this chapter to provide instructions for painting and for application of other measures to prevent corrosion on ships and boats in service. Additional information appears in the following publications. In those instances where information contained in other publications differs, the requirements of this Manual must be followed.

1. **Marine Fouling and Its Prevention**, U.S. Naval Institute, Annapolis, Maryland (1952).

2. Mare Island Booklet Number 1, **Description and Instructions for Use of Wet-Sandblasting Equipment.**

3. Mare Island Booklet Number 2, **Description and Instructions for Use of Hot Plastic Spray Equipment, Mare Island Type.**

4. Mare Island Booklet Number 3, **Description and Instructions for Use of Cold Plastic Spray Equipment, Mare Island Type.**

5. NAVSHIPS 250.342-1, "Handbook of Cleaning Practices."

6. The following training films obtainable from District Training Aid Sections are tabulated below:

| Film No. | Title | Running time |
|---|---|---|
| MC 4196 | Use, Care, and Maintenance of Spray Painting Equipment. | 26 minutes. |
| SN 107 | Spray-Painting Equipment (Film-strips). | 60 frames. |
| MN 76C | Painting Ships and Boats. | 9 minutes. |
| MN 2528A | Painting Ships Bottoms-Sandblasting. | 10 minutes. |
| MN 2528B | Painting Ships Bottoms-Hot and Cold Plastic Antifouling Paint. | 10 minutes. |
| MN 7498A | Industrial Hygiene-Breathe and Live. | 18 minutes. |
| MN 10341 | Painting Aboard Ship | 33½ minutes. |

### 9190.2 WHEN TO PAINT

1. Repaint damaged or badly worn surfaces as soon as practical to prevent corrosion of the metal or deterioration of wood.

2. Whenever a directive is issued by the Naval Ship Systems Command effecting a change in painting practice, repainting to conform with the directive should be deferred until repainting is necessary unless specifically directed to be done as soon as practical.

### 9190.3 FREQUENCY OF REPAINTING AND THICKNESS OF PAINT FILMS

1. Repaint no more often than is considered necessary for preservation.

2. Soiled interior surfaces should be cleaned rather than repainted. When repainting becomes necessary, apply minimum number of coats for satisfactory hiding (usually one coat is sufficient). When an interior metal surface requires further repainting, and the existing paint coats amount to a total of four (not including pretreatment coating) or an average thickness of 0.005-inch, remove all paint by scraping, chipping, wire brushing, or other methods, before any additional applications of paint.

3. Reduction in frequency of repainting interior bulkheads is especially important because of the fire hazard. This is necessary because fire-retardant paints lose fire-retardancy when applied in thick films. Individual paint coats, if applied in thick films, are likely to entrap solvents and thinners which burn very rapidly; therefore, they should be applied in thin films.

4. While a fire hazard exists from the exterior paint, this is less than those from the interior. Excessive build-up of paint thickness, particularly on wood hulls, should be avoided by removing old paint. Much manpower and material may be saved on exterior painting by spot touchup and by not repainting a faded surface of intact paint.

### 9190.4 GENERAL PAINTING PROCEDURE

1. Paints may be applied by spray, brush, roller coater, or dip.

2. Painting aboard ship should be done under the direction of experienced men qualified for such supervision.

3. Touching up, rather than complete repainting, should be done when possible. When the small areas to be touched up are cleaned to bare metal, the edges of adhering paint should be mechanically cleaned to a tapering edge and repainting done in such a way that the junction of old and new paint is as nearly unnoticeable as possible. When light blasting ("brush blasting") is accomplished, at least one coat of anticorrosive paint should be applied before applying topcoats or antifouling paint.

4. Use only standard Navy issue cleaning compounds, soap, or soap powder for cleaning painted surfaces. Strong lye, corrosives, or abrasives must not be used.

5. Unpainted metal surfaces should be kept to a minimum. Bearing surfaces and bright steel surfaces should be protected with colorless rust preventive compounds insofar as practical, if they are not frequently used or handled. Where surfaces are not protected they should be frequently cleaned to prevent corrosion, and care must be taken not to damage the surface. Unpainted steel not serving as bearing surfaces can be polished with emery cloth or abrasives; however, do not use abrasives on galvanized metal, brass, copper, nickel, aluminum, and corrosion-resisting steel.

6. See chapters 9110 and 9820 of the **Naval Ships Technical Manual** for care and maintenance of wood hulls other than painting.

### 9190.5 GENERAL SAFETY PRECAUTIONS

In addition to the precautions outlined herein, the safety precautions contained in **United States Navy Safety Precautions** (OPNAV 34P1), particularly chapters 10 and 14, must be complied with.

### 9190.6 ITEMS NOT TO BE PAINTED

1. In addition to those specified elsewhere in this chapter the following items must not be painted:

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

b. Decorative plastic surfaces such as on bulkheads or table tops.

c. Dogs and/or operating gear of watertight doors, hatches, scuttles, and similar items.

d. Hatch and door rubber gaskets.

e. Identification plates.

f. Insulators.

g. Knife edges of watertight doors and hatches.

h. Porcelainized bulkheads.

i. Threaded parts.

j. Zincs.

k. The following interior surfaces constructed of aluminum (these surfaces may be waxed where desired for appearance):

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

(2) Interior gratings, hand rails, and floor plates.

(3) Internal surfaces of ventilation ducts.

2. It is the policy of the Department of the Navy that paint products will be ordered in the largest size container feasible and practical. In determining the size of the container to order, consideration will be given to:

a. The total quantity of paint required.

b. The time and labor required in dividing the contents of larger quantities among several paint applicators.

c. The difficulty of mixing and handling larger containers.

d. The need for small quantities for touch-up.

e. The storage and deterioration problem associated with partially filled containers.

## SECTION II. SURFACE PREPARATION

### Part 1. Requirements

### 9190.11 GENERAL

1. The greatest single factor affecting the performance of any paint system is the method and care used in the preparation of the surface to be coated. Surfaces to be painted must be completely free of rust, loose paint, dirt, scale, oil, grease, salt deposits, and moisture. Paint should not be applied during cold weather unless care is taken to ensure absence of frost or ice on surfaces being coated. Drying time between coats should be increased as necessary.

2. When painting over damp exterior surfaces cannot be avoided, wiping surfaces with turpentine, methyl ethyl ketone or butyl alcohol will assist in removal of moisture. Also preferably, the first coat of paint should be brushed on.

3. Never paint over loose and badly cracked paint. When painted surfaces show evidence of corrosion, peeling, blistering, checking, scaling, or general disintegration, remove the paint down to the bare surface.

4. Old paint in good condition is an excellent base for repainting. When a surface is to be repainted and the old paint is not to be removed, the surface must be smoothed and thoroughly cleaned and dried before new paint is applied.

5. In touchup painting, when only localized areas or spots require repainting, it is essential that the removal of the old paint be carried back around the edges of the spot or area until an area of completely intact and adhering paint film, with no rust or blisters underneath, is attained. Edges of tightly adherent paint remaining around the area to be recoated must be "feathered."

6. Solvent type cleaners, as specified in article 9190.23, should be used for removal of oil and grease.

7. A protective coating should be applied as soon as practical after cleaning before corrosion or soil forms on the cleaned surface.

8. Secure scuppers or use drilled wooden plugs with pipe extensions to carry water clear of work during painting.

9. The selection of the proper method or combination of methods for the job to be done must be based on an underhistory, its intended use, a knowledge of the various cleaning methods available, and their advantages, peculiarities, and limitations. In certain instances, it is practical to give specific instruction as to the method to be used. In other cases, the judgment of the responsible activity will prevail.

10. Materials and methods for preservation can be hazardous unless proper care is taken to protect both associated and adjacent equipment and personnel from deleterious mechanical and toxic effects. These effects may arise from any of the materials and methods used, such as paint and varnish removers, heat from torches, solvents, abrasives and abrasive dusts. Preservation methods are engineering procedures that must be accomplished in precise ways and with specific precautions. These methods, however, often are developed for individual situations and the interpretation of the precautions to be taken, become through necessity, matter of personal judgment. Certain specific hazards are noted herein under the description of each material and method.

### 9190.12 METALLIC SURFACES

Blast cleaning is the most effective method for removing rust and scale and is preferred for steel surfaces. Equipment for this operation is not normally available to ships' forces and the latter should use other means to achieve as bright and clean a surface as practical. For other metallic surfaces, blast cleaning must be used with caution to avoid damaging the surface.

### 9190.13 WOOD SURFACES

1. See chapters 9110 and 9820 of the **Naval Ships Technical Manual** for structural repair. See chapter 9140 for wood decks.

2. Fill all dents, holes, and checks with putty prior to surfacing. Surfaces should be sanded or planed smooth.

3. Use double planking cement, Military Specification MIL-S-19653, on frame ends and stern head and between all faying surfaces where watertight integrity is mandatory. In such instances, do not use aluminum paint.

4. After shaping, boring, and cutting have been completed, soak all lumber except that for which varnish is specified, for 10 minutes in wood preservative, Military Specification MIL-W-18142, Type A or B. For lumber which is to be varnished, treat only those surfaces adjacent to moldings, coamings, and other locations likely to be exposed to a damp situation favorable to decay. Treat lumber for which varnish is specified only with Type B preservative in which no coloring ingredients have been added. Where fairing, boring, or trimming is necessary after preservative treatment, the reworked surfaces should either be submerged for fifteen minutes or liberally brushed with the preservative used originally. Retreatment of the outer hull is not required after sanding except in the way of the guards. Allow all treated lumber to dry a minimum of 72 hours before painting, calking, or gluing operations proceed.

5. All seams must be fair and continuous prior to calking and must be watertight when calked. Calk seams in hull planking with treated cotton and oakum.

6. Use calking compound Military Specification MIL-C-18969 for paying. The calking compound must be worked well down to contact the fibrous calking material. Allowance should be made for shrinking and swelling.

### 9190.14 PLASTIC SURFACES

Surfaces requiring painting should be lightly roughened. All extraneous matter should be removed by wiping with a solvent and hand sanding or by other suitable means.

### 9190.15 REMOVAL OF PAINT

1. For the following reasons, do not attempt to remove paint from electric cables, fixtures, control enclosures, or switchboards:

a. **Cables.** There is no practical way to remove paint from cables without injuring the protective armor and the watertight sheath directly beneath it. Damage of this nature from scraping tools has been noted on ships where removal of paint from cables has been attempted. Damage to the cable sheath permits entrance of moisture and results in ultimate grounding of the cable. In addition, the twisting and bending of the cable necessary to remove its paint destroy the watertightness of the packing in the bulkhead's stuffing tubes. However, where there is evidence of corrosion of the metallic armor (particularly on cables exposed to the weather) these locations should be sandpapered lightly for touchup, and corrosion products removed with a bristle brush.

b. **Fixtures and enclosures.** Paint dust impairs the operation of electric equipment and it is not practical to remove paint from electric equipment enclosures and fixtures without this dust getting into the equipment. Furthermore, the wall thickness of the sheet metal enclosures is generally such that if the factory-applied protective coatings are destroyed, the resultant corrosion will impair the function of the enclosure.

c. **Switchboards.** Switchboards of the deadfront type have a factory-applied protective coating and lacquer finish. Any attempt to remove these will endanger the meters and other equipment mounted on the switchboard and subject the switchboard to corrosion. Livefront switchboards have an insulating lacquer finish that is impractical to remove by scraping.

2. When paint is being removed from the ship's structure, all electrical equipment, such as generators, switchboards, motors, controllers in the vicinity of the area concerned must be covered to prevent the entrance of cleaning agent or dust. After completion of the paint removal, clean all equipment thoroughly, preferably with a vacuum cleaner, to remove any dust.

3. Critically or highly polished surfaces should be suitably masked before cleaning adjacent areas.

4. Aluminum, copper, nickel, and corrosion-resistant metals must be treated carefully so as not to scar or damage the surface. In the cleaning of aluminum clad, care should be taken not to perforate the cladding.

5. Wood surfaces can be cleaned of paint by using torches if the surface is to be repainted. Torches, however, must not be used to clean wood surfaces within compartments of ships or boats, or to clean wood adjacent to materials of items likely to be damaged by the heat. Cleaning with torches also is not suitable for wood that is to be refinished in its natural state. Wire brushing, scraping sanding, solvent cleaning, milling of surface, paint and varnish removers, and combinations thereof are commonly used methods to prepare a wood surface for repainting. Blasting has also been successfully used for preparing wood surfaces. Blasting with mineral shot also is effective for preparing wood surfaces. The method is similar to the sandblasting of steel hulls and utilizes the same equipment, except for a plain 3/4-inch pipe reduced from a 1-inch abrasive hose. The material is applied under 80 to 90 pounds of pressure while the hose is moved smoothly and continuously across the wood grain. The spraying is done from a distance of 6 to 8 feet and at an angle of about 45° to the hull. Holding the hose too long in one spot may cause the

wood to become fuzzy. Such areas can be removed by light sanding.

6. The use of metal conditioning compound Military Specification (MIL-M-15205, Type 1) is recommended for loosening rust and scale and reducing corrosion on steel, when, due to manpower shortages or other limitations, it is not feasible to do the required painting as soon as the need is apparent. The compound should be applied liberally to the rusty areas by c brush, or spray. There are two types available, a light and a heavy, for use whenever repainting is contemplated within 1 month and 3 months respectively. All visible evidence of the compound should be removed prior to repainting.

7. In all surface preparation methods, proper measures should be taken immediately before painting to assure that the surface is free from dust, moisture, or any corrosion products that may have formed subsequent to the cleaning.

## Part 2. Materials and Methods

### 9190.21 PAINT AND VARNISH REMOVERS

1. Allow paint remover to remain on the surface as long as is necessary to blister and lift; then, paint may be removed as in other cases. Precautions must be taken to guard against the careless use of paint remover as it usually contains solvents with fire, anaesthetic and toxic, or caustic qualities.

2. There are three types of paint and varnish remover in general use:

a. The flammable solvent type (containing benzol, acetone, and amyl acetate).

b. The nonflammable type (containing chlorinated hydrocarbons).

c. The water base alkali type (containing caustic).

3. The use of type (a) in the interior ships is potentially a fire hazard. The use of type (b) remover can cause serious illness to personnel because of the anaesthetic and toxic properties of the chlorinated hydrocarbons. The hazards associated with the use of caustic are inherent in type (c) removers, which must not be used on aluminum or zinc.

### 9190.22 TORCHES

The use of torches to blister paint for removal is satisfactory if properly done. The flame should be hot enough to blister the paint but not to burn wood underneath nor to discolor metal. As the torch blisters the surfaces, the paint, while soft and hot, should be immediately removed with a scraper. Do not use torches to remove bituminous coatings. Electrically heated devices are also available for this purpose. Whenever a torch is used for paint removal, the operator must guard against damage by accidental ignition caused by flammable materials in the immediate vicinity of both sides of the surface.

### 9190.23 SOLVENT CLEANING

1. Solvent cleaning is a procedure for removing detrimental foreign matter such as oil, grease, soil, drawing and cutting compounds, and other contaminants from steel surfaces by wiping or scrubbing the surfaces with rags or brushes wetted with solvent. The final wiping should be done with clean solvent and clean rags or brushes. Suitable ventilation and safety precautions must be observed. Do not use chlorinated hydrocarbons such as carbon tetrachloride for this purpose.

2. Emulsion cleaners or steam cleaning using detergents or cleaners may be used in place of solvents, provided that after treatment the surface is washed to remove detrimental residues.

3. An acceptable method for cleaning tanks of grease, oil, rust preventive compound, and similar materials is described in Mare Island Naval Shipyard Industrial Laboratory Development Report Number 2297-54 of 22 September 1955, "Vapor Injection Method for Removal of Formula 89 White Plastic from Submarine Tanks."

4. Grade I thin-film rust-preventive compound can be effectively removed with aromatic hydrocarbon solvents of reasonably high flash point (that is, aromatic petroleum naphtha, or coal tar naphtha, Military Specification MIL-N-15178, Type C), before it becomes hard due to aging.

a. The use of methylene chloride type paint removers, containing a minimum of 70 percent by weight of methylene chloride (that is, "Cosco 819-106 Remover" or "Turco 3095") followed by steaming has been found effective for removing this type film especially if it has been applied over paint.

b. Brush cleaning compound liberally on preventive-coated surface. Allow the material to penetrate into the preservative film about 15 minutes. If the cleaner appears to be drying, reapply. Hit the area to be cleaned with a jet of steam, holding the top of a steam gun (with approximately a ½-inch nozzle) 1 to 2 inches from the surface. If preservative compounds or loose paint remains, brush more cleaning material onto the surface, allow to soak again for 15 minutes and steam the area. In extreme cases, this cycle may have to be repeated once more.

5. Whenever practical, mixtures of Grade I thin-film rust-preventive compound and metal conditioning compound should be removed by straight steaming. When straight steaming is not successful, the following procedure is recommended:

a. Mix Hercules Powder "Dresinate 87," a liquid sodium rosin soap and high flash coal tar naphtha in a one-to-two weight ratio. Stir until a homogeneous mixture is obtained.

b. Brush cleaning compound on approximately 30 square feet of area. Allow the material to penetrate into preservative film for about 5 minutes. If the cleaner appears to be drying, reapply a small amount. Rinse the surface in a stream of hot water at about 90 to 100 pounds pressure. A Seller Type B Hi-Pressure Jet Cleaner, 1,000 gallons-per-hour capacity, with nozzle number 2351, is suitable for this purpose. Repeat the cleaning cycle over the same area, if necessary. Two cycles should be sufficient.

c. The naphtha-rosin soap mixture exhibits a low flash point (about 105°F.) and its use will require fire precautions equivalent to those observed when spray painting.

d. MIL-M-10578, Type I rust-removing compound (phosphoric acid base) diluted with water, as directed in the specification, can be used for removal of rust in presence of light grease and oil.

### 9190.24 HAND CLEANING

Hand cleaning is a method of preparing surfaces for painting by removing loose mill scale, rust, and loose paint by hand sanding, wire brushing, hand scaling, other hand impact tools, and by a combination of these methods.

This is not too effective except for small patches.





### 9190.25 POWER TOOL CLEANING

Power tool cleaning is a method of preparing surfaces for painting by removing loose mill scale, rust, and loose paint with power wire brushes, power impact tools, power rotary chippers, power grinders, power sanders, or by a combination of these methods. The power tools selected should be such that the surface is not excessively roughened. For example, scaling hammers should not be used in a vertical position as this results in a deeply dented surface with sharp edges. Soft metals such as aluminum and copper are particularly susceptible to scratching and gouging. Power tools should be used only where necessary and then with caution. Only a minimum of surface roughening should be accomplished on corrosion resisting metals. Scaling hammers must not be used on plate lighter than one-fourth inch (10 pounds per square foot) or on soft metals. The Master Allowance List, part II, group S92-1 contains the basic allowances of power preservation tools for all ships. The following table lists the power tools common to most Naval ships. Military Industrial Supply Agency, FSC Group 5, part 4 conatins many tool accessories which can be used. Changes in shipboard allowance may be implemented by direction of the Type Commanders.

**Power Cleaning Tools for Shipboard Use**

| Tool type | Stock No. | Power source | Use |
|---|---|---|---|
| ERS-Electric portable rotary scaling and chipping tool with cutter bundles | 5130-288-6577 | 115 ac dc | For shipboard use—to remove rust, paint, scale, etc. |
| Replacement cutter bundles | 5130-287-5199 | | |
| Electric deck scaling machine, Tennant Model K DC | 4940-595-9735 G.H. Tennant Co., Minneapolis, Minn. | 220 ac, 440 ac, 550 ac | For scaling, wire brushing or sanding large deck surfaces |
| Electric portable deck scaling machine, Tennant Model CDC | 4940-293-1460 G.H. Tennant Co., | 230 dc 220/440 ac | For scaling, wire brushing or sanding large deck surfaces |
| ES-Electric portable disc sander with three discs | 5130-203-4857 (7-inch) 5130-203-4856 (9-1/8-inch) | Universal Motor 115 volt | For shipboard use—can be adapted for use with wire-cup brushes, saucer grinding wheels, and planer head |
| EG-Electric portable aerial grinder with abrasive wheel | 5130-224-6504 (5-inch) 5130-540-0120 (6-inch) | Universal Motor 115 volt | Can be used with cup or wheel wire brush |
| PWG-Pneumatic vertical grinder without wheels or brushes (6-inch) | 5130-184-0090 | Air | For use with cup wheels and cup type wire brushes |
| PG-Pneumatic horizontal aerial grinder without wheels or brushes | 5130-242-0581 (6-inch) 5130-190-6434 (8-inch) | Air Air | Can be used with radial type or cup type wire brushes |
| EHS-Electric portable scaling hammer without accessories | 5130-294-9509 | Universal Motor 115 volt | For removing rust and paint. (0.495-inch-shank diameter) |
| PHS-Portable pneumatic scaling hammer | 5130-190-6442 | Air | For removing rust and paint |
| PSC-Pneumatic hammer with 3 Chisels, Ceco SC-3 scaler | Open purchase from Cleco Division, Reed Roller Bit Company, Houston, Texas | Air | For removing rust and paint |

### 9190.26 FLAME CLEANING

Flame cleaning is a method of preparing steel surfaces by passing high-temperature, high-velocity, oxygen-acetylene flames over the entire surface and then wire-brushing to remove loosened scale and rust. This procedure will not remove mill scale. Suitable precautions must be observed to avoid possible damage.

### 9190.27 BLAST CLEANING

1. Blast cleaning is a preferred method of preparing metal surfaces by removing mill scale, rust, rust-scale, paint, or foreign matter by use of abrasives (sand, grit, or shot) propelled by air or water through nozzles or by centrifugal wheels (see 9190.12).

2. Surfaces may be cleaned by any of the following methods:

a. Dry sandblasting.

b. Wet sandblasting.

c. Grit blasting.

d. Shot blasting.

3. For wet sandblasting, use a rust inhibitor in the slurry, followed by a rust-inhibiting wash. For galvanized surfaces, omit this inhibitor. Rust inhibitor solution is to prevent rusting of surfaces before painting. Use a 4 to 1 mixture of diammonium phosphate and sodium nitrite as follows: Add 2 pounds of the mixture (fill a quart can about four-fifths full of diammonium phosphate and then to the top with sodium nitrite) to 300 pounds of sand and 15 gallons of water in the blasting unit or the solution may be pumped into the discharge line of the blasting unit. Two pounds of mixture are added to 40 gallons of water to make up rust-inhibiting wash for washing down the abrasive from the blasted area. Since this solution decomposes to form gases on standing, stock solutions of the inhibitor must not be employed.

4. Grit or shot may be metallic or nonmetallic (mineral). Use of steel grit or shot on other than steel or cast iron surfaces should be avoided.

5. Dry blasting with silicious grits (sands, granite, etc.) will likely produce a high dust and health hazard. Certain by-product mineral grits and shots are low in free silica content, and produce considerably less dust. Dust conditions and danger of silicosis are less in wet sandblasting than in dry sandblasting.

6. Unless suitable reclaiming equipment is used, metallic grits and shots, or manufactured abrasives, which are relatively more costly, should not be used except where warranted by local conditions.

7. To prevent rerusting, the blast cleaned surface must be coated as soon as practical after cleaning. The freshly exposed bare metal will rust quickly under conditions of high humidity, or when wet. It is best to apply pretreatment formula 117 or primer within 2 hours after blast cleaning.

8. Air-fed respirators must be worn at all times by the blasting gun operator during blasting operations. Protective masks also should be worn by other workmen subjected to dusty conditions.

9. Abrasive blasting within ship should not be accomplished unless steps are taken which will positively prevent contamination and spread of abrasives and dust to adjacent compartments, machinery and equipment, and when extensive removal of machinery is accomplished for other than painting purposes. After any interior blasting or contamination of ship interiors, the equipment or components blasted or contaminated must be thoroughly cleaned and tested prior to use in service.

10. Suitable precautions should be taken to protect nearby equipment and structures. Drop cloths and masking will prevent damage through impact of the abrasive material; temporary divisional shields and other sealing or blanking-off measures will prevent abrasives from entering machinery, pipes, and pump wells through various openings.

11. Additional precautions should be taken to the extent necessary to protect adjacent ships, buildings, and stores. Abrasives and dust can enter ships through open sea valves, hatches, ventilation systems, temporary openings, and normal entry ways frequently opened and closed, or entry ways forced to remain open due to other work. Should there be instances where abrasives enter a ship, even though all possible precautions are taken, all machinery critical surfaces and parts, including electric and electronic equipment, should be adequately sealed or otherwise protected. Especially vulnerable are machinery components in various stages of disassembly. Personnel in or near the blasting area should be warned of the possible hazardous conditions. In all circumstances, close cooperation between ship and shipyard personnel is required.

12. Mil. Spec. MIL-S-22262(SHIPS) should be used as a basic specification for the local procurement of blasting abrasives and modified or implemented as necessary.

## 9190.28 ACID PICKLING

Acid pickling is a method of removing rust, mill scale, and other contaminants from steel by chemical means prior to painting. This method is complex and is used by shipyards primarily to prepare steel plate prior to fabrication. Visual standards for Grade M steel, illustrating desired surface conditions of various stages of the pickling procedure, are available in all naval shipyards. Visual standards for other grades of steel are under development. Visual standards may be obtained from the Naval Applied Science Laboratory, New York Naval Shipyard. During pickling, the steel plate shall be handled on edge and shall not be laid flat. The pickling procedure shall comply with the following sequence:

1. **Precleaning:** Solvent cleaning is the best method for removing waxes from metal surfaces. Oil and grease applied to the steel by suppliers, or otherwise present, may be removed by the use of 1 to 2 ounces of steam cleaning compound (Fed. Spec. P-C-437) per gallon of water in a steam-cleaning machine, or applied with a simple aspirating-type steam gun. Where the volume of steel requiring precleaning is large, and tank space permits, a cleaning tank containing caustic solution (for old paint films) or steam cleaning compound (for oil, grease, wax, etc.) is recommended. When alkali is used, steel shall be thoroughly rinsed between precleaning and pickling. This is best accomplished by using a rinse tank. Removal of heavy rust by mechanical means to break up heavy mil scale prior to pickling may be used to decrease immersion time in the acid bath. Each ship should obtain a copy of the original painting schedule.

2. **Pickling solution (bath 1):**

a. This bath shall consist of a sulfuric-acid solution. The acid concentration shall be maintained between 3-1/2 and 5 percent by volume. Initially, each 100 gallons of solution shall be composed of 5 gallons of 66° Baume sulfuric acid and 95 gallons of water. The bath shall be inhibited with pickling inhibitor, Federal specification O-I-501, type II, class a. Pickling inhibitor shall be used at the concentration recommended by the manufacturer. Since these inhibitors tend to lose their inhibiting properties in approximately 18 months, procurement should be limited to a one-year's supply. The bath shall be maintained between 170 and 180°F. Acid concentration and iron content of the pickling solution shall be determined as frequently as necessary, but not less than once a week. When the sulfuric acid is replenished, proportional quantities of the pickling inhibitor shall be added. When the weight of iron in solution reaches 5 percent of the total weight of the bath, the entire bath shall be discarded.

b. Where acid pickling is used for special-treatment and high-yield-strength steels, sodium chloride shall be added to the pickling solution (bath 1) to make a 1-1/2-percent solution. Sodium chloride shall be added as required to maintain this concentration. This modified solution also may be used for medium and high tensile steels. Pickled and primed special-treatment and high-yield-strength steels shall be aged a minimum of 24 hours before fabricating or welding.

c. The time of pickling shall be sufficient to remove the rust and mill scale completely. It will vary from 10 to 75 minutes depending on the thickness, continuity, and tightness of the scale, and the acid strength of the bath. Plates shall be withdrawn from the bath after no more than 30 minutes of pickling and examined for presence of scale. Plates should be withdrawn sooner if experience indicates complete scale removal is less than 30 minutes, as may be the case for medium and high tensile steels. If complete scale removal has not been achieved after 30 minutes, plates shall be reimmersed for successive 15 minute periods. An ohmmeter test as described hereinafter may be used to confirm visual estimation of completeness of scale removal. Medium and high tensile steels usually appear a clear uniform gray upon removal from the pickling bath. Special treatment and high yield steels will probably have slight to extensive soft dark smut deposits not removed by the acid bath. On visual examination these smut deposits may be confused with mill scale.

d. After pickling, the plates shall be withdrawn slowly from the acid and allowed to drain over the pickling tank for at least one-half minute to conserve acid and prevent carryover of acid to the rinse tank. The smut on the special treatment and high yield steels shall be removed by wiping with burlap or with a stiff bristle brush prior to or just after rinsing. (If smut is to be removed prior to rinsing, necessary precautions should be taken to protect operator from acid splatter.)

e. Ohmmeter test – Determine presence or absence of mill scale using an ohmmeter (0 to 10 ohms, full scale) fitted with test prongs. Press one prong firmly against the plate surface. With moderate pressure, slowly draw other prong along the plate surface for a distance of at least 2 inches. In the absence of mill scale the needle will not fluctuate and will remain below 0.5 ohms. The presence of mill scale is indicated by needle fluctuations and resistance above 0.5 ohms. Alternatively, the meter may be replaced by a suitably housed 2-cell flashlight with the test prongs in the bulb circuit. Flickering, dimming, or no light will indicate presence of mill scale. A bright steady light will indicate absence of mill scale. Sufficient individual checks should be made on each plate to assure that all mill scale has been removed, especially on dark areas remaining after removal of smut. At least on determination should be made for each 100 square feet of surface.

3. **Water rinse (bath 2):**

a. This bath shall consist of fresh water maintained above 190°F. It is important that the rinse water be kept free from excessive contamination. Combined concentrations of sulfuric acid and iron concentration (as ferrous) shall not exceed 2.0 grams per gallon. The water shall be tested for acid and iron concentration as frequently as necessary, but not less than once each week. When impurities have exceeded the maximum limit, the water shall be discarded, sludge removed, and the tank refilled with fresh water. The steel shall be immersed in the water rinse for about 2 minutes. Repeat dips with a short drain period between dips should be encouraged to ensure ample rinsing.

b. The presence of a powdery coating on the pickled steel indicates improper conditions in the pickling operation and further pickling should cease until test samples indicate that immersion times, bath concentrations, or temperatures have been corrected. This powdery coating shall be removed by brushing or wiping before painting. If copper deposits are observed on steel plate after pickling and rinsing, 0.1 percent by weight of diethylthiourea should be added to the sulfuric-acid pickling solution. A similar addition of diethylthiourea should be made on the reappearance of copper deposits.

4. **Rust-inhibiting solution (bath 3):**

a. This bath shall be made up in accordance with the following formula for 1,000 gallons (full strength):

Sodium dichromate, technical grade: 63 pounds.

Phosphoric acid, 75-percent grade: 56 pounds (4.2 gallons).

Fresh (tap) water: remaining volume to 1,000 gallons.

b. The bath shall be maintained between 190 and 205°F. Steel shall be immersed for not less than 2 nor more than 5 minutes. When removed from the bath, steel shall have a typically clean gray appearance.

c. An analysis of the bath shall be made as frequently as necessary, but not less than once per week. Sodium dichromate concentration shall not be allowed to drop below 50 percent of its full strength. When increasing the bath concentration, proportional quantities of the chemicals specified shall be added. Regardless of the concentration of chemicals, the bath shall be discarded when the steel comes out in a dirty condition because of accumulation of iron and sediment in the solution.

d. The steel shall be allowed to dry after removal from the rust-inhibiting bath.

e. Pretreatment, Formula 117, may be applied in lieu of the rust inhibiting bath. Formula 117, if used, shall be applied as soon as practicable after steel is removed from the water-rinse bath.

5. **Analytical control methods:** Pickling procedures specify determination of bath concentrations at least once a week. The technical assistance of a shipyard chemical laboratory should be requested for this purpose. It is intended that determination shall be made as frequently as necessary, but not less than once each week. Frequent analysis by the chemical laboratory is strongly recommended until the depletion rate of the components of the three baths is determined from local experience. Where practical, frequent field tests, in addition to weekly laboratory checks, are recommended. If desired, simple test sets for analyzing pickling baths for acid and iron, for use by personnel unfamiliar with standard laboratory practice, may be obtained for this purpose from the American Chemical Paint Company, Ambler, Pennsylvania. Methods which may be used by the chemical laboratory are given below. If solutions contain sludge or sediment, they should be allowed to settle and a clear sample decanted for analysis. Alternately, the solution may be filtered through a dry filter and funnel, discarding the first 50 ml. of filtrate, and using the remainder of the filtrate for analysis.

a. Pickling solution (Bath 1)

(1) Specific gravity-A reading with a Twaddell or Baumé hydrometer shall be taken and use to calculate specific gravity as follows:

$$\text{Specific gravity} = \frac{1 + \text{Twaddell reading}}{200}$$

$$\text{Specific gravity} = \frac{145}{145 - \text{Baumé reading}}$$

(2) Acid concentration-Dilute 5 ml. of pickling solution with 50 ml. of water in a porcelain dish. Add 2 grams of unadjusted sodium hexametaphosphate and stir until it is dissolved. Add 3 drops of methyl purple indicator and titrate with standard 0.5 normal NaOH solution to appearance of gray-green color. Percent sulfuric acid (by volume) = ml. NaOH x normality x 0.574.

(3) Percent iron-To 5 ml. of pickling solution, add 50 ml. of water and 5 ml. of dilute phosphoric acid (1:1) in a porcelain dish. Titrate with standard 0.1 normal potassium permanganate until a faint pink color appears.

$$\text{Percent iron (by weight)} = \frac{1.117 \times \text{ml. } KMnO_4 \times \text{normality}}{\text{Specific gravity}}$$

b. Water rinse (Bath 2)-Methods of analysis described above may be used.

c. Rust-inhibiting solution (Bath 3) Rapid control tests of the sodium dichromate concentration may be made with the Klett-Summerson (or similar) colorimeters, comparing the transmission data with curves obtained by measurements with known concentrations of sodium dichromate and phosphoric acid. For control purposes, it may not be necessary to measure the concentration of phosphoric acid, since it is depleted at essentially the same rate as the sodium dichromate.

## SECTION III. METHODS OF APPLICATION

### Part 1. General

#### 9190.41 FILM THICKNESS OF PAINTS

Knowledge of the thickness of dry paint films is of value to assure that coatings are of adequate thickness and are not excessively thick to cause early failure. Recommended dry-film thickness per coat of paint (for metal surfaces) and the approximate spreading rate (sq. ft. per gallon) which will give that thickness as follows:

1. Formula 117 - 0.5 mil at 220-230 sq. ft. per gallon.
2. Formulas 20, 30 and 104 - 1.5 mil at 295-305 sq. ft. per gallon.
3. Formulas (84 and 84D) - 1.5 mil at 310-320 sq. ft. per gallon.
4. Formulas 5H, 20L, 42, 116, 116D - 1.5 mil at 325-335 sq. ft. per gallon.
5. Formulas 5L, 5N, (5-0), 6, 23, 24, 38, 39, 40, 41, 46, 109, 111 and TT-E-00490-1.5 mils at 340-350 sq. ft. per gallon.
6. Formula 43-1.5 mils at 375-385 sq. ft. per gallon.
7. Formulas 119, 120, 122 - 1.5 mils at 145-160 sq. ft. per gallon.
8. Formulas 124, 125, 126 - 1.5 mils at 365-375 sq. ft. per gallon.
9. Formula 121-2 mils at 185-195 sq. ft. per gallon.
10. Formula 129-2-2 mils at 235-245 sq. ft. per gallon.
11. Formulas 105 & 146/50-3.5 mils at 120-130 sq. ft. per gallon.
12. Formula 34-5 mils at 125-135 sq. ft. per gallon.
13. Formula 15 HPN-30 mils at 30-35 sq. ft. per gallon.

#### 9190.42 MEASUREMENT OF FILM THICKNESS

Several measuring devices are available for determining paint film thickness. These include the following:

1. **General Electric Type B Thickness Gage.** The General Electric Type B gage is a rugged, reasonably portable instrument operating from a 115-volt, 60-cycle power supply. It operates on a magnetic principle and can only be used to measure coatings on a magnetic substance. The instrument is rapid and easy to use and can be used on slightly curved as well as flat surfaces. In practice, 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, as different surfaces will give different readings. Measurements should not be made close to edges and corners as this will cause variations in the readings. The accuracy of the result varies with the thickness of foil used to standardize the instrument. For best results, the standardizing foil should be close to the actual thickness of the paint film being measured.

2. **"Elcometer" Thickness Gage.** The "Elcometer" thickness gage (different ranges available) is a light, portable instrument, fitting readily into a coat pocket. It is operated by means of the variation in magnetic force between the metal surface (which must be magnetic) and a self-contained permanent magnet. No outside source of power is necessary to operate the instrument. Measurements can be made on slightly curved surfaces. To operate the instrument, 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 when set to zero. The results obtained will be satisfactory for most purposes for which field measurements are made, providing the necessary precautions are taken in its use.

3. **General Electric Permanent Magnet Thickness Gage.** This gage is a portable, self-contained gage with a dual scale. The low scale covers the range from 0 to 7 mils and the high scale from 1 to 60 mils. The instrument is also provided with a "go-not go feature" which can be set for a minimum and maximum thickness.

### Part 2. Brush Application

#### 9190.51 EQUIPMENT

Many types of brushes are carried in stock listed in **Federal Supply Catalog** (Department of Defense Section), FSC Group 80. Each brush is made for a particular purpose, and for best results, the right brush for the job must be used. (See Naval Ships Technical Publication Number 17.) The Revised Master List, Part III, contains the allowances of paint brushes for all ships.

#### 9190.52 TECHNIQUE

1. Work paint well into brush before starting to apply.
2. The brush should be dipped into paint not over halfway up the bristles and excess paint removed by patting the brush gently on the side of the can and not on the top. In painting, the brush should be held at right angles to the surface, and paint applied horizontally in one direction, lifting and applying a parallel stroke. This is termed "laying on." Edges and sharp corners should be coated as a preliminary to the overall coat.
3. After laying on a small area of parallel strokes, the work should be crossed at right angles to eliminate streaks and brush marks. This is called "laying off."
4. The surface should be finally smoothed out to a thin coat.
5. Some of the fast drying paints will not permit "laying off." In such cases, the paint should be applied, spread rapidly, and then left undistrubed.

#### 9190.53 CARE AND MAINTENANCE

1. Before using, rinse brushes with paint thinner. New brushes should be soaked in boiled linseed oil for about 48 hours to make the brush more flexible and easier to clean.
2. Brushes that are to be reused the following day should be marked for white, light colors, or dark colors. Brushes may be suspended by the handle, with the bristles immersed to just below the bottom ferrule in paint thinner or linseed oil in a closed container. The weight of the brush should not rest on the bristles.
3. Brushes that are not to be immediately reused should be carefully cleaned with thinner (at least three washings) and then washed. They should be stored, suspended from the handle on racks or wrapped in paper and stored flat.
4. Bristles are generally set in rubber or similar composition. Soaking in water to tighten loosened bristles causes the metal ferrule to rust, and often times split, due to swelling of wooden handles.

### Part 3. Spray Application

#### 9190.61 EQUIPMENT

1. A paint spray gun is a mechanical means of bringing air and paint together, atomizing or breaking up paint stream into a spray, and ejecting it for the purpose of applying a coating. The Revised Master Allowance List, part II, group S92-1 contains the allowances of paint spray equipment for all ships. Special procedures are covered in section V.
2. A spray gun consists of the gun body assembly and removable spray head assembly.
3. The principal parts of the gun body assembly are:

a. **Spreader adjustment valve.** This controls the air to the spreader horn holes to the air cap. This valve is generally equipped with graduated dial for facilitating adjustments. Changing the setting will affect the spray pattern.

b. **Air valve and fluid valve.** These control the supply of air and paint to the gun and are opened and closed by the pull and release of the trigger.

c. **Fluid needle adjustment.** This is a valve controlling the amount of material passing through the nozzle by controlling the movements of the fluid needle.

d. **Locking bolt.** This locks the spray head and gun body together.

4. The principal parts of the spray head assembly are:

a. **Air cap.** The air cap is that part at the front of the gun which directs the air into the paint stream to atomize the material and form it into a spray pattern. External mix guns mix air and paint outside the air cap. Internal mix guns mix air and paint inside the air cap. An external mix cap is equipped with two spreader horns and a center orifice and sometimes auxiliary orifices through which air is ejected and then mixed with the paint auxiliary orifices.

b. **Fluid tip and fluid needle.** The fluid tip is that part at the front end of the gun which meters and directs the paint into the air stream. The fluid tip fits inside the air cap and is available in several standard nozzle sizes. The nozzle refers to the size opening in the fluid tip. The fluid needle is actuated by the tigger and meters the paint passing through the fluid tip into the air stream. When the trigger is released, the fluid needle cuts off the paint flow.

5. One of the recent improvements in the paint application field has been the development of the hot-spray process. Such equipment is now commercially available. In most cases, paints are heated to fairly high temperatures before spraying, thereby reducing viscosity one-third to one-fourth the viscosity at 70°F. Benefits from this process include the following:

a. Elimination or reduction of holidays in the film.
b. Smoother and less porous finishes with fewer orange peels, sags, runs, etc.
c. Reduction in waste of paint in the form of overspray or fog.
d. Elimination of thinner additions to paint to reduce paint to spraying consistency where necessary.
e. Reduction of atomizing air pressures.
f. Minor gun adjustments over a wide range of weather conditions because of control of paint viscosities by maintenance of constant spraying temperatures, and therefore more consistent results.
g. Application of heavier coats requiring fewer coats for multiple-coat system and resultant reduction in time.
h. Reduction of clean-up time where paint is recirculated overnight.

#### 9190.62 TECHNIQUE

1. It is extremely important that all paint be thoroughly mixed and strained through a wire screen or a cloth to rid it of skins or coarse and foreign particles before spraying, thus preventing clogging in the nozzle with resultant uneven applications.
2. Be sure that an air filter is connected to the main air supply line to prevent mixing of moisture or oil particles with the paint discharged from the gun. The proper pressure to maintain depends upon the consistency of the paint, length of the hose, or the height the gun is used above the paint reservoir, and the speed of application.
3. The gun should be held from 6 to 8 inches from the surface being painted. Begin the stroke 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 right angles to the surface. Swinging the gun in an arc results in uneven application and excessive over-spray at the end of the strokes. When spraying corners, first spray to within 1 to 2 inches of the corner. Then, holding gun sideways, spray corner in such position that both sides are sprayed at once. Speed of application depends on material being sprayed, rate of paint flow, and surface to be coated.

4. Having made initial adjustments to air and liquid pressures, final adjustments are made by observations of spray patterns. Normal spray patterns will appear as illustrated in figures 9190-1 and 9190-2. Imperfect spray patterns usually are due to clogging of passages or improper balancing of air and fluid pressures.

5. Imperfect patterns due to clogged passages will take the following forms:

a. Heavy top pattern (see figure 9190-3).
b. Heavy bottom pattern (see figure 9190-4).
c. Heavy right side pattern (see figure 9190-5).
d. Heavy left side pattern (see figure 9190-6).

6. Imperfect spray patterns due to improper balance of air and fluid pressures will take one of the following forms:

a. Heavy centered pattern (See figure 9190-7) due to:
(1) Too low a setting of spreader adjustment valve.
(2) Too high fluid pressure.
(3) Viscosity of material too great.
b. Split spray pattern (see figure 9190-8) due to:
(1) Too high a setting of spreader adjustment valve.
(2) Too high fluid pressure.
(3) Material too thin.

7. Common causes of "orange peel" finish are too high a pressure and excess volatiles, insufficient atomization, and holding gun too close to surface (air ripples).

8. Another common defect in spraying is "mist" or "fog" due to:

a. Over atomization caused by:
(1) Air pressure too high.
(2) Fluid pressure too low.
(3) Wrong air cap for material used.
(4) Wrong fluid tip for material used.
b. Improper use of gun:
(1) Incorrect stroking.
(2) Gun too far from surface.

### 9190.63 CARE AND MAINTENANCE

1. Spray guns, paint containers, and hose must be thoroughly cleaned after use.

2. When using pressure feed tank, release pressure from tank, hold cloth over air cap, and pull trigger forcing material back into tank. Then remove paint hose from gun and run solvent through hose. Dry out hose with air. Spray some solvent through gun. Remove air cap and wash off fluid tip with solvent. Clean air cap and replace on gun. Clean out tank and reassemble for future use.

3. When using cup gun, hold cloth over openings in air cap and pull trigger forcing paint back into container. Empty cup of paint and replace with small quantity of solvent. Spray solvent in usual way. Then remove air cap and wash off fluid tip with solvent. Clean air cap and replace on gun.

4. Clean air cap by immersing in solvent. If small holes become clogged, soak in solvent. If reaming is still necessary, use match stick, broom straw, or any other soft implement. Digging out holes with wire or nail may permanently damage cap.

5. Never soak the assembled gun in thinner as this has a detrimental effect on the packing around the fluid valve as well as the grease and oil trigger action.

6. Do not use caustic alkaline solutions for cleaning spray guns as they destroy aluminum alloys used in gun bodies and parts.

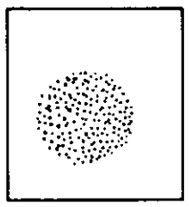

Figure 9190-1. NORMAL

Figure 9190-2. NORMAL

Figure 9190-3. HEAVY TOP

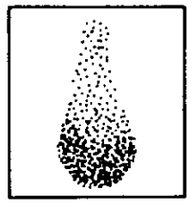

Figure 9190-4. HEAVY BOTTOM

Figure 9190-5. HEAVY RIGHT SIDE

Figure 9190-6. HEAVY LEFT SIDE

Figure 9190-7. HEAVY CENTERED

Figure 9190-8. SPLIT SPRAY





7. Spray guns require occasional lubrication. The fluid needle packing should be removed occasionally and softened with oil. The fluid needle spring should be coated with grease or petrolatum. All moving parts should get a few drops of light oil. Most spray guns are provided with oil holes for these parts.

## Part 4. Roller Coat Application

### 9190.71 EQUIPMENT

Dip coat roller coaters in 7-inch and 9-inch sizes which are available in standard stock.

### 9190.72 TECHNIQUE

1. A flat pan or container is required into which the roller can be dipped to receive the paint which is simply rolled onto the surface to be painted.

2. Inaccessible areas may be painted by attaching a long handle to the roller coater.

3. This technique is not suitable where discontinuity of the surface is encountered (that is, corners, crimped joints, rivets, and other places).

### 9190.73 CARE AND MAINTENANCE

Roller coaters should be cleaned immediately after use by washing thoroughly in the thinner recommended for the paint which was used. After cleaning with thinner, the cylinder cover should be washed thoroughly with soap and water, rinsed, and dried on the roller to prevent shrinkage. Combing the pile of the fabric while damp will prevent matting.

## Part 5. Dip Application

### 9190.81 EQUIPMENT

A receptacle to hold the paint is required. In general, the receptacle should be just large enough to conveniently permit the insertion of the article to be coated. Some method of agitation must be provided to keep a uniform mixture of pigment and vehicle.

### 9190.82 TECHNIQUE

1. The thinner used is an important factor in the operation of a dip tank. The optimum consistency is that which provides coverage at the highest point and yet allows the paint to draw off well from the lowest point of the article being coated.

2. Suspend article in a manner providing the shortest drain without developing pockets of paint. Immerse in paint, remove slowly and regularly, and allow to drain.

### 9190.83 CARE AND MAINTENANCE

When dipping operations are interrupted for several hours, paint should be removed and placed in sealed containers.

# SECTION IV. DETAIL PAINTING REQUIREMENTS

## Part 1. General

### 9190.91 COATINGS AND APPLICATION

1. Surface preparation should be in accordance with the requirements of section II. Repainting required by the condition of existing coatings or by other work in connection with repairs should be accomplished in accordance with the ships' original painting schedule if touchup is done; if the surface is cleaned to bare metal, painting should conform to the schedules herein. Each ship should obtain a copy of the original painting schedule.

2. Where more than one coat is specified, do not apply subsequent coats until the preceding coats have dried and, if necessary, have been suitable touched up to ensure uniform thickness and total coverage.

3. Painting of equipment not mentioned herein should be as required in the purchase specifications for that equipment.

4. Where minimum film thickness are specified herein, take measurements after the coating has dried.

5. The terms "exterior" and "interior" surfaces as used herein refer to the weather surfaces and surfaces inside the ship respectively.

## Part 2. Pretreatment and Priming

### 9190.101 PRETREATMENT

1. Unless otherwise specified, apply one coat of pretreatment coating, formula 117, to all bare metal and plastic surfaces to be painted, as soon as practical after surface preparation and prior to application of primers. (See article 9190.162 for application instructions.) However, Formula 117 should be omitted where interior painting is accomplished by ships force. If necessary, fill shallow pits in plates with cement, formula 62, or with approved epoxy hull-repair compounds. The epoxy hull-repair compounds listed in article 9190.169 are approved for filling and repairing corroded or pitted metal and minor damages in wood surfaces prior to painting. Hull-repair compounds are not approved for repair of severe deterioration as defined in chapter 9110.51. The repair procedures of chapter 9110 must be followed.

2. The following table should be used as a guide for repairing corroded or deteriorated aluminum and steel structures and fastenings:

| Trouble | Cause | Method of Repair |
|---|---|---|
| Buckled plating at lap of aluminum and steel | Electrolytic corrosion. Accumulation of corrosion products at faying surface. | Remove corrosion deposits from joint; clean plate, paint, and insulate. |
| Missing aluminum rivets | Chemical corrosion of aluminum due to environment. | Replace |
| Corroded aluminum-pits and holes. | Chemical corrosion of aluminum due to environment. | Fill depressions and small holes with epoxy repair compound listed in article 9190.169 or with resin-glass cloth supplied |

| Trouble | Cause | Method of Repair |
|---|---|---|
| | | in repair kit MIL-R-19907; where corroded beyond repair by this method, crop out corroded area and replace. |
| Corroded steel | Chemical corrosion of steel. | Clean and blast surface, fill depressions with epoxy repair compound listed in article 9190.169 or with resin-glass cloth supplied in plastic repair kit MIL-R-19907. (This method of repair should be used where strength is not important.) |

### 9190.102 UNGALVANIZED STEEL

1. To minimize misidentification in transfers from one shipyard to another (as a result of local color-coding), the following system should be used for identification of plates and shapes from which mill scale has been removed:

| Grade Steel | Steel Specifications | Color |
|---|---|---|
| M | MIL-S-22698 | Yellow |
| HT | MIL-S-24094 | Dark Green |
| HY-80 | MIL-S-16216 | Brown |
| HY-100 | MIL-S-16216 | Dark Brown |
| STS | MIL-S-20154A | Red |

These colors may be obtained as follows:

a. Yellow: Formula 84/47.
b. Dark green: Formula 84D/47.
c. Formula 84R or mix one gallon red, formula 40, with four gallons yellow, formula 84.
d. Brown: Formula 84B (Fed-Std-595, Color No. 30117).
e. Dark Brown: Formula 84 modified to approximate FED-STD-595 Color 30118.

2. The above color code is not required for the following:

a. Steel used by private shipyards for Naval work.
b. Shapes and plates already coated with primer, provided they are marked with positive identification.
c. Touch-up or recoating of steel surfaces after erection.

3. Shapes and plates already coated with primer but not marked with positive identification shall be color coded as specified above, or stenciled or marked by other suitable means.

4. Except where otherwise specified herein, paint steel with one coat of primer, formula 84 or 116, as soon as practical after surface preparation and pretreatment. For paint systems requiring pretreatment, do not apply primer prior to application of formula 117. This original priming coat, touched up as required, constitutes the first coat of primer where one or more coats are specified herein. Apply one priming coat to interior surfaces. Apply a complete second coat of primer to exterior surfaces. Formula 116D should be used to provide color contrast between coats. All edges, welding, rivet heads and other protruding objects should be given an additional coat of primer. Areas which become bare or show rust should be cleaned and touched up with one coat of formula 116 on interior surfaces and two coats on exterior surfaces. Pretreatment formula 117 should be used prior to application of primer, wherever practical. In interior locations, where necessary safety precautions normally are not practical, formula 117 may be omitted except under vinyl paints. Formula 117 may be omitted in all instances when painting is accomplished by ship's force, except under vinyl paints.

### 9190.103 GALVANIZED STEEL

1. Paint all galvanized steel unless painting is specifically excluded elsewhere herein. Apply one coat of formula 117 and one coat of formula 116 to surfaces that are to be painted. Formula 117 may be omitted for interior galvanized steel where painting is accomplished by ship's force. The specified number of coats of formula 119 should be used in lieu of formula 116 where a vinyl system is specified.

2. Paint welds and damaged areas of galvanized surfaces as required for the surrounding galvanized area.

3. Where painting is not required, apply one of the following coatings to welds and damaged areas:

a. One coat of inorganic zinc silicate (MIL-P-23236, C1 3)

b. Two coats of galvanizing repair paint (MIL-P-21035).

c. Two coats of zinc dust paint (MIL-E-15145, Formula 102)

Paint should be applied to a cleaned surface, preferably by abrasive blasting. (Abrasive blasting is required for inorganic zinc silicate.)

### 9190.104 ALUMINUM ALLOY

1. Exterior surfaces should be given two coats of primer, formula 84 and/or 84D over formula 117.

2. Interior surfaces which are to be painted should be given one coat of formula 84 or 84D.

3. See article 9190.6 for interior surfaces which are not to be painted.

### 9190.105 FAYING SURFACES – ALUMINUM

1. The most effective methods of preventing bimetallic corrosion lie in careful design and assembly and assembly practices. Excellent workmanship is required to effectively insulate dissimilar metals. Properly applied films of the paints and insulation tape specified will increase durability and prevent corrosion. It is important in the installation of insulation material that no place in the joint be left open where water can collect and form a bridge between steel and aluminum.





2. 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 should be sealed with calking compound.

3. Frequent inspection of aluminum structure and fastenings should be made by ship's force to determine condition of surfaces. Bare surfaces should be painted as soon as practical to prevent corrosion and maintain the state of preservation.

4. The painting of faying surfaces of aluminum in contact with aluminum in non-weather areas is not required. Where exposed to weather, faying surfaces of aluminum shall be coated with one coat of zinc chromate primer, formula 84, except in way of welding.

5. Where aluminum will be joined to other metals, including galvanized steel, or to wood, each metal faying surface should be protected by one coat of pretreatment formula 117 and two coats of primer formula 84. If a vinyl system is to be used, apply two coats of formula 120 in lieu of formula 84. Wood in contact with aluminum should be coated with one coat of phenolic varnish, formula 80.

6. In addition, where one or both sides of joint are exposed to sea water, weather, or wet spaces, one of the following insulation tapes, minimum thickness 20 mils (two thicknesses of MIL-I-7798 tape), and of sufficient width, should be installed between faying surfaces to extend beyond the edge of the joint:

MIL-I-7798, 10-mils thick, pressure sensitive one side.

Trantex V-20 vinyl tape, 20-mils thick, manufactured by Johns Manville Company, pressure-sensitive one side.

EC-1202 butyl rubber tape, 1/16-inch thick, manufactured by Minnesota Mining and Manufacturing Company, pressure sensitive both sides.

Other NAVSEC-approved equivalents.

7. Difficulties may be experienced with application of pressure-sensitive tape where procedures require insertion of insulating material after final drilling and cleaning out of faying surfaces. Wetting pressure-sensitive tape with kerosene or dusting lightly with talc prior to installation should facilitate insertion. No insulation tape is required for joints in dry spaces, and only one coat of primer for each faying surface is required.

8. Faying surfaces of aluminum in contact with other metals requiring stop waters or oil stops should be treated as specified in paragraphs 5 and 6, and all joints sealed with calking compound MIL-C-18969. For watertightness, horizontal joints exposed to the weather should be sealed with calking compound. This is not required where butyl or neoprene rubber tape has been used.

9. Label plates should be installed in accordance with NAVSHIPS Hull Type Drawing S-2803-980208.

### 9190.106 MISCELLANEOUS METALS

In general, corrosion-resisting steel, brass, nickel-copper alloy, and copper-nickel alloy are not required to be painted unless they abut painted surfaces in living, messing, recreation spaces and passageways and painting is desired for appearance. Where exterior areas are painted for camouflage reasons, apply formula 117 prior to application of finish paint.

### 9190.107 WOOD

1. Wood which is to be varnished (finished bright) should be filled with wood filler, Fed. Spec. TT-F-336b, stained to the shade desired and given a priming coat of varnish, formula 80.

2. Prime wood which is to be painted should receive one coat of aluminum paint (9190.111(o)), except on underwater surfaces and under vinyl paints.

3. Apply formula 117, under vinyl paints, to bare wood treated with wood preservative, for underwater surfaces.

### 9190.108 FAYING SURFACES, WOOD

Apply two coats of formula 105 to outer surfaces of hull planking behind teredo-protective wood sheathing and to inner surfaces and seams of the sheathing. Except for surfaces exposed to sea water, apply one coat of aluminum paint, before assembly to all butted-end joint faying surfaces and end grain of all members not otherwise specified to be calked or sealed.

### 9190.109 PLASTIC

Plastic surfaces which are to be painted shall receive a coat of pretreatment, formula 117. Primer coats are not required.

### 9190.110 ALUMINUM BOATS

**Exterior**

1. All loose paint, corrosion products and other contaminents shall be removed by light sandblasting power wire-brushing or orbital sanding. Only stainless steel wire brushes and scouring pads or abrasive sanding discs shall be used. None of these materials should have been used previously on other metal or for removal of copper or mercury pigmented paint prior to being used on aluminum. The edges of the good paint around bare areas shall be feathered. The surface shall then be washed with a liquid detergent cleaner (MIL-D-16791), thoroughly rinsed and allowed to dry. Painting shall take place as soon as possible after cleaning.

2. **Underwater hull.** The cleaned underwater hull shall be coated with an approved non-copper or non-mercury bearing antifouling paint system. The following systems are approved:

**Glidden System**

| | Dry film thickness |
|---|---|
| 1 coat Nupon Primer | 2 mils |
| 1 coat Vinyl-Cote AC Brown | 2 mils |
| 1 coat Vinyl-Cote Metallic Mastic | 4 mils |
| 1 coat Vinyl-Cote No-Cop AF | 2 mils |

**USS Chemicals System**

| | |
|---|---|
| a. Standard system | |
| 2 coats Shipyard Primer | 1 mil/coat |
| 1 coat Tarset 305 AF | 12 mils |
| b. Heavy Duty system | |
| 1 coat Shipyard Primer | 1 mil |
| 1 coat C-200 | 6 mils |
| 1 coat Tarset 305 AF | 12 mils |

3. **Boottopping and above.** Pretreatment formula 117 (MIL-P-15328) shall be applied to all bare metal. Two coats of primer formula 84 (TT-P-645) or formula 120 (MIL-P-16930) shall be applied within 24 hours after application of pretreatment. After the primer has dried at least 8 hours two coats of No. 27 haze gray (TT-E-490) shall be applied to a minimum dry film thickness of 1.5 mils per coat.

4. **Decks.** Areas subject to heavy traffic should be coated with non-skid paint MIL SPEC MIL-D-23003, Type II 30 mils thick replacing the No. 27 haze gray specified for boottopping and above.

**Interiors**

5. **Bilges and seawater ballast tanks.** All grease, oil and similar contaminents shall be removed with a well agitated solution of cleaning compound (MIL-C-22543) followed by a hot water flushing and rinse. The surfaces shall then be cleaned as described in 1. above and pretreatment applied to all bare metal. Over the pretreatment two coats of primer (MIL-P-23375) shall be applied to 2 mils dry thickness followed by one coat of topcoat (MIL-C-22750) to 3 mils dry film thickness.

6. **Fuel Tanks.** These tanks shall be cleaned and coated as described under Bilges except coating should be limited to bottom of the tank and approximately six inches up the sides of the tank.

## Part 3. Surface Ships

### 9190.111 EXTERIOR

Coat exteriors of all ships and craft in accordance with tables 1 and 2.

**TABLE 1. PAINT SYSTEMS FOR EXTERIOR STEEL SURFACES**

| Item | Surface | Paint system (number of coats-formula No.) | Notes |
|---|---|---|---|
| 1. | Keel to lower boottopping limit | a. 1-117; 3-14N; 1-15 HPN or | (a) (b) (c) (d) (e) (f) (s) |
| | | b. 1-117; 3-14N; 3-105 | (a) (b) (d) (e) (f) (s) |
| | | c. 1-117; 4-119 or 120; 2-121 | (a) (b) (d) (e) (f) (t) |
| 2. | Lower to upper boottopping limit | a. 1-117; 3-14N; 3-146/50 | (a) (b) (e) (f) (g) |
| | | b. 1-117; 4-119; 2-122-1 or 2-129 | (a) (b) (e) (g) (u) |
| 3. | All exterior and near vertical surfaces from upper boottopping limit | a. 1-117; 2-116; 2-5H | (b) (e) (h) (j) (k) (q) (r) (t) |
| | | b. 1-inorganic zinc 1-119; 5-5H | (h) (j) (r) |
| 4. | Exterior horizontal surfaces and waterways | a. 1-117; 2-116; 2-20 | (b) (e) (h) (j) (k) (q) (r) |
| 5 | Rudders and struts (external surfaces) | See Note (m) | |
| 6 | Fittings and exterior piping | 1-117; 2-84 or 116; 2-5H or 20 | (e) (h) (j) (k) (n) |

**TABLE 2. PAINT SYSTEMS FOR EXTERIOR WOOD SURFACES**

| Item | Surface | Paint system (number of coats-formula No.) | Notes |
|---|---|---|---|
| 1 | Keel to lower boottopping limit. | a. 1-117; 3-105 or | (b) (d) (f) |
| | | b. 1-117; 2-121 | (b) (d) (f) (s) |
| 2 | Lower to upper boottopping limit. | 1-117; 3-146/50; | (b) (f) (g) |
| 3. | Upper boottopping limit to main deck | 1-Aluminum paint; 2-5H | (o) |
| 4 | Exterior vertical surfaces (includes near vertical). | 1-Aluminum paint; 2-5H | (j) (o) |
| 5 | Exterior horizontal surfaces and waterways. | 1-Aluminum paint; 2-20 | (j) (l) (o) |
| 6 | Masts and spars | 2-Aluminum paint, 2-20 | (f). (o) |
| 7 | Accommodation ladders. | 4-80 | |
| 8 | Fittings | 1-Aluminum paint; or 20. | (j) (n). (o) |

NOTES TO TABLES 1 AND 2

(a) For complete painting, blast or otherwise clean to bare steel or to galvanized coating. If antifouling is to be retained, the coating should be washed down with water frequently to prevent drying out of coating. Intact formula 84 or 116 must be removed prior to application of anticorrosive to under water surfaces.

(b) Apply formula 117 over bare metal or wood surfaces.

(c) Hot plastic antifouling should be applied in lieu of cold plastic antifouling whenever possible.

(d) Zincs and waster rings must not be painted.

(e) Alternate coats of darkened shade of paints, such as 14ND, 84D, 116D, and so on, may be used where possible to ensure complete coverage of each coat. Vinyl primer, formula 119, may be darkened by addition of small quantities of formula 122-3 to one gallon of formula 119. Formula 119 also may be alternated with formula 120 to provide contrast between coats.

(f) Hot or cold plastic antifouling may be applied over intact vinyl paint. A minimum drying time of 4 hours must be allowed for each coat of anticorrosive and cold plastic





Table 1 and 2. Notes Continued

antifouling.Under conditions of high humidity and low temperature a minimum of 8 hours drying time is recommended and, where possible, preferably 18 hours. Interval between the final coat and undocking must not exceed 2 weeks for hot plastic and preferably should be between 24 and 72 hours for cold plastic. A coat of whitewash may be used to prevent sagging of hot plastic in hot weather.

(g) Boottopping areas on oilers, cargo ships, and similar craft having a wide variation in service drafts extend from the normal running light load line to 12 inches above the maximum water line at which the ship is expected to operate. The extent of boottopping area on other surface ships is from the minimum water line at which the ships are expected to operate to 12 inches above the maximum water line, except upper boottopping limit of ice breakers may be raised to confine scraping of paint to boottopping area. The upper and lower boottopping limits shall be parallel to the full load and light condition waterlines, respectively, even though the boottopping limits are not parallel to each other. Proposals to modify boottopping limits should be referred to the Naval Ship System Command with the reasons for proposed change.

(h) See article 9191.157 for painting of hospital ships.

(i) Use deck gray, formula 20 in lieu of haze gray, 5-H, on vertical surfaces of open gun shields.

(j) The paints specified are those required by Camouflage Measure U. S. 27 of NAVSHIPS 250-374, except overheads and undersides of horizontal surfaces, where white is specified. The provisions of NAVSHIPS 250-374 may be modified by Fleet and Force Commanders. Examples of exceptions which might be authorized are:

1. Use of black paint on areas which may be subject to discoloration from smoke and gases. For guidance, black paint formula 24 should be applied to areas between the highest point and a plane through the lowest point of the black portion of the stack and parallel to the deck, except deck houses, radio and radar antennas, and top hamper forward of the forward stack.

2. Painting of smoke pipes as specified in article 9190. 191, table 16.

3. Wood decks.

4. Use of white paint to facilitate night replenishment.

5. Use of haze gray on overheads and undersides of exterior horizontal surfaces where shadow counter effects of white paint are not effective.

6. Use of contrasting colors (e.g., Federal Code 12197, International orange) on tips of cargo booms and similar projections near landing areas for greater visibility.

(k) Use formula 84 on aluminum surfaces. (Both formula 84 and 116 may be applied over existing intact primer.

(l) Tops of cylindrical or rounded objects, such as gun barrels, and narrow surfaces, such as bulwark tops, are not considered borizontal surfaces. Do not paint surfaces in way of deck coverings unless otherwise specified. See article 9190.153 for flight-deck markings for aircraft carriers.

(m) Struts, strut barrels, and rudder assemblies (except where plated with special treatment steel) of active ships of the following types should be coated with coat tar-epoxy systems, MIL-P-23236, Class 2 system, or Desoto Chemical Coatings "KOROPON CT" or Inertel Company's "POXITAR" applied to a minimum dry-film thickness of 15 mils over abrasive blasted steel and in accordance with manufacturer's specifications, or the complete vinyl system specified in Item 1, Table 1: APD, CA, CAG, CL, CLG, CVA, CVL, DD, DDG, DE, DL, DLG, DM and PC. Apply appropriate antifouling paint.

Portions of rudder assemblies plated with special treatment steel should be coated with the same paint system specified for the underwater hull.

(n) Finish paint to match structure in stowed position.

(o) Prepare aluminum paint by mixing 2 pounds aluminum past (TT-P-320) with 1 gallon of varnish (formula 80). Add paste in small amounts to portion of varnish, stirring until no lumps remain. Add remaining varnish in small increments stirring after each addition until mixture is homogeneous.

(p) For increased durability a vinyl system should be used for boottopping areas of ships with a wide variation in service drafts and on ice breakers. (See article 9190.165 for application instructions.)

(q) When abrasive blasting can be accomplished on ferrous metal, apply one coat of NAVSEC approved ingoranic zinc silicate coating (note (r)), one coat of formula 119, and two coats of required topcoat.

(r) The following inorganic zinc silicate coatings, applied to a minimum dry film thickness of three mils, are approved for coating the exterior vertical and horizontal steel surfaces above the upper limit of the boottopping, including hull appurtenancies, over steel abrasive blasted in accordance with the proper instructions in note (a):

Post Cure type
- Cathacoat 300—Celamese Coatings Company
- Dimetcote No. 3—Amercoat Corporation
- Rust-Ban 121/195—Enjay Chemical Company
- Zincilate 101C—Industrial Metal Protective Company

Self Cure Type
- Carbo Zinc 11—Carboline Company
- Galvesil 1570—Hempel's Marine Paints
- Dimetcote No. 6—Amercoat Corporation
- Metalhide 100—Pittsburgh Plate Glass Co.
- Mobilzinc 7—Mobil Chemical Company
- Rust-Ban 191—Enjay Chemieal Company
- Zinc-ite B—Plaschem Corporation
- Interzinc 2140/2411—International Paint Company, Inc.
- Plasite 1000—Wisconsin Protective Coatings Corporation

Initial application should be by the shipyard. Touchup may be accomplished by the ship's force. Formula 119 should be applied as a tie coat where necessary, to a dry film thickness of 1 mil. If slip-resistance is desired, use MIL-D-23003, Type II, directly over inorganic zinc silicate. Other topcoats should be selected by environment and use.

(s) Ships utilizing an impressed-current system require the standard Navy vinyl paint system or other NAVSEC approved coating system on the underwater hull.

(t) Vinyl System may be used where economically practical. Total minimum dry film thickness should be 10.5 mils. Apply vinyl primer to a minimum dry film thickness of 6 mils. Where application is accomplished by hot

spray, a minimum of two coats may be applied. Apply vinyl antifouling and vinyl topcoats to a minimum dry-film thickness of 4 mils.

(u) Vinyl System shall be used where enconomically practical. Total minimum dry film thickness should be 10.5 mils. Apply vinyl primer to a minimum dry film thickness of 6 mils. Where application is accomplished by hot spray, a minimum of two coats may be applied. Apply vinyl antifouling and vinyl topcoats to a minimum dry-film thickness of 4 mils.

(v) Ships utilizing an impressed current system require the standard Navy vinyl paint system or other NAVSEC approved coating system on the underwater hull.

### 9190.112 INTERIOR COMPARTMENTS

1. **Metal Surfaces.** If accumulated paint is greater than 5 mils thick, clean the entire surface to bare metal and repaint in accordance with one of the following procedures as applicable (except in tanks, bilges, and voids):

a. Apply one coat of formula 116 (formula 84 on aluminum); use 2 finish-coats both sides of chlorinated alkyd-base paint on bulkheads and overheads. Chlorinated alkyd-base paints are applied the same as conventional alkyd-base paints.

b. One coat pretreatment, formula 117 (omit formula 117 where necessary safety precautions are not practical); 1 coat formula 116 (use only 84 on aluminum); 2 finish coats on decks.

c. Fire zone bulkheads shall receive two coats of MIL-C-46081 over the properly prepared and primed surface on both sides.

2. **Wood surfaces.** In general, coat wood surfaces in accordance with the following procedures (except in tanks, bilges, and voids):

a. **Painted wood:** 1 coat aluminum paint; 2 coats finish paint.

b. **Unpainted wood:** Wood filler, Fed. Spec. TT-F-336b, stain; formula 49, 50, 51, 52, 54; 3 coats varnish, formula 80.

3. **Fibrous Glass Board.** One finished coat of chlorinated alkyd base paint (use 2 if required for hiding).

4. **Rubber Items.** Rubber items such as gaskets, expansion joint components, and so on, in contact with painted or cemented surfaces should not be clamped in place under pressure until paints or cements in contact with the rubber have dried sufficiently. Painted surfaces should be allow to dry tack free, that is surfaces should not be sticky and a slight pressure of the finger should not leave a mark. Do not apply paint to rubber surfaces except when specified; for example, rubber accoustical surfaces of sonar equipment. Allow solvent to evaporate from cement which has been applied, until surfaces retain only a slight tackiness before putting rubber items in place. Allow an additional 3-hour drying period before applying pressure.

5. **Bulkheads and Overheads.** The chlorinated alkyd-base paints listed in table 3 should be used for overheads and bulkheads of living, messing, and recreation spaces and connecting passageways. Fibrous glass board should be painted to match surrounding structure. Antisweat paint should be applied to uninsulated surfaces of compartments subjects to sweating in accordance with article 9290.164, followed by the finish paint specified, allowing sufficient drying time prior to application of chlorinated alkyd paint to eliminate wrinkling. Do not apply paint to procelainized bulkheads or those constructed of corrosion-resisting steel (unless otherwise specified) or plastic. Antisweat paint should not be applied where hull damping is to be installed.

6. **Decks and Walking Surfaces.** Decks for which coverings are specified do not require finish painting where the deck covering consists of false decking, gratings, rugs or portable material. Do not paint surfaces of aluminum, or corrosion resisting steel. Bottoms and edges of steel floor plates in main and auxiliary machinery rooms should be given two coats of formula 116. Unless otherwise specified, finish paint all decks with gray, formula 20 L.

7. **Acoustical absorptive treatment**

Acoustical absorptive treatment 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 avoid bridging or sealing the perforations in the acoustical treatment with paint.

8. **Color schemes.**

a. A suggested list of color schemes is contained in the "Habitability Manual." Type Commanders may specify uniform painting schemes for ships under their command or may permit each ship to adopt its own scheme for living, messing and recreation, commissary and sanitary spaces, and the passageways serving them. The choice of colors, however, must be restricted to those specified for decks, bulkheads, and overheads. The minimum reflectance of 70 percent is mandatory for overheads except light traps (reflectance may be determined in accordance with Method 6121 of Federal Standard No. 141.)

b. Inter deck colors may be carried up onto the bulkhead adjacent to the deck to a height of approximately 6 inches. Table 3 paints may also be used for deck borders in spaces where rugs are installed. Interiors of weather doors may be finish-painted to match the surrounding bulkhead. Overhead colors may be carried down onto the adjacent bulkhead to a line at the level of the bottom of the overhead framing.

9. Finish paint all other compartments in accordance with table 4. Space and station names are segregated into functional groups as designated in S28-3-c of the General Specifications.

**TABLE 3. INTERIOR-FINISH PAINTS (CHLORINATED ALKYD BASE).**

| Item | Color | Formula | Specification | |
|---|---|---|---|---|
| 1 | White | 124/58 | MIL-E-17970C | 1 |
| 2 | Pastel green | 125/68 | MIL-E-17971C | 1 |
| 3 | Bulkhead-gray | 126/58 | MIL-E-17972C | 1 |
| 4 | Rosewood | | | 2 |
| 5 | Beachsand | | | 2 |
| 6 | Yellow gray | | | 2 |
| 7 | Green gray | | | 2 |
| 8 | Pearl gray | | | 2 |
| 9 | Sun glow | | | 2 |
| 10 | Clipper blue | | | 2 |
| 11 | Pastel blue | | | 2 |





NOTES:

(a) Paint suitable for overheads, that will provide a reflectance of 70 percent or more, is white or blends of one part of color with four parts of white (one quart to one gallon).

(b) These colors are prepared by tinting white formula 124/58 with tinting colors specified in MIL-C-22325, in the ratio of 1/2 pint of the tinting color to one gallon of white. If these colors are to be used for overheads, add 1/4 of the one-half pint of MIL-C-22325 tinting color to one gallon of the white paint.

**TABLE 4 SURFACE SHIPS COMPARTMENT FINISHES**

| Item | Compartment | Bulkheads | Overhead |
|---|---|---|---|
| 1 | Air control and associated spaces: | | |
| | a. Air operations | Green, 125/58 | Green, 125/58 |
| | b. Air radio room | Green, 125/58 | White, 124/58 |
| | c. Carrier control approach room. | Gray, 126/58 (b) | Gray, 126/58 |
| | d. Other spaces (a) | White, 124/58 | White, 124/58 |
| 2 | Commissary spaces | White, 124/58 | White, 124/58 |
| 3 | Damage control spaces: | | |
| | a. Central control station | Green, 125/58 | White, 124/58 |
| | b. Other spaces | White, 124/58 | White, 124/58 |
| 4 | Electronics spaces: | | |
| | a. Radar control room | Gray, 126/58 (b) | Gray, 126/58 |
| | b. Sonar control room | Gray, 126/58 (b) | Gray, 126/58 |
| | c. Other spaces | Green, 125/58 | White, 124/58 |
| 5 | Machinery and associated spaces (e) | White, 124/58 | White, 124/58 |
| 6 | Fire control and gunnery spaces (d): | | |
| | a. Gun mount enclosure (g) | White, 30 | White, 30 |
| | b. Powder test room | Green, 125/58 | White, 124/58 |
| | c. Surface battery plot | Green, 125/58 | White, 124/58 |
| | d. U B plot | Green, 125/58 | White, 124/58 |
| | e. Other spaces | White, 124/58 | White, 124/58 |
| 7 | Flag spaces: | | |
| | a. Flag planning center | Gray, 126/58 (b) | Gray, 126/58 |
| | b. Flag plot | Gray, 126/58 (b) | Gray, 126/58 |
| | c. Flag radio center | Green, 125/58 | White, 124/58 |
| | d. Secondary flag planning | Green, 125/58 | Green, 125/58 |
| | e. Support control room | Green, 125/58 | Green, 125/58 |
| | f. Supporting arms coordination center | Gray, 126/58 (b) | Gray, 126/58 |
| 8 | Medical and dental spaces | Green, 125/58 | Green, 125/58 |
| 9 | Offices | Green, 125/58 | White, 124/58 |
| 10 | Ship control and associated spaces: | | |
| | a. Captain plot | Gray, 126/58 (b) | Gray, 126/58 |
| | b. Captain tactical message center | Gray, 126/58 (b) | Gray, 126/58 |
| | c. Chart room | Green, 125/58 | Green, 125/58 |
| | d. C I C (i) | Gray, 126/58 (b) | Gray, 126/58 |
| | e. Pilot house (j) | Green, 125/58 | Green, 125/58 |
| | f. Secondary conn | Green, 125/58 | Green, 125/58 |
| | g. Other spaces | Green, 125/58 | White, 124/58 |
| 11 | Workshops (h): | | |
| | a. Aviation photographic laboratory | Green, 125/58 | Green, 125/58 |
| | b. Welding bay (c) | Black, 104 | White, 124/58 |
| | c. Other spaces | White, 124/58 | White, 124/58 |
| | d. Print shop photographic darkroom | Green, 125/58 | White, 124/58 |
| 12 | Storerooms, issue rooms and lockers | White, 124/58 | White, 124/58 |
| 13 | Utility spaces: | | |
| | a. Light traps (f) | Black, 104 | Black, 104 |
| | b. Other spaces | White, 124/58 | White, 124/58 |
| 14 | Sanitary spaces | White, 124/58 | White, 124/58 |

NOTES TO TABLE 4

(a) Hangar deck area not covered with deck-covering should be painted with gray deck paint, formula 20. Bulkheads of hangar bay areas should be finish painted with gray deck paint, formula 20 to four feet above the deck.

(b) The area directly behind vertical plotting boards and status boards plus a margin determined by a plane passing through the edges of the board at 45° to the bulkhead should be painted dull black, formula 104. Spaces containing electronic equipment in which scopes, dials, meters, and gauges are not read frequently (that is, not normally manned spaces and spaces where electronic equipment is not monitored continuously) bulkheads should be painted green and overheads white.

(c) Where welding with the electric arc is regularly carried on, the walls of the welding bay should be finish painted dull black, formula 104.

(d) Decks of powder magazines, ammunition stowage and handling spaces should be finish painted with white, formula 6.

(e) Gratings and handrails should not be painted. Decks and bulkheads should be finish painted with red, formula 23 (or with epoxy-type paints specified in Table 6, Item 16) to 2 feet above lower grating level. In minecraft generator and enginerooms, if practical, one heavy brush coat of wood preservative, Mil. Spec. MIL-W-18142 should be used over bare wood in lieu of painting.

(f) Deck should be finish painted black, formula 104.

(g) Deck should be finish painted gray, formula 20.

(h) Deck should be finish painted red, formula 23.

(i) In lieu of gray, CIC spaces with Broad Band Blue Operation Lighting Systems shall be painted as follows: Bulkheads—light pastel blue, Fed. Std. 595 Color No. 25526 (made up by modifying pigmentation of Formula 124/58 or by adding 1/2 pint pastel blue tinting pigment Mil. Spec.

Table 4. Notes Continued

MIL-C-22325 to 1 gallon formula 124/58. Overheads–Mil. Spec. MIL-E-5556 Insignia Blue, Fed. Std. Color No. 35044.

(j) For pilot house overhead, dull black, formula 104, may be used.

10. Surfaces to be coated with antisweat paint are specified in chapter 9390.

11. As an alternate to machinery gray, formula 111, the use of the following paints as described below is approved for machine shops and engine rooms aboard ship when prescribed by the Type Commander.

**TABLE 5. MACHINE SHOP AND ENGINE ROOM PAINTS**

| Color | Fed Std. 595 Color No. | Uses |
|---|---|---|
| Brilliant yellow[1] | 13538 | Crane hooks and pulleys |
| Vivid orange[1] | 12246 | Exposed hazards |
| Clear blue[1] | 15177 | Switch box control panels |
| High light buff[1] | 13578 | High light areas to concentrate attention |
| Machinery gray[2] | To match formula No. 111 | Body of machinery |

[1] Fed. Spec. TT-E-489.
[2] NAVSHIPS Formula No. 111.

### 9190.113 TANKS, BILGES, AND VOIDS

1. Tanks, bilges, and voids shall be painted in accordance with tables 6 and 7.

**TABLE 6. TANK COATINGS (METAL STRUCTURE)**

| Item | Space | Coatings (number of coats-formula No.) | Notes |
|---|---|---|---|
| 1 | Catapult gravity tank | Class 1 or 4 of MIL-P-23236 | (a) (b) (h) |
| 2 | Chain locker | Class 2 or 3 of MIL-P-23236 | (a) (d) (h) (i) |
| 3 | Drainage tanks | Class 1, 2 or 4 of MIL-P-23236 | (a) (d) (h) (i) |
| 4 | Feed water tanks | NAVSEC approved coating | (a) (h) (p) (q) |
| 5. | Floodable but normally empty voids | MIL-C-16173, gr 1 | (c) (f) (g) |
| 6 | Fresh water tanks | NAVSEC approved coating | (a) (h) (p) (q) |
| 7 | Fuel and ballast | Class 1, 3 or 4 of MIL-P-23236 | (a) (h) (i) |
| 8 | Fuel oil tanks | None | (c) |
| 9 | Cargo gasoline and JP-5 tanks on oilers | Class 1, 3 or 4 of MIL-P-23236 | (a) (h) (i) |
| 10 | Jet fuel tanks on carriers | Class 1, 3 or 4 of MIL-P-23236 | (a) (h) (i) |
| 11 | Gasoline tanks on carriers | Class 1, 3 or 4 of MIL-P-23236 | (a) (h) (i) |
| 12 | JP-5 emergency | Class 1, 3 or 4 of MIL-P-23236 | (a) (d) (h) (i) |
| 13 | Lubricating oil tanks | None | |
| 14 | Nonfloodable voids | 2-116; 1-30 | (c) (d) (i) (o) |
| 15 | Peak tanks | 2-116; 2-30 | (c) (d) (r) |
| 16 | Salt water tanks | | |
| | a. LSD's and LST's | Class 3 of MIL-P-23236 | (a) (h) (n) |
| | b. Other ships | Class 1, 2 or 4 of MIL-P-23236 | (a) (d) (h) (n) |
| 17 | Sanitary tanks | Class 2 of MIL-P-23236 | (a) (d) (h) (n) |
| 18 | Small inaccessible voids | MIL-C-16173 gr. 1 | (c) (d) (j) (m) |
| 19 | Structure and fittings below floor plates in machinery spaces (bilges, bilge wells and sumps | NAVSHIPS approved system or 2-116; 2-23 | see App. A |
| 20 | Silicone bronze diesel fuel-oil tanks | Class 1 of MIL-P-23236 | (1) |

**TABLE 7. TANK COATINGS (WOOD STRUCTURE)**

| Item | Space | Coatings (number of coats-formula No.) | Notes |
|---|---|---|---|
| 1 | Chain locker | Unpainted | (k). |
| 2 | Bilges | Unpainted | (k). |

NOTES TO TABLES 6 AND 7

(a) Remove after pickling primer by mechanical blasting.

(b) H4B catapult gravity tank if made accessible by relocation and H2-1, h4C, and H8 catapult gravity tanks.

This system must not be used for tanks containing MIL-H-19457 phosphate ester or chlorinated hydrocarbon type hydraulic fluids. In such instances, see article 9190.170. Gravity tanks for H4-1 and H4B system (unless made accessible by relocation) should not be painted.

(c) Retain after-pickling primer.

(d) No coating required for galvanized surfaces in good condition.

(e) Apply formula 117 only over bare metal surfaces.

In locations where necessary safety precautions are normally not practical, formula 117 may be omitted except under vinyl paints.





Table 6 and 7. Notes Continued

(f) Floodable but normally empty voids are those flooded only for damage control purposes or piped for small amounts of drainage. Tanks normally void but piped for use as fresh water tanks should be considered as fresh water tanks. Nonfloodable (dry voids) are cofferdams and inner bottom compartments not piped for flooding. Substitute formula 116 for formula 117 where necessary safety precautions are normally not practical.

(g) When abrasive blasting is accomplished apply one coat of NAVSEC approved inorganic zinc silicate. (See note (r) to table 1). If light color is desired for inspection purposes, inorganic zinc silicate may be overcoated with Formula 30.

(h) Surfaces must be blasted to bare steel.

(i) See chapter 9380 for static dehumidification of voids.

(j) Includes bottoms and edges of floor plates.

(k) Apply heavy coat of wood preservative, Mil. Spec. MIL-W-18142B.

(l) Surfaces should be clean and dry and free of all rust, paint, oil, grease, and other foreign matter. Sanding, wire brushing or other mechanical means should be used to obtain as clean a surface as practical. Abrasive blasting is recommended but should be used only when economically justified; i.e., when extensive removal of machinery is accomplished for other than painting purposes.

(m) Approved tank coatings which form hard films, as described in article 9190.167, are preferred. However, flotation type, MIL-R-21006(SHIPS), or spray-on-type, MIL-C-23050(SHIPS), ballast tank preservations are approved as alternates when blasting to bare metal is not possible. MIL-R-21006 should be applied in accordance with article 9190.173, and MIL-C-23050 in accordance with manufacturer's specifications.

Where MIL-R-21006 or MIL-C-23050 coatings are used, after pickling primer may be retained.

(n) Approved coatings are listed in article 9190.168.

(o) Preservative treatment shall not be required within welded, watertight and airtight small inaccessible voids whose boundaries are not exposed to the sea or to standing water.

(p) Approved coatings are listed in article 9190.171.

(q) Fresh and feed water tanks coated with formula 102 in good condition should be touched-up where necessary with formula 102.

(r) Peak tanks piped for ballast shall be classed as ballast tanks and coated as under Item 7. Peak tanks piped for fresh water shall be classed as fresh water tanks and coated as under Item 6.

2. **Locked-in fresh water ballast.** In lieu of the approved coatings in article 9190.173, locked-in fresh water ballast may be preserved with the following corrosion inhibitors:

a. Sodium chromate–2 lbs. per 100 gallons of fresh water (Stock Number - FSN No. 6810-240-2119 for 1 lb. container and 6810-264-6714 for 100 lb. container.

Sodium chromate should be dissolved in water (heat may be used to effect solution) and then added during tank filling.

b. Sodium silicate–"N - Brand" sodium silicate manufactured by Philadelphia Quartz Co., 1123 Public Ledger Bldg., Philadelphia 6, Pa. or equal - 0.25 gal. per 1000 gal. of fresh water to give a concentration of 100 parts per million.

c. Sodium chromate should not be used where possibility of contaminating potable water exists.

d. Since corrosion inhibitors are effective only below the level of the water, Thin Film Rust Preventive, MIL-C-16173, Grade 1 should be applied to all areas above anticipated water line and about two feet below, if tank is not completely filled.

## Part 4. Submarines

### 9190.121 EXTERIOR

Coat exteriors in accordance with the following table except as otherwise specified herein. The following vinyl paints and associated solvent thinners are intended for exterior use only and should not be used within the pressure hull.

**TABLE 8. EXTERIOR PAINT SYSTEMS**

| Item | Space | Coatings (number coats-formula No.) | Notes |
|---|---|---|---|
| 1 | Keel to waterline at maximum beam. | 1-117; 4-119; 2-121 | (a) (d) (e). |
| 2 | Waterline at maximum beam to waterline in maximum condition diving trim. | 1-117; 4-119; 3-129 | (a) (d) (e). |
| 3 | Exterior topsides | 1-117; 4-119; 3-122; or 1-117; 4-120; 3-122 | (a) (b) (c) (g) (h). (e) (f) |
| 4 | Diving planes | Same as item 2. | |
| 5 | Rudders and Struts (external surfaces). | Same as item 1. | |
| 6 | Wood slat decking | 2-104 or 122-$R_0$1.8 | (a) (e) (g). |
| 7 | Air Induction Piping | | (i) |

NOTES TO TABLE 8

(a) Total minimum film thickness should be 10.5 mils. Apply primer to a minimum dry film thickness of 6 mils. Apply antifouling paint and vinyl topcoats to a minimum dry film thickness of 4 mils. Use formula 120 or darkened formula 119 (prepared by addition of small quantities of black vinyl, formula 122-$R_0$1.8 beneath formula 122 and 129 on steel surfaces subject to camouflage. Coat free flooding surfaces and other areas subject to fouling and not visible outboard or above with formula 121 in lieu of formula 129. See article 9190.166 for vinyl paint application instructions. Use vinyl paints for touchup to the maximum possible extent where vinyl paints have previously been applied. Anticorrosive is not required for plastic surfaces.

(b) Formula 120 only should be used on aluminum surfaces. Formula 119 or 120 may be used on steel surfaces.

(c) All pressure hull shell plating and frames, outer shell plating, and other metal structure (including snorkel, periscope, and mast supports) above upper boottopping limit and in contact with water during submerged condition (except interiors of tanks otherwise specified). Surfaces not

Table 8. Notes Continued

subject to camouflage should be dull black, formula 122-$R_0$1.8. Surfaces subject to camouflage shall receive top-coats of the appropriate color. Only two coats of formula 122 are required for plastic surfaces.

(d) Because of the ketone solvent in these formulations spray application of vinyl paints in confined areas such as in ARD may not be practicable. In such instances, use formula 14N in lieu of 119, formula 105 in lieu of 121 and formula 146 or 146/50 in lieu of formula 129.

(e) Minor touchup by brush application of vinyl paints in relatively open spaces such as alongside a tender will not result in high concentrations of vapor. Natural ventilation will usually be adequate provided standard precautions pertaining to inflammable material such as no smoking, burning, welding in immediate areas, elimination of chipping and other-spark producing operations, and so on, are followed.

(f) It is the responsibility of the Fleet and Force Commanders to select measures contained in NAVSHIPS 0919-BD2-7010 of 1 March 1968 (Submarine Concealment Camouflage Manual) for application to ships of their respective commands and for new ships scheduled to join their commands.

(g) Complete painting system should be applied beneath slip-resistant rubber deck covering.

(h) As an alternative to the vinyl system, DEVRAN 219 or Amercoat 83/84 system may be used over bare steel when weather conditions permit (minimum temperature 45° F.), as follows:

(1) DEVRAN system—one coat of DEVRAN 201 primer, one coat of DEVRAN 204 and one coat DEVRAN 219 (appropriate color) to a minimum dry thickness of eight (8) mils.

(2) Amercoat system—one coat of Amercoat 83 and one coat of AMERCOAT 84 (appropriate color) to a minimum dry film thickness of eight (8) mils.

(i) When galvanized coating on the inside of air induction piping is found in unsatisfactory condition, exposed metal should be coated with Class 3 of MIL-P-23236 according to manufacturer's instructions.

### 9190.122 INTERIOR COMPARTMENTS

1. **Complete painting.** Where necessary to clean to bare metal, repaint surfaces in accordance with one of the following procedures:

a. One coat of primer and two coats of chlorinated alkyd enamel should be applied to bulkheads and overheads (where painting is required).

b. One coat of primer, Formula 116, and two finish coats should be applied to decks (where painting is required).

c. Surfaces lined with cork shall receive the finish paint only. Number of coats should be the minimum necessary for satisfactory hiding.

d. Surfaces lined with elastomeric foamed plastic insulation (MIL-P-15280) should be coated either with Devoe and Raynolds' "Devflex," Ocean Chemical's "Ocean Emulsion Fire Retardant Coating No. 634," or Amercoat Corp., "Amercoat 1768."

2. **Compartment finish.** Compartments should be finish-painted in accordance with the following:

a. Paints listed in table 3 (article 9190.112) should be used for overheads and bulkheads except as otherwise specified.

b. Type Commanders may specify uniform painting schemes for ships under their command or may permit each ship to adopt its own scheme.

c. Red deck, formula 23, or green deck, formula 19 (alkyd-resin phenolic varnish paint) for all decks except in way of deck coverings. Decks for which coverings are specified do not require finish painting except where the deck covering consists of false decking, gratings, rugs, or portable material. Engineroom deck mats may be painted with three coats of green shellac, formula 25, on both bottom and top sides.

d. Finish paints to match the surrounding structure for built-in steel furniture.

e. Battery compartments should be finish-painted with two coats of white formula 124 except in way of rubber lining (see chapter 9140).

f. Unless otherwise permitted by Type Commanders, radio rooms should be finish-painted yellow-gray on overhead bulkheads and furniture surfaces and green-gray on apparatus panels, cabinets, and racks.

g. As an alternate to machinery gray, the use of the following paints as described in table 9 is approved for engine rooms, when prescribed by the Type Commander.

**TABLE 9. ENGINE ROOM PAINTS**

| Color | FED-STD-595 Color No. | Surfaces |
|---|---|---|
| Clear Blue[1] | 15177 | Switch boxes, distribution panels, electric starting panels, start-stop switches, etc. |
| Vivid orange[1] | 12246 | Purifier belt covers and other rotating machinery |
| Brilliant yellow[1] | 13538 | Underside of deck access hatches |
| Machinery gray[2] | To match formula No. 111 | Other equipment including engines, generators, coolers, purifiers, and so on |

[1] Federal Specification TT-E-489.
[2] NAVSHIPS Formula No. 111.

3. **Torpedo tubes.** Steel surfaces of torpedo tubes of the SS563 class, SSN571 class, and other submarines built with ferrous torpedo tubes should be coated with brushon synthetic rubber coating, Military Specification MIL-S-15058, Type IV or with a vinyl system consisting of one coat pretreatment, formula 117 and four coats of vinyl primer, formula 119, applied to a minimum film thickness of 6.5 mils, or with coatings approved in Mil. Spec. MIL-P-23236. The procedure for application of a vulcanized neoprene lining, as developed by Mare Island and described in Mare Island Naval Shipyard Rubber Laboratory Technical Report No. 43-3 of 23 November 1954, is also approved for this purpose. Prepare surfaces to be coated by abrasive blasting. Monel surfaces must not be painted, and the interior of slide valve must be suitable protected during surface preparation.

4. **Nuclear-Powered Submarines.**

a. All appreciable painting with specified organic-solvent-thinned oil-based paints shall be complete on new and overhauling submarines five days prior to departure for sea. (The date of departure, as it relates to painting, shall be the date of the first dive after departure for a period of operation. The Commanding Officer of the submarine involved should determine the "date of departure" whenever the question arises.)

b. Exhaust ventilation to the weather, at a rate of at least ten changes per hour, shall be maintained during all painting and for at least 24 hours thereafter, from any compartment in which painting is done. Carbon filters should be changed prior to departure for sea.

c. Where paint is applied to surfaces which later will be heated; i.e., thermal piping, lagging, systems shall be activated (heated), at dockside, where practical before submergence, while exhausting to the weather.

d. After appreciable painting has been accomplished and the minor amount remaining must be completed within five days before departure for sea, it shall be done with the specified solvent-based paint, not exceeding one quart of paint per day and exhausting to the weather. Where this is not practical and painting is considered necessary, the following proprietary water-based paints may be used in lieu of chlorinated alkyd paints (Formula 124/58) pending development of a specification:

Amercoat Corporation "AMERCOAT 1768"
Devoe and Raynolds Company "DEVFLEX MD 2707"
Ocean Chemicals, Incorporated "OCEAN 634"

e. No painting shall be done at sea except after the last dive on return from patrol.

### 9190.123 TANKS

Paint tanks in accordance with table 10:

**TABLE 10. SUBMARINE TANK COATINGS**

| Item | Space | Paint system number coats formula no. | Minimum film thickness | Notes |
|---|---|---|---|---|
| 1 | Bow buoyancy and main ballast tanks | Class 1, 2 or 4 of MIL-P-23236 plus 2-121 to 2 feet above flood valve opening. | 4 mils (121) | (a) (c) (d) (f) |
| 2 | Fuel oil ballast and expansion tanks. negative tank and safety tank | Class 1, 2, 3 or 4 of MIL-P-23236 | | (a) (c) (d) (f) |
| 3 | Water round torpedo & round | Class 1, 2, 3 or 4 of MIL-P-23236 | | (c) (f) |





**TABLE 10. SUBMARINE TANK COATINGS (Continued)**

| Item | Space | Paint system number coats formula no. | Minimum film thickness | Notes |
|---|---|---|---|---|
| | mines; trim and auxiliary tanks | | | |
| 4 | Normal fuel oil, clean fuel oil, collecting fuel oil, & variable fuel oil tanks. | None | | (b) |
| 5 | Lubricating oil sump and lubricating oil stowage tanks | None | | (a) |
| 6 | Poppet valve drain tank | 1-117;2-116 or 14N; 2-23 | 5 mils | (b) (e) (h) |
| 7 | Sanitary | Class 1 or Class 2 of MIL-P-23236 NAVSEC approved coating | 10 mils | (a) (g) |
| 8 | Potable tanks | NAVSEC approved coating | | (a) (i) |
| 9 | Surge tanks | 2-Dampney Co. Apexior No. 1 | | (g) |
| 10 | Reserve feed tank | NAVSEC approved coating | | (a) (i) |
| 11 | Drain collecting tank | NAVSEC approved coating | | (a) (i) |
| 12 | Bilges, drainage trenches, and missle tube eject chamber interiors | 1-117; 2-116 or 2-14N;2-23 | 5 mils | (b) (e) (h) (j) |

NOTES TO TABLE 10

(a) Remove after pickling primer.

(b) After pickling primer may be retained; this coat, touched up as necessary, constitutes first coat of primer where one or more coats are specified.

(c) Surface preparation must be accomplished by abrasive blasting.

(d) Last coat should be white where practical. Repainting of relatively inaccessible areas on non-pressure structure such as shell behind air flasks may be deferred

Table 10. Notes Continued

until a more appropriate time provided coating is in good condition. Surface in way of lead ballast and holding straps should be coated with 1-117 and 4-119 vinyl system.

(e) Apply formula 117 to bare metal surfaces prior to application of primer. Pretreatment is not required over intact primer which is retained or where necessary safety precautions cannot be followed.

(f) Approved tank coating systems, as described in article 9190.167, may be used in lieu of the paints specified in the table. Surfaces must be blasted to bare steel.

(g) Clean to bare steel by suitable means.

(h) Mil. Spec. MIL-P-23236, Class 1 or 2 coatings may be used in lieu of paints specified. Surfaces should be free of all rust, paint, oil, grease, and other foreign matter. Sanding, wire-brushing, or other mechanical means should be used to obtain as clean a surface as practicable. Do not blast in machinery spaces.

(i) Approved coatings are listed in article 9190.171.

(j) Following specified painting of tanks, lead pockets and adjacent bulkhead and hull plating which will be in contact with lead ballast shall be covered with rubber sheeting conforming to MIL-S-2912.

## Part 5. Machinery and Piping

### 9190.131 COATINGS REQUIRED

Equipment will usually be furnished painted and preserved as required by the individual purchase specifications. If equipment is received in an unpainted condition or if paint is damaged before or during installation and for finishing after installation, painting and preservation should be accomplished as specified in table 11.

**TABLE 11. COATINGS FOR MACHINERY AND PIPING**

| Surface | Paint system (number coats-formula No.) | Notes |
|---|---|---|
| Ferrous machinery surfaces (unheated external). | 1-117; 1-116- 1-111 | (i). |
| Ferrous sheet metal surfaces (unheated external and internal). | 1-117; 2-finish coats | (a) (i). |
| Ferrous sheet metal surfaces (heated, external and internal). | 1 Mil. Spec. MIL-P-14276 | (b) (d) |
| Ferrous machinery surfaces (heated, external). | 2 Mil. Spec. MIL-P-14276. | (c) (d). |
| Condenser shells other than refrigerating (internal). | Corn oil and Japan drier mixture, or Apexior #1 (two coats). | |
| Machinery gage boards (including gages and clocks). | 1-117; 2-111 | (i). |

Table 11. Continued

| Surface | Paint system (number coats-formula No.) | Notes |
|---|---|---|
| Piping, fitting, and valves | 1-117 and 2 finish coats or 1-117; 2-116 or 14N; 2-23. | (a) (h) (i). (e) (h). |
| Non-ferrous saltwater piping surfaces). | Unpainted | |
| Machinery and piping thermally insulated. | 1 finish coat over thermal insulation. | (a). |
| Gasoline piping and valves | 1-117; 1-116; 1-42 | (g) (h) (f). |
| Oxygen piping | 1-117; 1-116; 2-39 | (h) (i). |
| Boilers and economizers (except parts used for heat transfer) | 2-MIL-P-14276 | (g) |

NOTES TO TABLE 11

(a) To match surrounding compartment except as otherwise specified. JP-5 piping should be finish painted purple in interior spaces. Purple paint should be prepared by mixing 1 part red striping (formula 40) with 2 parts blue striping (formula 43) and 1 part white (formula 30).

(b) Such as boiler casings except for those fabricated of corrosion resistant steel.

(c) Such as turbine casings, and boiler drums, pipes, valves, and fittings, whether to be insulated or not.

(d) Operating temperature over 300° F.

(e) For galvanized and ungalvanized steel or aluminum piping below level of floor plates.

(f) Piping and exterior valves should be painted the same color as surrounding structure. Identify exterior valves by painting a 90° section of the handwheel or a four inch band on operating levers yellow. No other exterior valves should be so painted. Interior valves except for moving parts should be yellow and no other valves on the ship should be so painted. Use two priming and two finish coats on exterior surfaces.

(g) Including valves, except moving parts and other operating accessories. Use two priming and two finish coats on exterior surfaces.

(h) Apply formula 117 to bare metal surfaces only. Pretreatment is not required over intact primer which is retained, or in confined spaces where necessary safety precautions cannot be followed. In such instances, substitute primer for formula 117 where none is specified.

(i) Apply 2 coats heat-resisting paint, Federal Specification MIL-P-14276 where operating temperature is over 300° F. and thermal insulation is not provided.

### 9120.132 ITEMS NOT TO BE PAINTED

The following items must **not** be painted:

1. Activating mechanisms of electrical safety devices and control switchboards on machinery elevators.
2. Bell pulls, sheaves, annunciator chains, and other mechanical communication devices.
3. Corrosion resisting steel piping and components.
4. Composition metal water ends of pumps.





5. Condenser heads and outside surfaces of condensers when of composition metal.
6. Dry sprinkling piping within magazines of the type having holes drilled in the pipe top.
7. Exposed composition metal part of any machinery.
8. Glands, stems, jokes, toggle gear, and all machined external part of the valves.
9. Heat exchange surfaces of heating or cooling equipment.
10. Identification plates.
11. Joint faces of gaskets and packing surfaces.
12. Lubricating gear, such as oil holes, oil or grease cups, lubricators, and surfaces in contact with lubricating oil.
13. Lubricating oil reservoirs.
14. Machined metal surfaces of reciprocating engines or pumps and all "oil wetted" surfaces of internal combustion engines.
15. Metal lagging
16. Rods, gears, universal joints and couplings of valve operating gear.
17. Expansion joints, pipe hangers, flexible hose connections, items partially fabricated of rubber and rubber resilient elements of isolation mounts.
18. Sliding feet of turbines and boilers.
19. Springs.
20. Strainers.
21. Threaded parts.
22. Turbine casing joints, nuts and bolts.
23. Working surfaces.

Paint shall not be applied on corrosion resisting steel piping. Brass, bronze, gun metal, and copper where used in submarine systems also shall not be painted. These restrictions do not apply to painting of lagging and insulation on piping and components.

Existing paint on corrosion resisting piping and components should be removed as required to perform maintenance or inspection. Paint should be removed only by the use of wire brushes, steel wool, or acetone. Wire brushes shall be in accordance with Mil. Spec. MIL-B-19888 or Federal Handbook H-B-178 and steel wool should be in accordance with Fed. Spec. FF-S-00740 except that the wire should be stainless. Acetone should be unused or redistilled in accordance with Fed. Spec. O-A-51.

### 9190.133 CLEANING AND PRESERVATION OF SSB(N) MISSILE LAUNCH AIR EJECT PIPING

1. Prior to leaving the Yard, all missile tubes, eject piping and eject chambers shall be inspected to insure that they are clean, dry, and free of rust. Represerve as necessary with specified coatings.

2. Immediately after draining tubes flooded with salt water, thoroughly flush entire tube and eject piping with FRESH WATER (tap water is satisfactory) to remove salt deposits. In eject pipe, use hose without metal fittings (or with fittings adequately protected) to prevent abrasion of coating and insert from eject chamber up to launch valve to flush entire pipe. Pressurize valve dome during flush operations to prevent entry of water into launch valve. Personnel should use rubber-soled shoes to prevent coating damage in eject chamber.

3. Dry surfaces thoroughly by swabbing, followed preferably by circulating heated dry air (100° to 140° F.) If shore compressors are used, provide with water removing traps and filters, dehumidifiers, and heaters, if practicable. Air from submarine flask also considered satisfactory. (Circulation of fresh supply of unheated air will also reduce drying time).

4. Inspect for rust and loss of adhesion of coating. If extensive rust exists, mechanically clean as necessary, vacuum, and apply thin film rust preventive, Specification MIL-C-16173, Grade, Stock No. 8030-244-1298 or red lead primer, MIL-P-17545, Stock No. 8010-165-8573, in eject pipe to maximum practical extent. A flexible shaft is recommended using a wire brush for cleaning and a swab for coating the eject pipe. Touch up eject chamber and torus ring with coating previously applied. Ventilate to weather air, if required, to remove solvent. In view of comparatively small area involved, solvent retained in film after four hours drying with ventilation should not be significant in atmospheric contamination. If the rust or loose paint is minor to the point that the possibility of damage from dislodgement would be negligible, the eject piping may be swabbed with metal conditioning compound, Specification MIL-C-15205 Type II, Stock Number 8030-255-4445 (5 gal. pail) without prior cleaning and subsequent ventilation.

5. Positive means of protecting first stage jetevators and missile components from dust and mechanical damage must be provided in performing the foregoing work.

6. **Subsequent Maintenance.** The eject piping shall be maintained as specified in the foregoing.

## Part 6. Electric and Electronic Equipment

### 9190.141 GENERAL

1. Equipment will usually be furnished painted and preserved as required by the individual purchase specifications. If equipment is received in an unpainted condition or if paint is damaged before or during installation and for finishing after installation, painting and preservation should be accomplished as follows except as otherwise specified:

a. One coat pretreatment, formula 117 (to bare metal surfaces only). Omit formula 117 on ungalvanized surfaces in confined spaces where necessary safety precautions are not practical.

b. One coat primer, formula 116 (use formula 84 over aluminum).

c. Two coats gray enamel, formula 111, class 2.

2. Before installation of front-serviced electric, interior communication, fire control, or electronics equipment, the bulkhead and deck area should be painted with two coats of primer, formula 116 (formula 84 over aluminum).

### 9190.142 MOTORS AND GENERATORS

1. **Exterior.** Except for shafts and identification plates, paint exterior parts in accordance with article 9190.141.1.

2. **Interior.** Do not paint electrical insulation of all types, surfaces in contact with lubricating oil or grease, commutators, collector rings, brushes, bearings, and bearing surfaces. Also, do not paint peripheries of armatures and rotors and any other rotating part of a machine from which centrifugal force may cause the paint to be thrown on the windings when the machine is operated at rated load and rated ambient temperature; insulation varnish conforming to Military Specification MIL-V-1137, instead of paint, may be applied to such parts. Paint corrosion resisting parts other than the above in accordance with article 9190.141.1.

3. Apply one coat of pretreatment, formula 117, or primer formula 116 followed by one coat of white enamel. Federal Specification TT-E-489 to the inside of both ends of the enclosure of water-air-cooled motors and generators.

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

### 9190.143 SWITCHBOARDS AND PANELS

Switchboards and panels of dead front type for control, power, and lighting applications and for electric propulsion should be given an additional finish coat only if cleaning and touchup will not accomplish the desired result.

### 9190.144 ELECTRIC CABLE

1. Paint cable as required by applicable cable specifications. During installation, after being pulled in, but before being strapped in place, and before stuffing-tube gland nuts are tightened, steel or aluminum armored cables (other than terminal ends on backs of switchboards and panels or inside fittings and terminal boxes) should be given a thorough inspection to determine whether the factory-applied paint has been damaged. Paint such damaged areas with one coat of primer, formula 84 or 116. Prime supporting structure for cable before installation of cable unless galvanized or zinc plated after fabrication. After being secured in position, cables and supporting structure should be painted with a finish coat to match the surrounding compartment, or with the same kind of paint used for the exterior surface on which cables are located.

2. Cables for repeated flexible service need not be painted for protection from weathering or the direct rays of the sun. If considered desirable, however, they may be painted to harmonize with their surroundings.

3. Electric propulsion cables in dc installations may be painted. Electric propulsion cables for ac installations have bronze armor and should not be painted. This is because these cables are mounted in insulating blocks so that the armor on each cable is insulated from the armor on the other cables to prevent circulating currents in the armor. It is difficult to paint the cables without getting paint on the insulating supports which might decrease the insulation resistance between the cables.

### 9190.145 METAL ENCLOSURES

Enclosures for motor controllers, electric panels, wiring boxes, fittings and fixtures, including those complying with NAVSHIPS standard plans, 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 coated in accordance with table 12.

### 9190.146 INTERIOR COMMUNICATION AND FIRE CONTROL EQUIPMENT

Interior Communication (IC) and Fire Control (FC) switchboards, amplifiers, panels, and equipment components usually will be supplied finished by the manufacturer in accordance with Mil. Spec. MIL-I-983 and will not require additional painting. Painting as required should be in accordance with table 12.

### 9190.147 LIGHTING SYSTEMS

Do not paint light reflecting and light transmitting surfaces of lighting fixtures and gaskets, rubber packing, or watertight work.

### 9190.148 ELECTRONIC EQUIPMENT

1. During installation, every precaution should be taken to preserve the original finish. Touchup damaged areas as required.

2. Antennas, surface ships, corrosion-resisting steel, or copper-nickel alloy antenna whips should have wax, Fed. Spec. JJJ-W-141, applied to all exposed metal surfaces before installation.

3. Aluminum alloy transmitting and receiving antenna whips and ferrous antenna whips should be given one coat of pretreatment, formula 117 and one coat of primer, formula 84 followed by one coat of haze gray paint, formula 5H, or formula 122 of the appropriate shade over vinyl primer, before installation, unless special finishes have been applied in accordance with purchase specifications.

4. Waveguides shall be protected and preserved on interior and exterior surfaces in accordance with NAVSHIPS 0967-000-0110 INSTALLATION STDS. OF EIMB before and after installation.

5. Care must be taken to avoid painting electrical contact points, ceramic insulators, rubber insulation mounts, (shock or noise mounts) and insulation materials of all kinds by masking all such parts before painting.

6. Submarine antennas, except insulators, should be finished painted as required for camouflage.

7. Coat radomes and other similar housings for exposed radiators in accordance with the applicable instruction book provided with the item. No other coating should be applied.

8. Acoustical surfaces of sonar, hull components (exterior to the hull of the ship) not supplied finished by the manufacturer should be painted in accordance with the following:

| | Method No. |
|---|---|
| a. Rubber surfaces (below the waterline of ships): | |
| Domes (exterior surface) | 1 |
| Domes (Interior surface) | 2 |
| Transducers, hydrophones, and baffles (housed within dome structure) | 2 |
| Transducers, hydrophones (hull or shaft mounted (undomed) | 1 |
| b. Rubber surfaces (topside of submarines): | |
| Domes and panels (exterior surface) | 3 |
| Domes and panels (interior surface) | 2 |
| Transducers, hydrophones, and baffles (housed within dome structure) | 2 |
| Transducers and hydrophones (hull or shaft mounted-undomed) | 3 |
| c. Steel surfaces (below the waterline of ships): | |
| Domes and panels (exterior surface) | 4 |
| Domes and panels (interior surface) | 5 |
| Sonar hoists and sea chests | 5 |
| Transducers, hydrophones, and baffles (housed within dome structure) | 5 |
| Transducers and hydrophones (hull or shaft mounted-undomed, exterior only) | 4 |
| d. Steel surfaces (topside of submarines): | |
| Domes (exterior surface) | 6 |





TABLE 12. COATINGS FOR METAL ENCLOSURES.

| Coatings | Galvanized[1] Steel | Ungalvanized[1] Steel | Aluminum[1] | Miscellaneous[2] Metals |
|---|---|---|---|---|
| Pretreatment | One coat F. 117 | a. One coat F. 117 or b. Phosphate coating TT-C-490, Type I | a. One coat F. 117 or b. Phosphate coating TT-C-490, Type I c. MIL-C-5541 | a. One coat F. 117 |
| Primer | a. One coat F. 84 or b. One coat TT-P-664 or c. One coat MIL-P-8585 | a. One coat F. 84 or b. One coat TT-P-664a or c. One coat MIL-P-8585A | a. One coat F. 84 or b. One coat TT-P-666a or c. One coat Mil-P-8585A | |
| Finish Coats[3, 4] | a. Two coats of F. 111, Class 2 (Type I only over F. 84) or b. Two coats finish paint to match surrounding structure | | | |

NOTES TO TABLE 12

[1] Damaged paint films shall be touched up as required.
[2] Brass, corrosion-resisting steel and other nonferrous metals, except aluminum should not be coated, except where painting is desired for appearance or camouflage.
[3] Where equipment is received with pretreatment and primer only, apply finish coats as appropriate.
[4] Finish paint to match surrounding structure may be applied over formula 111 to avoid masking enclosures when painting surrounding structure.

| | Method No. |
|---|---|
| Domes (interior surface) | 5 |
| Transducers and baffles (housed within dome structure) | 5 |
| Transducers (hull or shaft-mounted, undomed, exterior only) | 4 |
| e. Zinc protectors for cathodic protection | Unpainted |

9. Painting methods should comply with the following:

a. **Method No. 1:** Clean the outside of the rubber dome with grease cleaning compound, Military Specification MIL-C-22230, diluted with two to ten parts of the fresh water. Wear clean oil resistant rubber gloves to avoid finger printing the dome. Rinse with fresh water and dry, using air blast. Apply two coats of Formula 133, MIL-P-22298, and two coats of Formula 134, MIL-P-22299. Where improved adhesion is required, rubber cement should be used prior to applying Formula 133. After installation, touchup the scratches and apply one additional coat of antifouling paint. Paint the outside steel parts of the dome with hull paint, or in accordance with Method No. 4 below.

b. **Method No. 2:** Clean the inside of the rubber domes in accordance with Method No. 1 above and apply a coat of Formula 133 and one coat of Formula 134. Paint the inside steel parts in accordance with Method No. 5 below.

c. **Method No. 3:** Rubber domes, panels, and baffles installed above the waterline of submarines do not require antifouling paint. However, rubber surfaces exposed to sunlight should be protected by the application of three thin coats of Military Specification MIL-C-11520, Stock No. 8030-201-1103. Color shading for camouflage purposes may be accomplished by application of mist coat of vinyl-alkyd paint of appropriate color, as identified in Ship Concealment Camouflage Instructions, NAVSHIPS 0919-002-7010.

d. **Method No. 4:**

(1) Remove any grease and oil using emulsifying-type cleaner followed by hot-water rinse. Pressure wet blast, using a slurry of abrasive and water. (Dry blasting results in embedding particles of abrasive into the "CRES."

(2) Wet blast at 40-60' pounds air pressure with an abrasive slurry containing, 110-120 mesh silica sand and water. A suitable ratio of sand to water is one gallon dry sand to three gallons of water. (The resulting finish should have a roughness of 75-125 microinches as identified by the American Standard "Surface Roughness, Waviness and Lay, ASA B46. 1-1955 UDC 621.016" or by "MIL-STD-10A" of 13 October 1955 (slightly rougher surface is acceptable). A finish of 75 to 125 microinches is commonly known as a satin finish. An instrument that can measure the roughness of the sandblasted surface is the Brush Electronics Company "Surfindicator" Model BL 110. A close inspection of the blasted surface must be made to insure that holidays are detected and reblasted. The final finish should be uniform white metal.

(3) After blasting, the surface shall not be touched and foreign matter shall not be allowed to come in contact with the surface. All exterior surfaces should be covered (clean paper is suitable) when dome is transferred to another location. Do not use masking tape directly on blasted surface. All painting shall be accomplished under shop conditions in a clean atmosphere and a temperature of at least 60°F. When dome is ready, paint immediately.

(4) Apply one coat (in two crossed-spray passes) of Formula 117 to obtain a dry-film thickness of approximately 0.7 mils. The surface shall be dried under mild heat, such as lamps, at a surface temperature of 100°F. to 110°F. Spray apply Formula 120 to a dry-film thickness of 1.5 mils and permit one-hour drying at 100°F. to 110°F. Spray apply formula 119 at 1.5 mils dry-film thickness and repeat

drying. Spray apply a second coat of Formula 120 and Formula 119 at a dry-film thickness of 1.5 mils each and repeat drying procedure. Then spray apply two coats of Formula 121 to a dry-film thickness of 2 mils each and allow drying at 100°F. to 110°F. between coats. Allow final coat to dry for a minimum of four hours before handling. The complete system should have a minimum dry-film thickness of 10.7 mils.

(5) Where painting of the mounting, fairing strips, and hull area within five feet of the mounting is required, the foregoing vinyl system should be applied. If painted dome is more than three months old prior to installation, apply 1 coat of Formula 121.

(6) The foregoing method is applicable for CRES domes. For non-CRES domes, dry or wet blast may be used. Although the heat drying procedure is not required, care should be taken to ensure release of solvent between application of coats.

e. **Method No. 5**: Same as Method No. 4 except apply only one coat of vinyl antifouling, formula 121 in lieu of two coats.

f. **Method No. 6**: Same as Method No. 4 except apply two coats of formula 122 of appropriate shade in lieu of antifouling paint.

10. Plastic domes and panels should be treated the same as for steel domes (Method Numbers 4 and 5) except that anticorrosive is not required.

## Part 7. Identification and Awards

### 9190.151 SHIP'S NAMES AND DRAFT MARKS

1. Ship's names should be painted in with black, formula 24 as prescribed by the Force Commanders. It is recommended that insofar as practical, the name should be painted in 12-inch letters directly on the stern at the center line in a suitable location below the main deck. NAVSHIPS Plan Number S2804-860347 may be used as a guide for style of letters. On vessels with sharp sterns or interferences in stern area, the name should appear on each quarter.

2. Draft marks should be black, formula 24, above upper limit of the boottopping and white, formula 6, below.

3. The following should be used as a guide for portable nameboards for display while in port, unless otherwise specified by Force Commanders:

a. Nameboards—mahogany, varnished, approximately 9-inches wide by 1-1/4-inches thick.

b. Letters-brass, 6 inches by 3/16-inch thick (Federal Stock Nos. H2040-271-9149 through H2040-271-9200) in accordance with NAVSHIPS Drawing No. 220598. Letters should be secured to board with brass wood-screws.

c. Nameboards should be attached port and starboard in a suitable location on the side of the bridge or at the rail.

### 9190.152 DISTINGUISHING NUMERALS AND LETTERS

Paint distinguishing numerals and letters as required by the plans listed below except as modified in article 9190.153 for aircraft carriers.

| Title | BuShip Plan No. |
|---|---|
| Distinguishing figures for battleships and cruisers | S-2804-921791 |
| Distinguishing figures-destroyers, destroyer escorts, and type conversions. | S-2804-860345 |
| Figures for distinguishing marks, submarines | S-2804-860346 |
| Distinguishing figures for mine craft | S-2804-921769 |
| Distinguishing figures for landing craft | S-2804-921783 |
| Distinguishing figures and special insignia for AVP's and ASR's | S-2804-860342 |
| Distinguishing figures and special insignia for light mine layers (DM). | S-2804-860343 |
| Distinguishing figures and special insignia for AVD's, DMS's and APD's. | S-2804-921582 |
| Distinguishing figures for miscellaneous ships. | S-2804-921819 |

### 9190.153 CARRIER DECK MARKINGS

1. Flight deck marking on aircraft carriers should be in accordance with the latest applicable Visual Landing Aids General Service Bulletin.

2. The area within a boundary of 24 inches adjacent to each high thrust tiedown shall be painted with red striping paint, formula 40 and plainly stenciled "FOR HIGH THRUST ENGINE TURN–UP."

### 9190.154 LETTER AWARDS

1. Letters should be painted on as prescribed by Fleet Commanders who will also designate the locations and sizes. If desired, the locations and sizes tabulated in table 13 may be used as a guide.

2. Letters should be block-type shaded on the right sides and lower edges with black, formula 38, as shown on NAVSHIPS plan S2804-921819. The assault boat insignia should be displayed so that the arrowhead always points forward, as illustrated in figure 9190-9.

3. In engineering, it is recommended that the award letter be painted on each side of the forward stack and located with the top edge of the letter one-half the stack diameter below the top of the stack and the center of the letter on on the center line and with the same rake as the stack. The letters' height should be one-half the stack diameter.

4. For battle efficiency it is recommended that the "E" be located on bridge wing bulwark, port and starboard if practical; otherwise, in general vicinity of painted campaign ribbons.

5. For the second and each consecutive award of the Navy E, one service stripe shall be painted under the "E." The distance between the shading on the bottom of the "E" and the upper corner of the stripe and between stripes should equal to half the stripe width. When facing the "E," the stripe should slant downward from the upper right to the lower left, regardless of the side on which displayed.





TABLE 13. TABULATION OF LETTER AWARDS.

| | Insignia | Size | Location |
|---|---|---|---|
| (a) Winner of intra-type battle efficiency competition. | White "E" | 20" x 16" | Bridge bulwark (fwd., P&S). (or sail of submarines) |
| (b) Engineering | Red "E" | See para.3. | See para. 3. |
| (c) Gunnery. | | | |
| 16", 8", 6" turrets. | White "E" | 15" x 12" | Center, each side of turret. |
| 5" gun mounts. | White "E" | 10" x 8" | Center, each side of mount. |
| 3" and 40-mm mounts | White "E" | 10" x 8" | Center of splinter shield, outboard, (on each side of center line mounts). |
| Main battery and 5" directors. | White "E" | 15" x 12" | In appropriate position on each side of director shield. |
| 3" and 40-mm directors. | White "E" | 10" x 8" | Center of splinter shield, outboard, (on each side of centerline director). |
| (d) Guided Missiles | White "E" | 15" x 12" | In appropriate position on each side of director tower |
| (e) CIC | Green "E" | 15" x 12" | Bridge bulwark (aft, P&S). |
| (f) Communications | Green "C" | 15" x 12" | Signal bridge bulwark (P & S). |
| (g) Assault | Assault boat insignia. | 15" x 15" or 21" x 21" | On hull or superstructure in immediate vicinity of forward Welin davit. |
| (h) Minesweeping | White "M" | 15" x 18" | Each side of ship slightly forward of bridge. |
| (i) ASW | White "A" | 15" x 12" | In appropriate position on or adjacent to main ASW armament (P & S). |
| (j) Weapons Dept. | Black "W" | 15" x 18" | Bridge Bulwark (P&S). |
| (k)Air Dept. | Yellow "E" | 15" x 12" | Near area of Primary Flight Control station. |
| (l) Supply Dept. | Blue "E" | 15" x 12" | Bridge Bulwark (P&S, aft.) |

If no splinter shield installed, "E" will be painted on the hull or superstructure in the immediate vicinity of the mount.

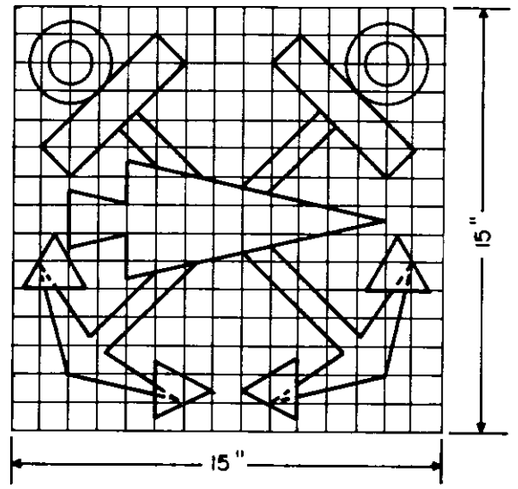


Figure 9190-9. ASSAULT BOAT INSIGNIA

6. In lieu of the letter plus four service stripes for winning the award five consecutive times, a gold insignia shall be displayed. A gold service stripe, under the gold insignia, should be displayed for the sixth and each subsequent award




Figure 9190-10. ASSAULT BOAT INSIGNIA

7. For 10 or more consecutive awards the Assault Boat Insignia shall conform to figure 9190.10 above, the gold insignia on a blue shield background. Gold stripes are not used to indicate the number of the award, this being designated by the appropriate number in blue in the insignia. Subsequent awards are indicated by the addition of blue stripes.

### 9190.155 REPLICAS OF CAMPAIGN AND COMMENDATION RIBBONS

Replicas to be painted on ships must be prescribed by Fleet Commanders who will also designate the locations and sizes. If desired, the locations and sizes tabulated in table 14 may be used as a guide.

**TABLE 14. TABULATION BY REPRESENTATIVE SHIP TYPES OF INSIGNIA SIZES AND LOCATIONS**

| Vessel | Size of insignia | Location of insignia |
|---|---|---|
| AGC | 6 by 18 | Bulwark area adjacent to aft of single bridge. |
| APA | 6 by 18 | High on wheelhouse structure. |
| APD, AVS, and ARV. | 6 by 18 | High on side of wheelhouse. |
| LSD | 6 by 18 | Side of wheelhouse above ports. |
| LST and ARL | 6 by 18 | |
| LSM | 4 by 12 | |
| LSMR | 4 by 12 | Fore and aft vertical bulkheads of conn behind side lights. |
| LC(FF) | 4 by 12 | Center of sides of conn windshield at fr. 55. |
| LCT | 4 by 12 | Center of sides of conn. |
| PCE(O) | 4 by 12 | |
| SS | 4 by 12 | Side of bridge superstructure bottom edge of bottom row, 18" above the top of hull number or as near thereto as individual installation allows. |
| AS | 6 by 18 | Windshields at wings of pilot house. |
| ASR | 4 by 12 | Center of fore and aft section of gun sponsons on bridge deck. |
| CVA | 8 by 24 | Bulwark area adjacent to the navigating bridge, or starboard side of hangar deck. |
| CVE | 8 by 24 | |
| CVL | 8 by 24 | |
| CVS | 8 by 24 | |
| AV | 6 by 18 | Bulwark area adjacent to the navigation bridge. |
| AVP | 6 by 18 | Bulwark area adjacent to the navigation bridge. |
| AVS, ARV | 6 by 18 | High on wheelhouse structure. |
| DD types | 4 by 12 | Outside of bridge, shield, port and starboard, 2 feet below top edge. |
| DE Types | 4 by 12 | Outside of bridge shield, port and starboard, 2 feet below the top edge. |
| DL Types | 4 by 12 | |
| BB55 Class | 8 by 24 | Fire control tower, port and starboard. |
| BB61 Class | 8 by 24 | Bridge shield, port and starboard 04 level between frs. 87 and 91. |
| CA68 Class | 8 by 24 | Bridge shield, port and starboard 04 level between frs. 64 and 68. |
| CA122 | 8 by 24 | Forward main battery fire control station under peepholes between frs. 63 and 67. |
| CL55 | 8 by 24 | Bridge shield, port and starboard 04 level between frs. 57 and 60. |
| CL106 Class | 8 by 24 | Between 05 and 06 levels, port and starboard, frs. 60-62. |
| CLC-1 Class | 6 by 18 | Bridge shield, port and starboard 04 level. |

NOTES TO TABLE 14

(a) The diameter of the operation and engagement stars should be three-eighths the width of the ribbon and the stars should be painted on the replicas with point down.

(b) The painted replicas of ribbons should be arranged in the same order as ribbons worn by personnel, with a maximum of three replicas in a horizontal line.

### 9190.156 SQUADRON INSIGNIA

The display of a squadron insignia on the exterior of ships of Destroyer or smaller type is authorized at the discretion of the Fleet Commanders in Chief. It is considered that the design initiation can best be accomplished by the enterprise of squadron personnel. The final approval of design, size, and placement on the exterior of ships and keeping within the limits of good taste rest with the Fleet Commanders in Chief.

### 9190.157 HOSPITAL SHIPS

1. Exterior vertical surfaces above the waterline should have two finish coats of white, formula 6, except those areas designed for identifying insignia. Weather decks covered with wood should be unpainted, except for a square white area to be painted around the crosses required below. Steel weather decks outside of walking areas should have two finish coats of white, formula 6, and walking areas thereon should have two finish coats of gray, formula 20. Outer smokepipe casing, booms, masts, and boats should have two finish coats of white, formula 6. A black band, formula 24, should be painted around the smokepipe from the top to a depth of one-third of the fore-and-aft pipe dimensions.

2. Red crosses should have a width approximately equal to the height and width of arms approximately one-third the width or height of the cross. Paint three red crosses, formula 40, on each side of the hull, with the center of each cross at the same distance above the ship's load waterline. Each cross should be of the maximum possible height but not exceeding nine-tenths of the ship's freeboard at a particular location. The forward cross on each side should be so located in the vicinity of the stem that, dependent upon the hull lines in that area, it is readily identifiable when viewed from dead ahead of the ship. The center cross on each side should be located abaft the bridge. The after cross on each side should be located approximately half-way between the center cross and the stern of ship.

3. Minor variations in locations prescribed for crosses are permissible where such variation permits painting a larger cross because of increased freeboard at a nearby location. Paint red crosses, formula 40, at least 34 feet by 34 feet, if practical on top of the superstructure or awnings fore and aft or in helicopter platform in locations visible from the air. The surrounding area should be blocked in with white paint so that the crosses will stand out well on the white background. Paint four red crosses of maximum practical size on the four sides of the stack, so located that the cross on the other side of the stack may be most clearly seen from astern. Paint one red cross of maximum practical size on the forward vertical face of the forward superstructure, where the cross may be most clearly seen from ahead.

4. Boat should be painted as specified in section VI and should have a 15-inch by 15-inch red cross on each side of stern. Life rafts should have 15-inch by 15-inch red crosses on each side.

5. The name of the ship should be painted in black letters, formula 24 on each side of the bow and across the center line of rounded sterns or on each side of pointed sterns.

Wording shall be:

U. S. NAVY HOSPITAL SHIP-(See (a) below).
(NAME OF SHIP)-(See (b) below).

a. Twelve inches high for ships under 450 feet long and 16 inches high for ships over 450 long.

b. Sixteen inches high for ships under 450 feet long and 20 inches high for ships over 450 feet long.

## SECTION V. PROCEDURES

### 9190.161 SPRAYING HOT PLASTIC ANTIFOULING PAINT

1. Hot plastic is issued in drums containing about 600 pounds of solidified plastic paint. For application to shipbottoms, the solid plastic is broken and the broken paint is shoveled into a reducing kettle which can be heated by gas, oil, or steam, depending upon location and available facilities. The hot liquid is transferred by bucket to the pressure kettle spray unit and the molten paint forced through the electrically heated hose and spray gun where the paint is atomized into a fantype spray.

2. Shipbottom may be sprayed from staging, but on ships with high waterlines it is preferable, if not essential, to mount the spray unit in a skip box which can be handled by crane. In this manner the surface below a high waterline can be conveniently and rapidly coated with hot plastic.

3. Since the hot plastic has a sag temperature of 140° to 145°F., it is essential in very hot weather or in the Tropics that the hot plastic paint be applied during the cooler part of the day or night. The ship should then be immediately undocked before the sun melts the coating and causes it to sag off the ship. If it is impossible to undock immediately in hot weather, any areas of hot plastic upon which the sun directly falls can be kept cool with salt water hoses. A coat of white wash may also be used to prevent sagging. During the fouling season, it is preferable that a newly painted ship get underway soon after undocking, rather than remaining motionless in an anchorage.

4. **Detailed Description of Spray Equipment.**

a. **Reducing kettles (three types).** Three types of plastic paint-reducing kettles have been developed. These kettles are similar in general design but differ in type of heating element, using gas, oil, or steam to melt the solid plastic paint. These units consist of 110-gallon inner kettle surrounded by an insulated heating jacket, the complete unit being mounted on a wheeled chassis to facilitate movement in and about the dock. A removable air-driven agitator is mounted on each type kettle to secure adequate mixing during the reduction process. A hinged metal cover is provided, as well as a draw-off outlet at the kettle bottom.

(1) The gas-fired kettle has a heating element comprising a ring of eight gas-type burners arranged to give a swirling flame. The products of combustion rise between the inner kettle and the outer jacket, being discharged through the annular opening at the top.

(2) The oil-fired is equipped with a fuel oil tank of approximately a five-gallon capacity. A commercial type air atomization oil burner is used to heat the kettle. The fire box on this unit has been enlarged by raising the inner kettle somewhat higher than the gas or steam-heated kettles. The products of combustion rise between the inner kettle and the outer jacket, being discharged through the annular opening or the top. This kettle has been designed to burn diesel oil.

(3) In the steam-jacketed kettle, an insulated steam jacket surrounds the sides and the bottom of the inner kettle. A pressure gage, steam pressure regulating valves, and suitable relief and shut-off valves are provided on the steam supply line. A steam trap is provided at the bottom of the jacket for discharging condensate. Steam at not less than 75 pounds gage pressure should be available for suitable operation of the reducing kettle. Steam pressure in the jacket should never exceed 150 psi.

b. **Spray unit and auxiliary equipment.** The hot plastic paint spray unit consists of a 15-gallon insulated and electrically-heated pressure kettle mounted on a wheel chassis with all auxiliary equipment necessary to the spraying of molten hot plastic paint. Molten hot plastic paint from the reducing kettle is poured into the pressure kettle through a filling plug located at the top of the kettle. An air motor agitator operating through a packing gland keeps the hot plastic paint stirred and prevents local overheating or settling in the pressure kettle. A compressed air connection allows air pressure to be introduced into the kettle over the charge of hot plastic paint. The air motor agitator is also connected to this compressed air line. A check valve on the compressed air line between the air motor and the air connection on the pressure kettle prevents any plastic from being blown back from the kettle into the air motor. Two special electrically-heated spray hoses and guns are connected to an outlet at the bottom of the kettle.

(1) A built-in electrical kettle heating unit is mounted under the kettle for maintaining the plastic paint at a proper temperature. A special transformer is provided for supplying heating current to the spray hoses

and guns. The pressure kettle is equipped with an air pressure control valve and a safety and pressure relief valve mounted on the head of the kettle. Also a pressure gage is provided for determining the air pressure in the kettle, and either a dial thermometer or indicating thermostat for measuring and maintaining the temperature of the plastic paint. The shut-off valve on the bottom kettle outlet is equipped with a long valve stem so that it can be controlled from the top of the kettle. Even kettle should be provided with suitable electric and air lines of sufficient length to allow a considerable area of shipbottom to be coated without changing connections.

(2) The hose and gun are electrically heated to prevent the molten plastic paint from cooling off between the pressure kettle and the nozzle. The synthetic rubber spray hose is heated by a stranded resistance wire running through the center of the hose. This resistance wire is connected to the hose fittings which are used for electrical contacts. This circuit is not grounded to the kettle chasis as a special insulated hose fitting is used to make electrical contact. The heating element in the gun is connected in series with the resistance wire in the hose, and a return lead wire is provided along the outside of the hose back to the transformer, thus completing the circuit. A paint shutoff valve is attached to the gun trigger and provides a means of controlling the flow of the molten plastic paint.

(3) The reducing kettles are equipped for operation on 220-volt, 3-phase current. The electrical connections provided on this reducing kettle actually operate on one phase of this 3-phase line. The 50-foot electrical leads include an extra ground wire for safe operation. The thermostat which controls the temperature of the plastic paint is in turn connected to a solenoid valve which actuates the flow of oil into the oil burner.

5. **Electrical Assembly of Spray Unit.** A pressure kettle heater consisting of 18 chromalux strip heating elements rated at 250 watts each is mounted under the kettle. This heating unit is controlled by an indicating thermostat which automatically maintains the kettle at the proper heat. The transformer mounted on the pressure kettle chassis is used to supply heating current to the spray hose and gun. The transformer primary draws 220-volt, single-phase current. The transformer secondary is tapped in the following manner: 0, 8, 12, 17, and 24 volts to provide heating current for the hose and gun. A special tap is provided to supply 110-volt current for lighting, thus eliminating the necessity of running another line in the dock. By plugging the hose and gun circuit into the proper transformer taps, it is possible to maintain the plastic paint in the spray hose at application . When using the 12-foot hose, the plugging of the hose and gun circuit into the 8 and 17 volt taps of the transformer will give off 9 volts which will supply suitable current without the use of an external resistor.

6. **Arrangement of Spray Equipment in Drydock.**

a. **Reducing kettles.** The reducing kettles should be placed in the bottom of the drydock as centrally located as possible. Some type of temporary structure should be provided to house the kettles, particularly in wet weather. Compressed air connections should be readily available as well as steam, gas, or oil depending upon the type of heating element in the kettles. Thermometers should be available for checking the temperature of the molten plastic paint. One reducing kettle is required for each two to four pressure kettles. It is generally advisable to locate reducing kettles in groups of two so that each kettle is alternately either melting or supplying hot plastic paint. In this way an uninterrupted supply of paint is available for the pressure kettles.

b. **Pressure kettles.** It has been found good practice to set up all of the spray equipment on one side of a ship, to spray that side completely, and then shift all equipment to the opposite side. Staging should be rigged in separate units comprising about two lengths of planking. This permits a sprayman starting at the waterline to spray down to the keel along the entire unit of staging as it is lowered to the dock.

(1) For spraying the boot top to bilge area of battleships, carriers, and other large craft, it is essential to mount the spray unit on an elevated platform or in skipbox. If this is not done, it will be impossible to spray the high areas adequately, for the static pressure of a high column of molten plastic paint in the elevated spray hose will reduce the effective air pressure of the spray unit. Under these conditions the lowered effective discharge pressure results in poor atomization at the spray nozzle and a consequent inferior paint job.

(2) It is considered desirable that a plastic paint spray job be completed within one 8-hour shift. To achieve this rate of application the following arrangement of spray kettles equipped with skilled operators is necessary:

**Battleship and carrier types.** Nine to twelve spray kettles should be used for spraying ships of this category. Where skipboxes are used, the number of spray kettles can be reduced to 7 or 10. If skipboxes are used, two cranes, one at the bow and one at the stern, should be provided to spray the boot top to bilge area. The rest of the spray kettles are, in general, spaced within the area encompassed by the bilge keels.

**Cruiser and auxiliary types.** Six to eight spray kettles are required to complete application within one shift if skipboxes are used. Two additional spray units are required if the ship is sprayed from staging.

**Destroyer types.** Where these ships are docked in pairs, two spray kettles per ship are sufficient for a one-shift application. Two spray kettles are placed between the ships, one forward and one aft. These units thus spray one side of both ships. The two remaining kettles are used to spray the outboard sides of each ship.

(a) The drydock should be equipped with an adequate number of compressed air connections. For uneven dock floors, planking should be laid along the bottom of the dock on each side of the ship to racilitate movement of the spray units in the dock.

(b) A parallel trunk line should be run from the bow to stern of the ship along the keel blocks of the drydock. The cable should be tapped every 100 feet and provided with connectors suitable for the use of three spray units at any one location at any time. The 220-volt circuit requires four-conductor cables. Three legs of this circuit supply 220-volt, 3-phase alternating current while the fourth leg is used to ground all the spray units. Three special four-conductor plug-in type cable connectors with built-in switch should be available at each 100-foot location of the 22-volt trunk line. These connectors are designed so that the kettle connection cannot be made or broken under load. Thirty-





ampere fuse capacity for each pressure kettle should be provided on the trunk line of the 220-volt circuit.

7. **Instructions for Operating Plastic Paint spray Equipment.**

a. **Reduction of Plastic paint.** To reduce the solid plastic paint to a liquid, it is recommended that the following procedure be carefully followed. An entire drum of plastic paint should be cut open with an ax and broken up into small pieces with sledge hammers. No pieces of solid plastic paint larger than four inches in diameter should remain after this treatment. It is essential that whole drums of hot plastic be used, for while every drum as a whole is constant in composition, parts of any one drum are not uniform. Some of the broken plastic paint is shoveled into the reducing kettle and low heat is applied. When sufficient plastic has melted to free the agitator, stirring should be started at about 20 rpm. This will help prevent charring due to local overheating in the bottom of the gas and oilfired kettles and will speed up the rate of melting due to better heat transfer. The flames of the gas and oil-fired kettles may now be increased without danger of overheating in the kettle bottom. There is much less chance of overheating in the steam heated kettle. The remaining solid plastic paint can now be shoveled into the kettle. When the temperature of the plastic paint reaches 275° F., the heat in the kettle should be greatly reduced so as to maintain the temperature of the paint at 275-300° F. In no case should the maximum temperature of 300° F. be exceeded.

**CAUTION:** Formula 15-HPN hot plastic paint will flash and burn vigorously at 450° F. In no case should the kettle be filled higher than 10 inches from the top after the material has melted. In the event that the hot plastic paint should foam during the heating up period, heating should be immediately stopped and 15 to 20 gallons of melted paint drawn from the kettle. When foaming stops, the drawn-off paint can be replaced and heating continued. Ordinarily foaming is caused by water getting into the reducing kettle and for this reason every effort should be made to have the plastic paint dry before it is melted. It is recommended that operators of the reducing kettles wear light canister masks during the time spent in the immediate vicinity of the kettles. Fire extinguishers should be readily available near the reducing kettles at all times.

b. **Connecting and preheating spray equipment in drydock.** When the pressure kettle is in position in the drydock, the following procedure should be observed in connecting and preheating the equipment. The synthetic rubber spray hoses, guns, and nozzles should be connected. The kettle should be perfectly clean inside and the safety valve on the kettle cover should be set at 125 pounds pressure. The air hose should be bled free of moisture and connected to the kettle. The return circuit from the spray hose is plugged in at the transformer but the circuit should be open at the gun connection. The kettle heating switch should be on the "OFF" position. The switch on the main trunk line should be closed. Plug the electric cord on the pressure kettle into the receptacle on the main trunk line.

**CAUTION:** Make sure that the pressure kettle is properly grounded. Before preheating the kettle, the following procedure should be observed for safe operation during the preheating period:

(1) The filling plug should be open.

(2) The pressure relief valve on the kettle cover should be open.

(3) The valve on the outlet of the kettle should be open.

(4) The valve at the spray gun should be open.

(5) All nuts around the kettle cover should be loose.

(6) All air valves should be closed. When the above items have been checked, turn on the kettle heater and close the hose heating circuit at the spray gun. When the air temperature in the kettle registers 250° F. on the kettle's thermostat, tighten the cover nuts evenly. Close the valves at the spray gun and bottom kettle outlet. The unit is now ready to be charged with hot plastic paint.

c. **Filling of pressure kettle with hot plastic.** Molten hot plastic paint at 275° to 300° F. should be drawn from the bottom tap of the reducing kettle into 5-gallon buckets. It is not advisable to place more than 3½ gallons of hot plastic in each 5-gallon bucket. The kettle should be filled with the hot plastic paint by placing the combination funnel-strainer in the filling hole and pouring the molten paint from the 5-gallon buckets into the unit. At least 3 inches air space should always be left over the hot plastic in the kettle. **(Note.** –It is essential to use the 40-mesh strainer while filling the pressure kettle to avoid foreign material and chips plugging the gun nozzle.)

(1) When the kettle is filled with hot plastic, tighten the filling plug and close the pressure relief valve. Start the air motor agitator. Charge the kettle with air pressure and open the valve on the bottom spray hose outlet. The flow of hot plastic paint is now controlled by the gun trigger and the unit is ready for operation.

(2) When it is necessary to refill the pressure kettle with hot plastic paint, close the air supply valve and open the pressure relief valve on the kettle cover. When the kettle is free of pressure, remove the filling plug and refill with hot plastic as before.

d. **Procedure for spraying hot plastic paint.** Under average conditions, approximately two hours should be allowed for connecting and preheating pressure kettles, reducing the first solid plastic and completing other work preliminary to the actual spraying of hot plastic paint.

(1) The plastic paint should be held between 275° F. and 300° F. for formula 15HPN in the pressure kettle. Although hot plastic paint can be sprayed with air pressure as low as 80 psi, superior performance is obtained if the pressure is not less than 90 psi.

(2) Certain fundamental principles should be observed while spraying hot plastic paint. The plastic paint spray gun should be held from 18 to 24 inches from the perpendicular to the shipbottom during all but the ends of the spray stroke. The motion of the gun should be controlled by arm and body movement alone except at the ends of the stroke where a wrist motion is used to thin out the plastic paint for lapping. The spray stroke should always

be in a horizontal direction, if possible, and should be about 4 feet long. The wrist motion at the end of the strokes should thin out the plastic so that a 6-inch to 1-foot lap can be taken in a horizontal direction without building up an excessive thickness in the double-coated area. If the spray gun is held more than 24 inches from the shipbottom, the plastic paint stream will cool excessively in the air and will deposit as a rough, granular film.

(3) The plastic paint fan-type spray has been designed so that in a vertical direction the paint is deposited thickest at the center of the spray and tapers off rather evenly at the edges. This allows about a 4-inch lap to be taken between strokes in a vertical direction without building up excessive thickness in the double-coated area.

(4) It is essential that an even coat of hot plastic, free from holidays or thin spots, be applied. Care must be taken to spray into the angle at plate laps to avoid holidays. Rivet heads should be carefully sprayed to ensure complete coverage. The supervisors of all plastic-paint applications should carefully inspect the work and any bare or thin spots should be retouched before the ship undocks. The plastic paint coatings should be from .025- to .030-inch thick. This corresponds to approximately 2 pounds of plastic paint per square yard of surface.

8. **Precautions.** It is essential that the hot plastic paint system be applied to a properly prepared surface. If the old paint is excessively thick, shows poor adhesion, or has allowed black iron oxide to develop, blasting of the entire shipbottom should be done. If blasting equipment is not available, the bottom should be chipped and power wire brushed. It is useless to apply hot plastic over loosely adhering old paint, for such applications will invariably show premature failure due to flaking. When the old paint is in good condition and firmly adherent with no underlying corrosion, it is advisable to wet sandblast or wire brush any bare or corroded areas and apply a touchup coat of new paint.

9. **Instructions for Cleaning Spray Equipment:**

a. **Reducing kettles.** The reducing kettle is normally cleaned only when the unit is retired from service upon completion of a painting job. The heat source should be cut off and the molten plastic remaining in the kettle drawn off in buckets through the bottom outlet. The inside of the kettle should be scraped to remove any adhering material, particularly on the bottom. The reducing kettle is now ready to be placed in service again.

b. **Pressure kettles.** Upon completion of a painting job when a pressure kettle is to be retired from service, it should be carefully cleaned. All surplus paint should be blown out of the kettle through the spray hose. The orifice nozzle can be removed from the spray gun to facilitate transfer of the paint. After the paint ceases to flow, continue to blow air through the spray hose for about two minutes. Close the air supply valve, open the pressure relief valve, and disconnect all electrical connections. Disconnect the spray hose from the kettle. Loosen the filling plug and remove the kettle cover. Scrape the inside of the kettle free from all adhering material and blow out loose material with an air hose. After reinstalling the kettle cover, the unit is ready to be placed in operation.

10. **Safety Precautions.** Hot plastic antifouling paint will burn the skin. Therefore, care should be taken not to get any on the face, hands, or clothing. Masks and gloves must be worn while using this paint.

## 9190.162 APPLICATION OF PRETREATMENT COATING FORMULA 117

1. Formula 117 is intended for use as a pretreatment on bare metal surfaces, underwater preservative treated wood surfaces and plastic surfaces, prior to the application of priming coats, except where interior painting is accomplished by ships force. All surfaces should be thoroughly cleaned to assure good bonding to the surface. Formula 117 improves adhesion and life of subsequently applied paints. Instructions given below should be carefully followed.

2. Formula 117 is a two-package unit. Four gallons of resin component and one gallon of acid component comprise one unit. The mixing instructions below must be strictly followed:

a. While stirring, add slowly one gallon of acid component to four gallons of resin component which has been thoroughly mixed to disperse any pigment which has settled. After this addition, the pretreatment coating is stable for approximately eight hours. Therefore, only such quantities should be mixed as can be applied within the eight-hour stability period. Loss of stability cannot be ascertained from the visual appearance of the mixture; unused mixed pretreatment coating should be discarded. If less than 5 gallons of pretreatment are required, stir 1 volume of the acid component into 4 volumes of the resin component, taken after thorough mixing in the 5-gallon container. For example, 1 quart of the acid component may be stirred into 1 gallon of well-mixed resin component.

b. The acid component is not a thinner. It is a necessary activator and must be used exactly as directed. When thinning is required for proper spraying to obtain continuous film, it is permissible to thin the above mixture with denatured ethyl or isopropyl alcohol. When the spray is too dry, a retarder such as butyl alcohol may be added. A commonly used spray reduction is 4 volumes resin component, 1 volume acid component, and 1 volume alcohol.

3. Avoid contact of the acid component on the skin or in the eyes. In case of contact, wash with plain or lime water.

4. Apply a thin coat of pretreatment, preferably by brush (0.3 to 0.5 mils dry film thickness). This thickness is reached when the metal background is just discernible through the wet film. Coverage should be approximately 250 square feet per gallon. The pretreatment is sufficiently dry for recoating within 30 minutes and should be coated with primer as soon as practical.

5. The usual paint thinners are incompatible with pretreatment coating, formula 117. Cleaning of equipment and brushes after using formula 117 is best accomplished by using isopropyl or denatured ethyl alcohol.

6. The safety precautions below must be followed when pretreatment coating is being applied to interior surfaces. (See article 9190.163 for detail safety precautions.)

a. All the safety precautions of chapter 9920, section VI, of the **Naval Ships Technical Manual**, "Hot Work in Way of Flammable or Explosive Material and Entry Into Closed or Poorly Ventilated Spaces," should be followed.

b. All precautions and safety measures pertaining to flammable materials such as no smoking, welding, or burning in the immediate areas, grounding of spray equipment and elimination of chipping and other spark producing operations, should be forced.

c. Adequate ventilation of the explosion-proof type should be utilized, and proper gas masks or respirators should be used by spray hands.

## 9190.163 CONTROL OF HAZAROS FROM THE USE OF FLAMMABLE COATINGS IN ENCLOSED SPACES

1. **Discussion:**

a. **Ventilation.** Ventilation is one of the main factors in reducing the hazards that are inherent in these applications. Generally speaking, there are too many variables present to rely completely on any pre-established tables or standards for ventilating a tank being painted. The placement of duct, blowers, etc., is, in each case, an individual problem which will vary according to the shape, size, and number of openings in the tank. In some cases, additional openings will have to be cut in a tank in order to establish proper ventilation shown to be needed by testing at a given time. Frequent testing is necessary because the amount of ventilation needed to properly ventilate a tank will vary from time to time even though the obvious controlling factors remain constant (number of blowers, number of painters, etc.). Only experience can serve as a guide on the approximate amount of ventilation that should be supplied to a specific tank under a particular set of circumstances.

(1) With reference to the type and size of ventilation equipment that should be used, this also must be determined by local conditions and no overall guidance can be given on the matter. Experience has shown that blowers rated for certain capacities will often deliver less than their rated capacities; the size, type, and amount of duct work is generally the controlling factor. Also lack of uniformity has shown up in field tests where exhaust fans have been hooked up in parallel or series; that is, the actual exhaust capacities of these hookups are often considerably less than the theoretical capacities.

(2) Inasmuch as most of the solvents used in these applications are heavier than air, they have a tendency to collect in pockets. These pockets can readily form in the tank being painted, in other areas of the ship accessible to the vapors, and in drydock areas. Small blowers of various types have been used effectively to agitate the air in areas where regular blowers might not be able to move it. Also the flooding of drydock sumps has been used to reduce the amount of mechanical ventilation needed.

(3) Field tests have shown that during the spray painting of submarine ballast tanks, high concentrations in the tank occur most frequently when the painter is in the upper half of the tank; that is, at the most distant location from the inrushing fresh air.

(4) The venting of a tank by blowing air through a top opening and having its exhaust through a bottom opening is not a good practice because of the ease with which the vapors can accumulate in the dry-dock or in adjacent tanks that have openings in or near their bottoms.

(5) Ideal ventilation conditions do not eliminate explosive concentrations within a limited area adjacent to a spray nozzle. The actual size and shape of this area will depend upon several factors, including the rate and direction of air movements and the configuration of the tank. Based on certain test information, it can be assumed that this area does not extend beyond a distance of five feet from the nozzle. In these tests, samples were taken only above the nozzle; however, the distance of five feet should be considered to apply in all directions from the nozzle. It is hoped that, as a result of additional tests being conducted information can be obtained in connection with the possibility of flash fires originating within the area immediately adjacent to a spray nozzle. The Naval Ship Systems Command has no knowledge of any flash fire ever originating in this area during painting operations.

(6) The guides below are recommendations only. The exact capacity and distribution of equipment and ducts is for the industrial activity to determine. The criterion as to effectiveness will be the readings obtained by the Gas Free Engineer. Those readings shall determine the kind (supply or exhaust) and distribution of duct work.

(a) Use weather air for supply and exhaust directly to the weather.

(b) Consider carefully the number, placement, and capacities of blowers and the number and size of flexible ducts and size and shape of space to obtain maximum uniform air distribution. Err here on the safe side.

(c) The point of exhaust shall be as far as practical from the point of supply.

(d) In tanks, where necessary to obtain uniform air distribution and safe vapor concentrations, use as many feeder ducts as needed and distributed throughout each tank.

(e) In areas where vapors may "pocket", add more ducts. Solvent vapors are heavier than air and will tend to collect at lower levels.

(f) Use venturi-type exhaust blowers operating on compressed air wherever possible. For example, Mine Safety Appliance Company "Lamb Air-Movers" which are easily portable are available with the following capacities:

| Model | Weight (lbs) | Gage Pressure (lbs) | Compressed Air (cfm) | Induced Air (cfm) |
|---|---|---|---|---|
| 3" | 6.5 | 20 to 80 | 19 to 72 | 255 to 664 |
| 6" | 31 | 20 to 70 | 48 to 293 | 852 to 2857 |
| 10" | 47 | 30 to 80 | 149 to 398 | 2751 to 5162 |

For large air flows, centrifugal exhaust blowers with much larger capacities are available.

(g) The rated or name plate capacity of all blowers should be verified with measuring instruments at reasonable intervals.

(h) The use of supply or exhaust ventilation should be based upon the internal configuration of tanks, location of openings, distribution of staging, blowers available whether ship is in dock or not, and similar considerations.

b. **Testing.** It is considered that hard and fast rules as to the location and frequency of tests are not advisable; however, for guidance purposes, certain minimums should be established. Well trained gas-testers are vital in obtaining maximum safety. Testers should be thoroughly trained in the hazards that are inherent in the subject applications together with the unusual behavior of the solvents (collection in pockets, effects of weather, etc.). They should also

be given sufficient background in order to anticipate trouble areas that might develop under particular sets of circumstances. With basic knowledge of this type, the tester should then determine the frequency and location of tests needed in order to achieve maximum safety. (See chapter 9920.457 for pertinent information in connection with combustible gas indicators (explosimeter.)

c. **Accidental ignition.** Another essential safety factor is the elimination of all potential sources of accidental ignition. The principal sources of accidental ignition, in addition to open flames, are sparks from welding operations, sparks from electrical equipment, sparks from static electricity, and contact sparks (those generated by the striking of steel, concrete, etc.).

d. **Responsibility and training.** The two most important safety precautions in connection with these applications are the matters of "responsibility" and "training". This should be firmly established and clearly understood by all personnel connected with these applications. At the level of actual operations, the line supervisors are responsible for the operations, and the gas-testers and safety personnel are responsible for providing staff assistance to the line supervisors. This "responsibility" factor is also particularly important at those levels of supervision where painting work is coordinated with other types of work. The results of a survey of flash fires of a minor nature indicated that the majority of these incidents developed as a result of welding, burning, or grinding operations being performed in the vicinity of areas that had not been pronounced gas-free. However these functions should be "safety engineered" and not be unduly restrictive.

e. Commensurate with their responsibilities and participation, all personnel connected with these operations should be made aware of the hazards that are inherent in the applications, together with the appropriate safety precautions. This should be made part of each individual's job training.

2. **Safety Precautions.**

a. **Ventilation.** Ventilation requirements should be established on the basis of past experience and shall be followed up by continuous testing to ensure its adequacy.

(1) The point of exhaust in a tank should be as far away from the point of air entry as feasible in order to minimize the possibility of pockets.

(2) Air which is being exhausted from a tank should be exhausted above the tank and if feasible, above the hull of the ship.

(3) As few painters as practical should be permitted to work in the tank at any one time in order to keep the solvent concentrations as low as possible.

b. **Tests.** The maximum allowable solvent concentration is 20 percent of the lower explosive limit. This restriction does not apply within 5 feet (in all directions) of a spray gun nozzle.

(1) Periodic tests should be made throughout the tank being painted, at the exhaust areas, at the air intake areas, and in all other areas where it is considered possible that explosive vapors may collect (drydocks, adjacent tanks, mixing areas, storage areas, etc.).

(2) Testing should commence with the painting operations and should continue until such time as all areas involved are pronounced gas-free.

(3) A gas-tester must have a predetermined course of action to follow when his explosimeter shows a reading above the maximum allowable.

(4) Tests made at the point of exhaust should be made solely for determining whether an explosive vapor is concentrated at the exhaust and should not be made for determining whether or not there are any explosive concentrations within the tank. Tests should be made at the air intake of a tank to be certain that explosive mixtures are not being drawn into the tank. This latter test is particularly important when other tanks in the area are being painted.

(5) All readings taken by the gas-tester should be logged and a minimum frequency of readings should be established.

(6) Occasional tests for residual vapor pockets should be made after an area has been pronounced gas-free.

c. **Accidental ignition.**

(1) Good housekeeping should be maintained at all times.

(2) A "danger area" for each painting operation must be defined by the local activity and clearly delineated by signs. A "danger area" is that area in which there is a possibility that explosive mixtures may collect.

(3) Explosion-proof lights must be used in the danger areas. Only explosion-proof lights approved for use in Class I, Group D atmospheres should be used. With reference to portable explosion-proof lights, those lights approved for shipboard use, in accordance with Military Specification MIL-F-16377C and stocked under Number AF6230-266-9692, are considered adequate. The following lights, listed by manufacturer and type number are the only portable lights approved as explosion-proof under the above specifications:

| Manufacturers | Type of Model |
|---|---|
| Crouse Hinds Company | EVH100 and EVH110 |
| Russel and Stoll | F4255A |
| Stewart R. Browne Manufacturing Co. | XP, 100 Watts; XPN and XP-100-M |

(4) All other types of explosion-proof lights should have underwriter's approval for Class I, Group D atmospheres in accordance with the National Electric Code. Care should be exercised to prevent relamping or repairing any lights within the danger area and to assure that all lights used are completely and properly assembled.

(5) Only sealed electrical leads should be used within the danger area.

(6) Plastic protective clothing should not be used by mechanics because of the spark hazards.

(7) No welding, cutting, open flames, or smoking should be permitted in the danger area until pronounced gas-free. Further, this restriction should apply aboard any ship being painted. Ships in commission should exhibit the danger signal (baker flag or red light).

(8) All material and equipment used in connection with the subject applications should be of such material and/or construction that they preclude the possibility of any kind of a spark being generated (blowers, duct work, spray guns, paint brushes, buckets, etc.).

(9) All blowers must be equipped with explosion-proof motors and associated control equipment and should be properly maintained and grounded. Proper maintenance includes checking the flame gaps between the joint surfaces





to preclude exceeding safe limits. These flame gaps should not be gasketed or painted since this would destroy their basic function. Also, holes should not be drilled through explosion-proof enclosures. Enclosure parts should not be machined in such a manner as to decrease the flame gap length. Bolts should not be omitted or permitted to become loose, and bolts of a diameter smaller than the original should not be used. Spray guns and kettles should be adequately bonded and grounded to the ship.

(10) If metal staging is used, it should be installed in such a manner as to eliminate the possibility of a spark being struck, through the use of wooden or nonferrous plugs or fittings.

(11) Any ship being painted in drydock should be electrically grounded.

(12) Persons engaged in preparing and applying these coatings should not carry such items as matches, cigarette lights, and steel buckles.

(13) Portable lights should be hung on stiffeners by means of spark-proof hooks and should never be wrapped a ground or draped over supports.

(14) Electrical equipment and circuits within the danger area should be de-energized with the exception of explosion-proof equipment and the circuits feeding it. Connections for necessary electrical services should be made outside the danger area.

(15) A periodic check system should be established to determine that explosion-proof light assemblies, spray gun assemblies, and other equipment used in the painting operations do not have any exposed ferrous metal parts which could strike a spark on contact.

(16) When paints are being mixed on a steel deck, the deck should be covered with canvas.

(17) Solvent storage tanks and transfer lines should be grounded. Containers such as buckets, when used to transfer solvents, should make a metallic contact with the equipment during the filling and emptying period; metallic contact should also be made when pouring solvent from one bucket to another, as in mixing.

(18) Painting operations should be suspended during electrical storms.

d. **Miscellaneous.** Personnel applying coatings and personnel working in adjacent areas, should be properly protected from the toxic effects of the solvents and clothed in such a manner (rubber-soled shoes, rubber gloves, etc.) as to prevent their accidentally striking a spark.

(a) No food or drink should be allowed in the danger area.

(2) Personnel connected with the painting operations should be alerted to the fact that weather conditions play an important part in the behavior of solvents; i.e., that solvents have a tendency to collect more readily in humid, foggy, or rainy weather.

## 9190.164 APPLICATION OF ANTISWEAT PAINT

1. Apply one heavy spray or brush coat of binder formula 34, to 0.005 inch in thickness. The binder must not be thinned.

2. Apply vermiculite, Military Specification MIL-V-15196 (50 lb.) to the binder by means of compressed air, observing the instructions below. Compressed air guns for drawing up vermiculite and blowing into the binder may be designed and utilized for this purpose:

a. Particle velocity should be a maximum with a minimum air discharge in order to prevent premature setting of the binder, formula 34, by the air blast.

b. Vermiculite should be entirely free of dust and fine particles in order that the antisweat properties may be maintained.

c. Rate of flow should be even in order to obtain a uniform surface.

3. Composite vermiculite binder mixture may be applied, if desired, as follows:

a. Apply mixture, preferably by means of an air-driven pump equipped with two air control valves and two air pressure gages, so that pump air pressure and spray gun air pressure can be independently controlled (such as utilized for application of cold plastic antifouling paint). The mixture may also be applied using standard pressure pot spray equipment. The pressure pot should be modified so that the material outlet and fittings are not smaller than the ½-inch pipe size at any point. Separate air pressure gages and diaphragm control valves should be provided in order that pot pressure and spray gun pressure can be independently controlled.

b. An internal mix spray gun equipped with a ¼-inch inside diameter spray tip has been found most satisfactory for the application of vermiculite antisweat paint. The gun should have a large back closing needle and paint supply fitting not smaller than ½-inch pipe size.

c. The spray hose should not be less than ½-inch inside diameter and should be suitable for use at pressure up to 200 psi. Standard 3/8-inch air hose is suitable for supplying air to the spray gun. An overall supply hose length of 25 feet has been found most convenient for the application of vermiculite antisweat paint. Longer hoses can be used if necessary but are not often required.

d. Prepare a thinner binder paint by mixing 20 gallons binder, formula 34, 7½ gallons mineral spirits, and 0.2 gallon and 0.1 gallon of lead and manganese naphthenate driers respectively, Federal Specification TT-D-643. Slowly add a water solution of ammonium oleate (prepared by dissolving 3 pounds ammonium oleate soap in 40 gallons of fresh water) to form an emulsion. The soap may be prepared by slowly adding 28 pounds of ammonium hydroxide, Federal Specification A-O-415 (27 percent minimum $NH_2$) to 100 pounds technical oleic acid (red oil) with continuous stirring and mixing the resulting soap until thoroughly homogeneous. The soap should be stored in tightly sealed containers to avoid the loss of ammonia. These steps are best performed in a tank equipped with a high speed propeller-type agitator. The soap solution should always be added to the binder with violent agitation to ensure the formation of a stable emulsion. At this stage the emulsion can be stored for several weeks or longer if necessary. Within 2 days of the time of application, stir 120 pounds vermiculite, Military Specification MIL-V-15196, into the emulsion binder mixture. This can best be accomplished in a slow speed paddle type paint mixer, dough mixer, or even a small concrete mixer. It is preferable that the complete spray mixture be used within 2 days although it is possible to spray materials after 1 week storage with fair results. Violent or prolonged agitation of the vermiculite-emulsion binder combination will tend to break up the fragile vermiculite granules and will result in a spray mixture of inferior quality.

e. For application, the spray pump should be placed upright in a bucket of vermiculite-emulsion binder spray mixture with air and material hoses connected. About 15-20 psi air pressure should be placed on the spray pump which, with its 5.5 to 1 pressure ratio, will give about 80-110 psi in the material line. The spray gun trigger should now be depressed to fill the material hose with vermiculite spray mixture and to eliminate all air from the line. Spray gun air pressure should be adjusted to 8-10 psi. Final adjustment of spray gun and pump air pressure should be made after spraying a test area. The spray gun should be held 10-18 inches from the surface with the trigger fully depressed. It has been found desirable to use the lowest pressures which permit a satisfactory rate of application and provide complete atomization of the spray mixture.

f. The optimum pressures will be determined by hose length and size, viscosity of the spray mixture and characteristics of the spray gun. Pump air pressure over 25 psi (140 psi pressure) has been found very undesirable since the vermiculite granules will be both compressed and broken at high pressures. Spray gun pressure should not exceed 12 psi or a considerable fraction of the vermiculite granules will be flattened or will bounce off the sprayed area. The aim should be to obtain a very rough film comprised of a single layer of evenly spaced vermiculite granules. The vermiculite-emulsion binder spray mixture should cover between 35-40 square feet per gallon. The rate of application should be in the range of 5-10 square feet per minute to obtain the best quality antisweat surface. The spray gun should be triggered either full on or full off with no attempt made to control the rate of application at the gun. The rate of application should always be controlled by adjusting pump air pressure, and quality of workmanship should never be sacrificed for speed. With what is considered an ideal application, the zinc chromate undercoat will not be entirely covered at all points in the interstices of the vermiculite granules. An attempt to obtain complete coverage usually results in an undesirably thick film of antisweat paint.

### 9190.165 APPLICATION OF VINYL PAINTS

1. **Surface Preparation.** A clean, dry surface free of scale, corrosion, dirt, grease, oil, marine fouling, or other foreign matter for both touchup and complete painting will provide optimum performance for all coatings. This is especially critical in the case of the vinyl paints where inadequate surface preparation will result in unsatisfactory performance.

a. Clean surfaces by abrasive blasting or other mechanical means or by any combination thereof depending on amount and type of cleaning required. Abrasive blasting is most effective for metals. Removal of fatty material and flux components and roughening of surfaces on newly galvanized steel is required for satisfactory adhesion of pretreatment. Light blasting or mechanical roughening followed by a solvent wash may be used for this purpose.

b. During cleaning operations, considerable dust or debris collects on otherwise cleaned surfaces, and, depending on weather conditions, some after-rusting may occur. Such foreign matter must be removed prior to application of coatings.

c. For touchup painting of vinyl bottom paint, surfaces should be washed down with streams of high pressure water as soon as practical after docking to remove mud, slime, scum, and loose marine fouling. Light blasting may be used for removing adherent marine life from intact paint.

d. Deteriorated areas of old paint and corrosion products should be removed, and surfaces prepared as specified above prior to touchup.

e. Oil and grease may be removed with suitable solvents (e.g., naphtha); in some instances, use of mineral sprits may leave an oily film which prevents proper adhesion of formula 117.

f. To avoid after-corrosion or surface contamination, no more areas should be cleaned per work shift than can be conveniently coated in the same shift. Coat all freshly cleaned surfaces (this includes removal of oil and grease as well as corrosion products) as soon as practical.

2. **Pretreatment.** Use of pretreatment, formula 117, on all galvanized and bare metal surfaces is mandatory to ensure adhesion of vinyl paints. Formula 117 should be applied to cleaned areas as soon as practical to prevent further surface contamination. The following precautions should be observed to assure adhesion of vinyl paint over Formula 117:

a. Apply first coat of vinyl primer, Formula 119 or 120 over Formula 117 as soon as practical, and preferably within 24 hours after application of Formula 117. Any rusted areas should be re-blasted and recoated as above indicated.

Where Formula 117 has been on long enough to pick up blasting dust, oil film or other contaminants, a second coat of Formula 117 should be applied by brush. In any event if the Formula 117 is more than a week old, a second thin coat of formula 117 should be applied by brush or spray to insure adhesion of vinyl primer.

c. Where a moisture problem exists, addition of up to a pint of methyl ethyl ketone, ethyl or butyl alcohol per gallon of Formula 117 may eliminate the last trace of moisture and promote adhesion.

d. For further details, see article 9190.162.

Vinyl paints should not be applied over conventional films because of the softening effect of the ketone solvent ingredient. When vinyl antifouling paint is applied over cured epoxy anticorrosive, adhesion of the vinyl paint is improved if a mist coat of epoxy paint is applied ahead of the vinyl paint. The vinyl paint should be applied while the mist coat is tacky.

3. **Film Thickness.** Proper film thickness is mandatory in the application of vinyl paints. Approximate areas covered by one gallon of paint at required film thickness are given in following table:

| Material | Dry film thickness | Area |
|---|---|---|
| Vinyl primers | 6.0 mils | 35 sq. ft. |
| Vinyl antifouling | 4.0 | 125 sq. ft. |
| Vinyl-alkyd paint | 4.0 | 100 sq. ft. |

4. **Mixing.** Mix paints thoroughly prior to use to ensure uniform dispersion of pigments. This is best accomplished with mechanical shakers or high-speed stirrers and is very important in the case of antifouling paint. The copper pigment will settle to the bottom of containers during storage of the paint. All of the pigment must be thoroughly dispersed in the liquid paint in order to achieve optimum antifouling properties. After agitation, examine with suitable hand paddles to ascertain that the contents are properly mixed. Re-stir as necessary to keep the pigment in suspension.

5. **Vinyl Paints.** These may be applied by roller-type applicator, brush, or spray (conventional, hot spray or airless).

6. **Spray Application of Vinyl Paint.** The actual application of vinyl coatings by spray requires more technique and a better understanding of spray equipment than is usually exercised with other type finishes.

a. Since these products are comparatively low in nonvolatile film forming materials, the operator must take slow steady passes with the spray gun and supervisors have to constantly restrain the sprayers from going too fast. The speed of the passes has a direct relation to the dry film thickness which, in turn, influences the ultimate performance of the system. Hot and airless spray require special techniques that should be developed by the shipyard. Formulas 119, 120, and 121, should never be heated over 120° F. in hot spray applications

b. For conventional spray, adjustments should be made to determine the pressure most suitable for obtaining a uniform fan with proper atomization. A fan which produces too dry a spray will result in a "powdery" surface with considerable deposit of spray dust upon it. To correct this, the air pressure should be reduced and the paint pressure increased. Conversely, a fan which gives a spray too wet may result in a "splotchy" film or may sag. To correct, 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.

c. Atomizing, fluid pressures, and necessity for thinning paints are variable factors largely depending upon one's familiarity with the paints and are influenced by the viscosity of the paint as received, temperatures prevailing during application, type of spray equipment, length and diameter of paint lines, whether or not the paint line is lifted against gravity, and similar factors. Thus, for each application or new shipment of paint, the spraying conditions may be somewhat different. In the absence of previous experience, the steps below should be followed:

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

(2) Adjust the spray gun to wide fan position and the paint fluid valve to about one-half full opening. Adjust the atomizing air on the gun to about 60 pounds and the paint fluid pressure to about 30 pounds and sample the spray pattern. If the spray pattern is not suitable, and no further adjustment or combination of adjustments of the fan width and paint fluid valve will correct it, increase the fluid paint pressure in increments of 10 pounds, up to 60 pounds. If the spray pattern is still not suitable, thinning of the vinyl paints will be required.

(3) A ketone solvent (methyl isobutyl ketone or methyl ethyl ketone or a 50/50 mixture of ketone and xylol) should be used for thinning paints (when required to obtain suitable spray pattern) or cleaning equipment. A reduction of one-half to 1 gallon of ketone to 5 gallons of paint as received has been found to meet most situations.

(4) Reduction of viscosity of vinyls has also been accomplished by warming cans in steam box located on the job, maintaining temperature below 95° F. Formula 119 or 120 that has gelled because of storage at low temperature can be restored by heating to a maximum of 120° F.

d. Application should be made with a continuous stroke parallel at all times and overlapping preceding stroke at least two inches. Care should be exercised not to pause at the end of the stroke since this will cause piling up at the laps, causing an uneven appearance and perhaps sagging. The proper distance from gun to surface should be maintained as closely as practical. In general, this distance should not exceed 16 inches. In tight corners and weld areas, the pattern should be reduced to a small oval to adequately cover these areas. A spray coat consists of one or more passes depending on paint and should be considered as that amount of paint applied at one time just short of sagging.

e. A three pass cross technique, found particularly suitable for application of vinyl primers to large areas, in order to produce uniform films of the proper thickness, is as follows:

(1) Cover any given area with horizontal passes of the gun, moving the gun at a speed consistent with keeping the spray pattern wet and the film continuous as the area is covered. Next, cross the same area with vertical passes of the gun in like fashion. Lastly, recross the area horizontally. Consider these three passes of the gun as one spray coat.

(2) In confined areas such as crown frames and other welded structural members, it is generally not practical to "cross-stroke" each spray pass as suggested by this technique. In such instances, the three spray passes may be made back and forth in the same direction and the spray hand must reduce the middle of the spray pattern to fit the structural member.

f. If too high a spreading rate is obtained on the job with a given coat, the surface should be examined for light spots and holidays.

g. Depending on thickness of the wet film and weather conditions, vinyl paints may be recoated within one hour. A minimum drying period of four hours, preferably longer, is necessary between the final coat and undocking to ensure solvent release.

7. **External Atomizing Spray Guns.** Most types of external atomizing spray guns, normally available to shipyards and ships and assembled with a pressure tank equipped for separate control of paint and atomizing air pressures to obtain a satisfactory spray pattern, may be used. However, some will perform better than others. Some assemblies will be found to clog at air cap during continuous spraying and may require too frequent cleaning. This may produce too small a spray pattern or may require spraying too close to the surface.

8. **Recommended Air Caps and Fluid Tips.** Information regarding recommended air cap and fluid tip combinations for all of the approved brands of spray guns available in standard stock are being obtained from equipment manu-

facturers. To date, recommendations have been received as follows. (Similar information received from manufacturers of other equipment will be disseminated upon receipt.)

| Model-Binks gun | Combinations: Material nozzle Part No. | Size | Air nozzle Part No. | Size | Needle valve Part No. | Size |
|---|---|---|---|---|---|---|
| 7 | T-702 | 33PB | T-701 | 33PM | T-703 | 33 |
| 18 | T-903 | 63PB | T-901 | 63B | T-1074 | 63A |
| 19 | T-903 | 63PB | T-901 | 63B | T-1028 | 16 |

| De Vilbiss Gun | Fluid Tip | Size | Air Cap | Size | Fluid Needle | Size | Production |
|---|---|---|---|---|---|---|---|
| MBC-510 | AV-601 | D | AV-640 | 64 | MBC-496 | D | Very rapid. |
| MBC-510 | AV-601 | E | AV-640 | 704 | MBC-444 | E | Moderate. |
| JGA-502 | AV-601 | D | AV-640 | 64 | MBC-496 | D | Very rapid. |
| JGA-502 | AV-601 | E | AV-640 | 704 | MBC-444 | E | Moderate. |

| Eclipse gun | Fluid gun | Nozzle |
|---|---|---|
| G6 | No. 40 or 44 | No. 1,2,3, or 6 fan-slot or cone-fan, adjustable |
| GAT | No. 40 or 44 | No. 17, 27 or 37 fan-slot or No. 47, adjustable (when ordering No. 47, adjustable, specify gun model). |

9. **Other Acceptable Spray Gun Combinations.** Other combinations which have been used for shipyard application or vinyl paints include the following. (Part descriptions as reported by shipyards are indicated.)

a. Binks Thor No. 23 external mix extension gun with T90367 air nozzle and T901 No. 67 material nozzle.

b. De Vilbiss MBC external atomizing gun with following combinations:

(1) 62 air cap with MB-1015-CS or AV-601 fluid tip.

(2) 62-1 air cap with AV-15AC-1 fluid tip.

(3) 64 air cap with AV-15-D or AV-115-DN fluid tip.

(4) 65 air cap with AV-15-D fluid tip.

(5) 763 or 765 air cap with FX fluid tip.

c. De Vilbiss MBD gun with 54 air cap and AV-FF fluid tip or 64 air cap, AV-15-D fluid tip and MBD 403DEX needle.

d. De Vilbiss type PQBC-510 and Graco No. 202-798 pressure pumps have been used to supply paint to the spray gun.

10. **Safety Precautions.** The solvent used in the component formulations of the vinyl systems is more flammable than other paints. Their vapors can produce physiological and toxic effects if breathed continuously for long periods, but no more so than results from previously used paint coating solvents. All precautions and safety measures pertaining to flammable materials, such as no smoking, welding, burning in the immediate areas, grounding of spray equipment, elimination of chipping, and other spark-producing operations, should be enforced. Proper gas masks or respirators for spray hands and proper ventilation (of the explosion-proof type) should be utilized. Spray equipment discussed in paragraphs 8 and 9 above was not specifically designed for the application of these coatings. It is possible that spray guns have exposed ferrous parts, and therefore are capable of producing a spark. Safeguards should be taken to guard against this hazard where it is found to exist. (See article 9190.163 for detailed safety precautions particularly with respect to tank applications.)

### 9190.166 SYNTHETIC RUBBER COATING

1. To ensure compatibility of each item with the components of this system, all items being used must be products of the same manufacturers.

2. Prime immediately after abrasive blasting. Apply two coats priming cement by brush to ensure complete surface coverage. Allow at least 20 minutes drying time between priming coats and before first liquid synthetic rubber coat. Do not apply priming cement over any previously applied rubber compound.

3. The liquid compound is shipped unaccelerated and is ready for use only after accelerators have been added. Instructions for use on the package indicate how much accelerator is required and how much should be supplied. Thoroughly stir the accelerator before mixing. Add accelerator in proportions indicated while stirring vigorously to obtain best dispersion. Mix only as much compound as can be applied in 40 minutes.

4. Apply accelerated liquid synthetic rubber compound by brush, using short even strokes. Avoid scrubbing action. Brush from dry to wet area. Entire brush should not be dipped into the liquid compound since so doing will have a tendency to trap excessive amounts of air in the brushed coat. Hold brush at an angle and pick up material on one side of the brush, leaving the other side of the brush practically dry. This dry side of the brush can be used to advantage in counter-stroking for even distribution of coating material. After material has been applied, do not disturb again except to smooth out runs or drips. Spray the coated surface immediately after each coat with xylol from atomizing spray gun such as a common insect-repellent sprayer. This will disperse any air bubbles formed during brushing. Allow one hour minimum between coats. Each coat will average about .008-inch thickness. Apply five coats to a thickness of approximately 0.40 inches. Dry final coat from two to four hours to allow solvents to evaporate.

5. The coating requires heat, preferably heated dry circulating air to cure. The rate of increasing the temperature to a maximum of 175° F. to 200° F. is indicated in the manufacturer's instructions and should be followed as closely as practical since improper or incomplete curing results in short lived coatings.

6. Troweling compound is used as a putty or filler for abnormal pits or where sharp corners or grooves require filleting. Material must be accelerated before use. Thoroughly mix accelerator and troweling compound in accordance with manufacturer's instructions. Apply over either priming cement or rubber compound as necessary. Apply successive coats to build up required thickness rather than excessively heavy applications. Troweling compound can be applied over synthetic rubber compound but requires a tie cement over priming cement.

7. Finally the cured coating should be tested for hardness using the Shore "A" Durometer and for pinholes using the "electrolysis test." These tests are indicated in Mil. Spec. MIL-R-1508.

### 9190.167 TANK COATING SYSTEMS

1. Paint coating systems qualified under Mil. Spec. MIL-P-23236 are approved as tank coatings, except in fresh water tanks. Thorough surface preparation by blasting to bare steel must be accomplished to obtain maximum adhesion and performance. Coatings shall be applied as recommended by the manufacturer, except that minimum film thickness shall be as shown in table 15.

2. Selection of any one of the above classes of coatings should be made on the basis of the following factors contributing to total application cost and time available for application:

a. Total coating material cost (that is, cost per square foot for recommended film thickness rather than cost per gallon);

b. Number of coats to be applied.

c. Equipment available for coating application and ease of application.

d. Ambient temperature, pot life, drying time required between coats, and curing time.

e. Safety precautions required.

f. Colors of coating system from standpoint of aid to application and inspection of tank during application and in service.

g. Availability of technical services.

3. **Maintenance.** When touchup or repair of tank coatings is required, the following procedures should be used:

a. **Surface Preparation.** Brushblasting to remove loose and deteriorated paint is recommended. Where not practical, wire brushing, sanding or other suitable mechanical means should be used. Intact paint should be "faired" prior to application of new coats of paint. Grease, oil, dirt, and other contaminants should be removed.

**TABLE 15. MIL-P-23236 QPL COATINGS***

| Spec. Type and Class | Coating System | Total Dry Film Thickness (Mils) | Manufacturer |
|---|---|---|---|
| Type 1, C1.1 | DEVRAN 203<br>1-202 Primer<br>2-Tank Coating 203 | 8 Min. | Devoe & Raynolds Co.<br>Rutherford & Delancy Sts.<br>Newark, N.J. and<br>Riverside, Calif. |
| Type 1 C1 1 | DEVRAN 215<br>1-202 Primer<br>1-Tank Coating 215 | 8 mils | Devoe & Raynolds Co.<br>Newark, N.J. and<br>Riverside, Calif. |
| Type 1, C1.2[1] | AMERCOAT No. 78<br>1-No. 78 Black<br>1-No. 78 Red | 16 mils | Amercoat Corp. |
| Type 1, C1.2[1] | AMERCOAT No. 79<br>1-No. 79 Black<br>1-No. 79 Red | 16 mils | Amercoat Corp. |
| Type I, C1.2[1] | TARSET-2cts[1] | 15 min. | Pittsburgh Chem. Co.<br>Neville Island<br>Pittsburgh, Pa. 25 |
| Type I, C1.3 | DIMETCOTE No. 3[3]<br>1-Dimetcote<br>2-D-3 Nonflammable[2]<br>Curing Solution[1] | 2 to 3 | Amercoat Corp. 4809<br>Firestone Blvd. South<br>Gate Calif. and<br>Buffalo, N.Y. |
| Type 1, C1.3 | DIMETCOTE No. 4<br>- (1 coat) | 3-5 mils | Amercoat Corp. |

TABLE 15. MIL-P-23236 QPL COATINGS—Continued

| Spec. Type and Class | Coating System | Total Dry Film Thickness (Mils) | Manufacturer |
|---|---|---|---|
| Type 1, C1.3 | ZINCILATE 101-C | 3-5 mils | Industrial Metal Protective Co., Inc., 401 Homestead Ave., Dayton, Ohio; 414 Wilson Ave., Newark, N.J.; and Xenio, Ohio. |
| Type 1, C1 3 | ZINKOTE-(1 coat)[3] | 3-5 mils | Amercoat Corp. South Gate. Calif. and Buffalo, N.Y. |
| Type 1, C1 3 | CARBO ZINC No. 11-HFP-(1 coat)[3] | 3-4 mils | Carboline Co. 32 Hanley Ind. Ct. St. Louis, Mo. 17 |
| Type I, C1.3 | RUST-BAN 190/195[3]<br>1-Rust-Ban 190<br>1-Rust-Ban 195[2]<br>-Nonflammable Curing Solution | 2 to 4 | Humble Oil and Refining Co. 8230 Stedman St. Houston, Tex. |
| Type I, C1.3 | CATHA-COAT 300[3]<br>1-Catha-Coat 300<br>1-MD-2599 Curing Solution[3] | 2 to 4 | Devoe & Raynolds Co. Rutherford & Delancey Sts. Newark, N.J. and Riverside, Calif. |
| Type 1, C1.4 | DEVRAN 203W System<br>1-202 Primer<br>2-Tank Coating 203 W (Winter Grade) | 7-8 mils | Devoe & Raynolds Co., Inc. Rutherford & Delaney Sts. Newark, N.J. and Riverside, California |
| Type I, C1.4 | LAMINAR X-500<br>1-Primer (Yellow-green) 4-G-14<br>1-White 4-W-1<br>1-Gray 4-X-13<br>1-White 4-W-1 | 6 min. | Magna Coatings & Chem Co. 1785 N. Eastern Ave. Los Angeles, Calif. |
| Type 1, C1 3 | RUST-BAN 191[3] (1 Coat) | 3-5 mils | Humble Oil and Refining Co. |
| Type 1, Class 1 | Amercoat Primer No. 81<br>Amercoat Topcoat No. 82 | 8 mils | Amercoat Corp. |
| Type 1, Class 1 | Varni-Lite 1000 Series 3 coat system | 8 mils | Varnilite Corp. 3005 Copper Rd. Santa Clara, Calif. 95051 |
| Type 1, Class 2 | Tarep 401 Black | 16 mils | Corro-Ban Prod. Co. 2526 N. Naomi St., Burbank, Calif. 91504 |
| Type 1, Class 2 | Tarep 940 Red | 16 mils | Corro-Ban Prod. Co. |
| Type 1, Class 2 | Tarset Std/Tarset Red | 15 mils | Pittsburgh Chemical Co. |
| Type 1, Class 3 | Zincilate | 5 mils | Industrial Metal Protective Co., 401 Homestead Ave. Dayton, Ohio 45408 |





TABLE 15. MIL-P-23236 OPL COATINGS—Continued

| Spec. Type and Class | Coating System | Total Dry Film Thickness (Mils) | Manufacturer |
|---|---|---|---|
| Type 1, Class 3 | Galva-Pac | 4 mils | Cook Paint & Varnish Co. P.O. Box 389 Kansas City, Mo. 64141 |
| Type 1, Class 3 | Metalhide 100 | 4 mils | Pittsburgh Plate Glass Co. One Gateway Center Pittsburgh, Pa. 15222 |
| Type 1, Class 3 | P-1500 Inorganic Zinc Primer | 3-5 mils | Andrew Brown Co. 5431 District Blvd. Los Angeles, Calif. 90022 |
| Type 1, Class 1 | Farbo-Coat No. 99<br>1-Primer No. 99R (Red)<br>1-Topcoat No. 99E (White) | 10 min. | The Farboil Company 8200 Fischer Road Baltimore, Md. 21222 |
| Type 1, Class 1 | Intergard Tank Coating<br>1-Primer No. 4421/4423 (Blue)<br>1-Topcoat No. 44/24 No. 4423 (White) | 8 min. | International Paint Co. Inc. 220 S. Linden Ave. S. San Francisco, Calif. 94080 |
| Type 1, Class 3 | Biozinc 103-1 ct. | 4 mils | Banner Paint Co. 1825 Avenue H St. Louis, Mo. 63125 |
| Type 1, Class 3 | Mobilzinc 1-1 ct. | 3 mils | Mobile Chemical Co. P.O. Box 512 Metuchen, N. J. 08840 |
| Type 1, Class 3 | NAPKO 42-1 ct. | 3 mils | Napko Corp. P.O. Box 14509 Houston, Texas 77021 |

[1] Class 2 coatings not recommended for aviation fuel tanks because of fuel discoloration.
[2] Coatings applied in excess of recommended film thickness require additional coat of curing solution.
[3] Inorganic zinc coatings should not be used where exposed to an acid environment (such as in sanitary or drainage tanks) or where acid cleaning is used. Where white powder and crystals formed during curing has to be removed (such as in fuel tanks where these deposits may clog filters), removal should be accomplished within 24 hours after application of curing solution by flushing with water. Mechanical scrubbing should also be used if necessary.

*See latest QPL 23236 for approved coatings.

b. For compatibility, touchup of coated tanks should be accomplished with the same system as originally applied. For example, Class 1 material should be used over Class 1. Where this is not practical, the following systems are approved:

(1) If Class 1 or Class 4 coating system has been applied, repaint with Class 1 or Class 4; Class 2 coating, where approved, may be used over Classes 1 and 4.

(2) If Class 2 was applied, repaint with Class 1, 2 or 4.

(3) If Class 3 was applied, repaint with Class 1, 3 or 4 (or Class 2 where approved).

### 9190.168 VINYL PLASTISOL COATING, MIL-P-20689

1. **General.**

a. A vinyl plastisol is a liquid paste (dispersion) of polyvinyl chloride resins in a plasticizer. The liquid plasticizer replaces the solvent, hence the term plastisol. In contrast, a less viscous mixture of resin, plasticizer and a solvent is known as an organosol. To this dispersion, fillers, stabilizers, pigments, and other modifying ingredients are added to give special physical and rheological (flow) properties. The method of application consists of preheating an article, dipping in the plastisol, and fusing it at a temperature of 350° to 375° F. During fusing, the

plastisol is converted into a solid in which the resin and plasticizer become mutually dissolved. Plastisols have a multiplicity of uses and are particularly adapted for application in thicknesses of 10 to 100 mils on complex shapes that can be accommodated in a dipping operation.

b. Plastisol coatings are particularly useful in covering intricately shaped surfaces where heavy, impervious, seamless coatings are desired. Plastisols have been used for coating tool handles, washers, metal O-rings, drums, valve hand wheels, steel racks, hooks, pipe sections (exterior surface), strainers, panel knobs, duct work, strongback, stowage clips and many other items.

c. Plastisols form tough, flexible, abrasion-resistant coatings which have good retention of their physical properties after immersion in aliphatic hydrocarbons, acids, and alkalies. There is, however, an appreciable leaching of plasticizer in aromatic hydrocarbons and ketones.

d. Due to thermal-decomposition products emitted by plastisols when exposed to elevated temperatures, the use of plastisols should be limited to relatively small areas. Proposals for application of plastisol to extensive areas should be referred to the NAVSEC for approval.

2. **Surface preparation.**

a. Surfaces to be coated with plastisol must be free of all traces of oil, rust, scale, and dirt. All welds must be chipped and all flux from soldering or brazing must be removed. All loose joints, small holes, and porous welds must be eliminated as they trap air and cause blistering of the coating during cure. It is not necessary to grind welds and metal as smooth as in sheet-lining work since the plastisol will assume the contour of the metal and, to some degree, fill in and smooth over a rough surface.

b. The surfaces should be cleaned by abrasive blasting as this method provides a surface for maximum bond strength. (For soft metals such as aluminum, suitable chemical cleaning may be used in lieu of sandblasting. Chemical residues must be thoroughly removed by hot water rinse). After abrasives blasting or chemical cleaning and immediately prior to application of the primer the surfaces should be degreased by solvent washing.

c. Soft solder (50-50) cannot be used for a joint to be coated with a plastisol without mechanical fastener because it loses all strength at the baking temperature (10 percent tin-90 percent lead or 20 percent tin-80 percent lead solders can be used unsupported for a joint).

3. **Priming.**

a. Plastisol when applied to bare metal has little or no adhesion and can easily be stripped off. However, plastisol applied over an approved primer (specified by the plastisol manufacturer) has excellent adhesion. Therefore, when applying the primer, do not apply it to surfaces from which the plastisol coating will be removed, such as the core of valve hand wheels.

b. Primers contain solvents. The proper safety precautions pertaining to the use of solvents should be followed. The primer can be applied by brushing, spraying, or dipping, as stated below:

(1) Over aluminum: Apply one coat of pretreatment, formula 117, and allow to dry for 10 minutes. Then apply one coat of plastisol primer and air dry for 20 minutes minimum, but not more than 16 hours.

(2) Other metals: Apply a single coat of plastisol primer directly to the metal surface and allow to dry for a minimum of 20 minutes, but not more than 16 hours.

4. **Application of Plastisol.**

a. Suspend the primed article in a forced-draft air oven at 350° to 375° F. for 10 to 20 minutes or until the metal reaches the oven temperature.

b. Remove the article from the oven and immediately immerse it in the plastisol, leaving it completely immersed for 30 to 60 seconds, depending upon the thickness of coating desired.

c. Withdraw the article slowly from the plastisol tank in such a manner that the excess fluid-compound can run off at a single point which will not be readilly visible on the finished article.

d. Allow the article to drain until all dripping has stopped.

e. Return the article to the oven at 350° to 375° F. for 10 to 20 minutes, or until dense fumes are emitted from the coated article, indicating complete fusion.

f. Remove the article from the oven and suspend it on a rack until it is cooled to room temperature.

g. Trim drip marks and excess plastisol from areas which were not to be covered.

5. Plastisol coatings, if damaged, can be patched with a heat-curing putty or an air drying vinyl putty which are available from the plastisol manufacturers.

6. The dip coating of various articles with plastisols, owing to differences of specific heat, cooling rate, mass, etc., of the materials to be coated, requires that the process be precisely tailored to the article. The above procedure is adequate for the average product. However, separate specific instructions should be obtained for special products.

## 9190.169 EPOXY REPAIR COMPOUNDS

1. **General.**

a. The epoxy hull-repair compounds listed in paragraph 2 below are approved for filling and repairing corroded or pitted metal and minor damage in wood, prior to painting.

b. The epoxy hull-repair compounds are not approved for repair of severe deterioration as defined in chapter 9110 of the **Naval Ships Technical Manual.** For making repairs of this nature the procedures outlined in chapter 9110 must be followed.

c. The epoxy-type compounds herein specified are not affected by vinyl primers, show good resistance to sagging on vertical areas, and can be ground or sanded after curing.

d. Epoxy resins and catalysts present toxic hazards because of severe skin irritations caused by allergic reactions in some individuals. Safety precautions must be followed to avoid inhalation or direct skin contact.

2. **Approved hull smoothing compounds.**

a. Epoxy hull repair compounds qualified under MIL-C-24176, Type I, are approved for general use and for application in way of cathodic protection. The compounds listed below have been approved for Type I (see latest QPL-24176 for approved materials).

| COMPOUND | MANUFACTURER |
|---|---|
| Devcon A with Devcon A Hardener | Devcon Corporation<br>Danvers, Mass. |





| COMPOUND | MANUFACTURER |
|---|---|
| Epoxit PM6003 Resin with PMH-403 Hardener | Palmer Products Inc.<br>Montgomery County<br>Worcester, Pa. |
| Poxy Putty Blue Gray Resin 1124 with Poxy Putty Energizer | Permalite Plastics Corp.<br>608 Terminal Way<br>Costa Mesa, Calif. |
| Epocast 8002A Resin with Epocast 8002B Hardener | Furane Plastics, Inc.<br>4516 Brazil St.<br>Los Angeles, Calif. 90039 |

b. The compounds listed below qualifying for Type II are not alkali resistant and should not be used in areas affected by cathodic protection. (See latest QPL-24176 for approved materials).

| | |
|---|---|
| Devcon F with Devcon F hardener | Devcon Corporation |
| Epocast 8163A with Epocast 8163B Hardener | Furane Plastics, Inc.<br>4516 Brazil Street<br>Los Angeles, Calif. 90039 |

3. **Surface preparation.** Paint, rust, scale, and grease should be removed by wire-brushing, abrasive-blasting, or other suitable means. The surface should be thoroughly dried prior to the application of the hull smoothing compound.

4. **Application**

a. Hull smoothing compounds should be applied in accordance with manufacturer's instructions. When fully cured, the filled-in area should be sanded smooth and painted as required.

b. Epoxy smoothing compounds are two-component systems which harden by curing. Curing time is affected by temperature. It is recommended that at temperatures below 50° F. the epoxy compound be mixed indoors, and that the hull plating be warmed prior to application, where practical. Warming the repaired area with hot-air guns or infrared heat should accelerate the curing. At 70°F., the compounds will cure in approximately 24 hours.

5. Safety precautions for proper handling.

a. Avoid contact with skin and eyes during application and grinding operations. Use protective clothing and skin creams, gloves, and goggles as necessary.

b. Do not inhale fumes and dust. If work is to be done in interior spaces, positive exhaust ventilation should be provided. Organic vapor respirators, approved by Naval Mines System Command, may be necessary for protection against fumes, if such ventilation is not provided. An approved dust respirator may be necessary when excess resin is ground off.

c. Good housekeeping is very important. Avoid spilling. Promptly clean up all drippings, waste, and deposits on tools. Wash all protective clothing and equipment if contaminated. Place waste matter in covered waste cans. Keep chemical containers clearly labeled and tightly covered when not in use.

d. If any individual worker shows a sensitivity to the compounds, he should be removed immediately from this work and referred to the Medical Department. Where these compounds are used extensively, the shipyard hygienist should be called to the job site for advice.

## 9190.170 PAINTS RESISTANT TO PHOSPHATE ESTER AND PETROLEUM TYPE HYDRAULIC FLUID

The following coating systems are approved for painting of surfaces subject to exposure to Mil. Specs. MIL-H-19457 phosphate ester, and MIL-L-15017A, MIL-L-17331D, and MIL-L-17672A petroleum-type hydraulic fluid from spillage. Because of the flammability of solvents, application of coatings of ship's force should be limited to those with a minimum flash point of 100°F.

1. Mil. Spec. MIL-P-23236, Class 1, 2, and 4 (see article 9190.167 for approved coatings and dry film thickness). Application should be in accordance with manufacturers instructions.

2. Phenoline 372 system consisting of one coat Phenoline 372 primer and one coat Phenoline 372 finish coat, applied to a total dry-film thickness of 8 mils. Application should be in accordance with manufacturer's instructions.

Manufacturer: Carboline Company
32 Hanley Industrial Court
St. Louis, Mo.

## 9190.171 TANK COATING SYSTEMS FOR FRESH WATER

The following coating systems are approved as tank coatings in potable and feedwater tanks (except in feedwater tanks on nuclear-propelled ships). Thorough surface preparation by blasting to bare steel must be accomplished to obtain maximum adhesion and performance. Proprietary coatings shall be applied as recommended by the manufacturer.

1. Devoe and Raynolds Co. "DEVRAN 207" three-coat system (consisting of one coat Formula 207 Pale Gray, Formula 207 Pale Yellow, and one coat Formula 207 Pale Blue). Dry-film thickness should be a minimum of 6 mils.

2. Wisconsin Protective Coating Corp. "Plasite 7133 HC" coating system consisting of two coats of "Plasite 7133 HC" applied to a minimum dry-film thickness of 8 mils.

3. Mobile Chemical Co. "Mobil 264" two coat system consisting of one coat of "Mobil 224-F-25" and one coat of "Mobil 264-W-12" applied to a minimum dry-film thickness of 10 mils.

## 9190.172 INSTRUCTIONS FOR APPLICATION OF BALLAST TANK FLOTATION TYPE RUST RETARDING COMPOUND

### GENERAL

1. Preservative shall be applied and all surfaces coated as described herein. Preservative remaining on top of the water after application may be stripped from those tanks which may act as a source of harbor pollution during later operations and from all tanks which may be used for ballast cooling water during beaching operations. "Stripping" means removal of any floating layer of material which remains after coating the sides and overhead.

2. Insofar as practical, compounds should be retained on the water surface.

3. The presence of flotation type compounds increases the time required to separate water from Navy special fuel oil and diesel oil. Accordingly, tanks to be used for fuel stowage should be steamed clean if flotation compounds have been applied.

4. The minimum flash point of MIL-R-21006 flotation type preservative is 325°F. Accordingly, it should be considered the same as lubricating oil with respect to safety precautions as outlined in chapter 9920.

5. In cases where the salt water ballast discharge is located close to the distilling plant suction, the distilling plant should be secured during deballasting to prevent contamination of the drinking water.

**APPLICATION**

6. Preservative should not be applied when the water temperature is less than 50°F.

7. Quantity of preservative added shall be calculated as follows:

Q = L x W x T x 5/8 where L = average length, W = average width, and T = 3/4 inch thickness of preservative compound on surface of water.

For example, to calculate amount needed for tank whose length is 20 feet and width is 17 feet:

20 x 17 x 3/4 x 5/8 = 160 gallons of preservative needed.

8. To prevent harbor pollution by overballasting and discharge of preservative overboard, ballasting and deballasting operations in connection with the application of preservative should be done out of the harbor area.

9. Before preservative is applied, all surfaces of each tank should be washed with a high pressure stream of salt or fresh water. All sludge, mud, etc., should be removed before compound is added. Loose rust and heavy rust scale should be removed before application of preservative. Intact paint and previously applied preservative need not be removed.

10. To ensure complete coverage of the tank bottom and overhead plating (and intermediate level horizontal plating in LSD wing tanks) compound should be pumped on these surfaces. Pump pressure should be approximately 80 pounds. The use of a pump with 1-½ inch suction and discharge hoses is recommended. The end of the discharge line should be fitted with a piece of pipe flattened to form a non-atomizing nozzle. Application of preservative by an eductor which mixes water and preservative directly should not be used.

11. Insofar as practical, the other surfaces should then also be sprayed. Tank should then be filled with water up to the level of the bottom longitudinals and the remainder of the specified quantity of compound poured into the tank.

12. Ballasting should be started immediately after pouring in compound. Flood each tank at a maximum rate of six inches per minute. Ballasting must be stopped when the level is within a few inches of the top in order to prevent loss of material through the vents. Add more water to the tank with a hose until the overhead is in contact with the floating layer. In addition, if practical, trim the ship fore and aft and list it port and starboard to ensure coverage of overhead plating which may have been missed during pump application. After a minimum of one hour, deballast all tanks at a maximum rate of six inches per minute taking care not to strip the floating layer when the level approaches the suction inlet. (LSD third deck tanks should retain approximately 6 to 12 inches of water in the bottom to prevent runoff of excess preservative. Experience has shown that coating in the third deck tanks is often very thin as these tanks can be drained dry by dump valves directly above.) This is considered one cycle except that "tank topping" is necessary only for the first cycle.

13. Continue ballasting and deballasting each tank once every 24 hours for a total of three cycles allowing a minimum of one hour between the ballasting and deballasting operation. An additional three cycles should be completed at the convenience of the ship. These materials may not form a gel during the ballasting cycles.

14. If the tank is to be stripped of all residual preservative strip the tank of all ballast water and floating compound.

**MAINTENANCE**

15. All tanks should be inspected at least once every four months and preservative added if necessary. The quantity to be added will depend on frequency of ballasting and previous condition of surfaces. Addition of compound is necessary if surfaces are not coated with preservative. Heavy accumulations of rust and sludge on the bulkheads or tank bottom should be removed.

16. Preservative added for maintenance purposes need not be the same brand as originally applied but should be a material which has been procured from an approved source.

17. The quantity to be added will depend on the condition of the preservative. If complete reapplication is necessary, the original quantity should be added. Otherwise the quantity judged to be needed should be applied.

18. Experience has shown that the overhead is most frequently in need of maintenance. At convenient intervals after the initial application compound should be pumped on the overheads (even though nothing is added for the sides) until a heavy permanent coating is built up.

### 9190.173 CORROSION PREVENTIVE COMPOUNDS

1. Corrosion preventives are, as a class, compounds which are relatively inexpensive. They are used to protect equipment and components whose dollar value is frequently almost infinitely greater than that of the corrosion preventive. Not only are corrosion preventives inexpensive but they exist in a variety of formulations, which have a wide range of properties and are intended for a multiplicity of purposes. It is difficult to assess the value of these products visually or by limited tests. Generally, corrosion preventive compounds provide temporary protection. Utmost precautions must be taken at the time of preservation of each item to assure that the correct corrosion preventive compound for the purpose is used. Corrosion preventive compounds improperly or inappropriately used can be a liability from many standpoints. Some of these are:

a. Lack of adequate protective properties for the desired period or under specific service conditions.

b. Possible damage to organic components.

c. Possible creation of toxic or explosive conditions.

d. Difficult removal.

e. Introduction of latent corrosive effects.

2. **Guidelines.** The designation or approval of a compound is based on the demonstrated ability of a specific product or class of products to perform the specific functions required, without accompanying deleterious effects, as indicated by QPL or other appropriate tests. The corrosion preventive to be used should be determined as follows:

a. It is designated for the particular end use by documents such as manuals, equipment or general specifications or detail shipbuilding specifications. In this connection, the fact that a product complies with a military or other material specification does not constitute authorization for general use.

b. In those instances where no corrosive preventive is designated by document for the end use desired, assistance from NAVSEC should be solicited, furnishing detailed information concerning the specific item end use and environment.

c. Corrosion preventive compounds designated and/or qualified for the specific end use shall be applied to machinery, equipment and ship components whether or not installed on a ship.

## SECTION VI. BOATS AND SMALL CRAFT

### 9190.181 GENERAL

After adequate surface preparation, surfaces of boats (except inflatable boats) as described in chapter 9820 must be coated in accordance with one of the following procedures.

1. **Painted Wood (Except Underwater).** One coat aluminum paint and two coats finish paint.

2. **Unpainted Wood.** Wood filler, Fed. Spec. TT-F-336b, if necessary; stain, formula 49, 50, 51, 52, or 54 if desired; four coats varnish, formula 80. Surfaces below the level of floors or walking flats, forepeaks or transom compartments should not be painted, but should be treated with a heavy brush coat of wood preservative, Mil. Spec. MIL-W-18142B.

3. **Metal Surfaces (Except Underwater).** One coat pretreatment, formula 117; two coats primer, formula 84 or 116 (use 84 for aluminum surfaces); and two coats finish paint. Only one priming coat and one finishing coat are required for surfaces not exposed to the weather. Ferrous surfaces on topside of wood landing craft should be abrasive blasted and receive one coat of NAVSEC approved inorganic zinc silicate coating (see note (r) to tables 1 and 2), one coat of Formula 119 and one coat of suitable color of Formula 122.

4. **Plastic Surfaces (Except Underwater).** One coat pretreatment, formula 117, and two coats finish paint where required for color. Where the color of plastic is satisfactory, painting is not required.

5. **Voids.** Inner surfaces of voids of small steel landing craft where surface preparation and application of paint are difficult should be coated with thin film rust preventive, Mil. Spec. MIL-C-16173, Grade 1.

### 9190.182 UNDERWATER

1. After adequate surface preparation, apply to underwater metal surfaces one coat of pretreatment, formula 117, followed by one of the following:

a. Four coats of vinyl primer, formula 119 or 120 applied to a total minimum dry film-thickness of 6.5 mils (use only formula 120 for aluminum surfaces).

b. Three coats of anticorrosive, formula 14N (14ND) applied to a total minimum dry film thickness of 5 mils. Formula 117 may be omitted if ventilation requirements make its use impractical.

c. Finish coats as specified in paragraph 2.

2. Apply finish coats for underwater surfaces as follows:

a. **Boats, dry-berthed on shore.** None for metal or plastic boats. Appropriate finish coats should be applied when placed into service. Wood boats should receive finish coats as specified in paragraph e.

b. **Boats wet-berthed in fouling waters.** Two coats of vinyl antifouling, formula 121, or three coats of cold plastic antifouling, formula 105. Formula 121may be applied over aged, tightly adhering anticorrosive formula 14N (14ND) but allowing 48 hours drying time prior to application.

c. **Boats stored on ships in service.** Two coats black cold plastic antifouling, formula 146/50, or black antifouling, formula 129, or as specified in paragraphs d and e.

d. **Boats issued for individual use of an officer of flag rank and boats issued to hospital ships.** Two coats medium green paint, Federal Specification TT-E-490. Class A.

e. **Boats operating in nonfouling waters.** Two coats of black paint, formula 24, or Federal Specification TT-E-490. Class A.

3. Wood surfaces treated with wood preservative and plastic surfaces should receive one coat of pretreatment, formula 117, and finish paints as specified in paragraph 2. Formula 117 may be omitted where ventilation requirements make its use impractical. Untreated wood surfaces do not require pretreatment. Formula 117 must be used under vinyl or vinyl-alkyd paints. Vinyl paints should not be used on oil-soaked bottoms.

4. The bottom paint should extend from the keel to the painted waterline scribed in the hull or six inches above the normal water line which is the water line at which the boats will float under the following loading:

a. **Pulling boats.** Full outfit and maximum number of persons permitted to be carried.

b. **Power boats.** Full outfit, full fuel and one-half the maximum number of persons permitted to be carried.

5. Where there is a structural fender approximately tangent to the upper limit of the bottom paint, the bottom paint system may be carried up to, and may follow the lower side of the fender if it improves the appearance.

### 9190.183 MISCELLANEOUS

1. Boat hooks, oars, and boat flag and pennant staffs should be finished in natural wood and varnished.

2. Canvas canopies should be painted on the outside with canvas preservation Federal Specification TT-P-595. The underside of canvas canopies should not be painted. All other canvas, such as curtains for cockpits and gangway, should not be painted.

3. Side running light boxes should be finished with black, formula 104, on their inner surfaces. Outer surfaces should be painted to match surrounding structure.

4. Cylinders of carbon dioxide fire extinguishers should be finished with red, formula 40. All operating parts should be left bright, especially the valve and the distant control gear on built-in units. Piping, except nozzles, should be painted to conform with the colors of adjacent bulkheads. Special care must be taken to keep discharge nozzles free from paint.

### 9190.184 OPEN BOATS

1. Surfaces other than underwater body of pulling boats, motor launches, utility boats or motor whaleboats

should receive a finish coat of gray, formula 5H, except as otherwise specified.

2. The parts enumerated below of pulling boats, motor launches, utility boats and motor whaleboats should be given four coats of varnish, formula 80:

a. Awning stanchions, wood.
b. Backboards.
c. Capping and clamp at gunwale (except clamps made of yellow pine which should be painted in accordance with 1).
d. Decks and flats at level of gunwales.
e. Flagstaffs.
f. Platforms on level of thwarts.
g. Stretchers.
h. Structural fenders of gunwale (half-round or built-up).
i. Thwarts.
j. Tillers.
k. Top of rudders above lower edge of fender at gun-wale.
l. Towing posts.

3. Fittings, such as bitts, chocks, cleats, cutwater, fender facings when of brass, should be left bright.

4. Transom angles, frame clips, breasthooks, caps for shaft logs, and lifting pads should be left bright.

5. Engine exhaust pipes should be left bright.

### 9190.185 CABIN BOATS

1. The outside of the hull between the level of the deck and the underwater portion should receive a finish coat of gray, formula 5H, except as otherwise specified.

2. Motorboats assigned for the individual use of officers of flag rank, should be finish-painted black, formula 24, or Federal Specification TT-E-489, Class A on the outside of the hull between the level of the deck and the underwater portion. Use formula 117 as a priming coat under vinyl-alkyd paint in lieu of aluminum paint.

3. Closed-in compartments, which are not exposed to view from the outside should be finished with white, formula 30, down to the level of the floors or walking flats, as the case may be.

4. Surfaces below the level of the floors or walking flats, forepeaks, or transom compartments should not be painted, but should be treated with a heavy brush coat of wood preservative, Mil. Spec. MIL-W-18142B.

5. The following should be given four coats of varnish:

a. Benches.
b. Coamings.
c. Cockpits.
d. Decks.
e. Gunwales.
f. Locker tops.
g. Waterways.
h. Woodwork above level of deck.
i. Main bulkheads which can be seen at a distance from the outside except those already coated with paint.

6. Brass fittings, such as rails, port rims, voice tubes, cleats, bell and bell brackets and steering wheel should be left bright.

7. The exterior of brass and copper ventilator cowls on motorboats assigned to officers of flag rank should be left bright. Brass ventilator cowls on other motorboats should be painted on the outside, but the rim should be polished. The ventilator cowls on the inside should be finish-painted red, formula 40.

8. Aluminum canopies and fittings should be painted. Metal hoods, and spray shields should be finish-painted on the outside with gray, formula 5H, except on flag rank boats used as barges and gigs and hospital ship boats which should be white, formula 30. All hoods on the inside should be finish-painted with white, formula 30.

### 9190.186 BOATS FOR HOSPITAL SHIPS

Boats should be finish-painted white, formula 6. This includes the side planking (except underwater body), transom and inside of hull down to the footings or walking flats. On closed motor boats, the interior white should be formula 30. The cockpits and other parts ordinarily finished bright on other boats should be finished bright on boats for hospital ships. Surfaces below the level of floors or walking flats should not be painted but should be treated with a heavy brush coat of wood preservation, Mil. Spec. MIL-W-18142B. Identification should be as specified in article 9190.157.

### 9190.187 IDENTIFICATION MARKINGS

See chapter 9820, **Naval Ships Technical Manual,** for proper identification markings.

### 9190.188 SEARCH AND RESCUE AVR's

1. Sixty-three-foot, 45-foot, and 40-foot search and rescue AVR's should be painted in accordance with section VI of this chapter, except as follows, with respect to finish coats:

a. Underwater wood hulls: two coats of vinyl anti-fouling, formula 121, should be used.
b. The hull (except underwater body) should be finish-painted with white enamel, Fed. Spec. TT-E-490C, Class A.
c. Weather decks should be finish-painted with brilliant yellow enamel, FED-STD-595 Color No. 13538, Fed. Spec. TT-E-490C, Class A.
d. Exposed painted surfaces above weather decks should be finish-painted with international orange enamel, FED-STD-595 Color No. 12197, Fed. Spec. TT-E-490C, Class A.
e. Wood surfaces not required to be painted and inside trim should be given four coats of varnish, formula 80.
f. Distinguishing figures (call sign identification) should be painted with black, formula 24, using figures of suitable size and location so as to be visible from the air.

2. Nineteen-foot search and rescue AVR's should be painted in accordance with section VI of this chapter, except as follows, with respect to finish paints.

a. The hull (except underwater body and above gunwale) should be finish-painted with white enamel, Fed. Spec. TT-E-490C, Class A.
b. All surfaces requiring painting above the gunwale should be finish-painted with international orange enamel, FED-STD-595 Color No. 12197.

3. Previously existing coatings should be removed prior to application of these coatings. Surface preparation and manner of application should be in accordance with manufacturer's instructions. Type and number of coats should be as indicated.





### 9190.189 PLASTIC BOATS

1. **Surface Preparation.** Prepare surfaces of plastic for painting by brush blasting or other mechanical means to remove parting compounds and other contaminants. Care should be taken not to damage any of the fiberglass underlay.

2. **Painting.** One coat pretreatment, Formula 117, and two finish coats as required. For underwater, painting should in accordance with article 9190.182 except that anti-corrosive paint is not required.

## SECTION VII. SPECIAL ITEMS OF SHIPBOARD EQUIPMENT

### 9190.191 MISCELLANEOUS—COATINGS REQUIRED

The items listed should be coated as indicated:

**TABLE 16. COATINGS FOR MISCELLANEOUS ITEMS**

| Item | Paint system | Notes |
|---|---|---|
| Anchor chain and securing chains | Asphalt varnish, Fed. Spec. TT-V-51c. | (a) |
| Antenna insulator fittings. | 2-116D | (b) |
| Bilge keels (internal surfaces). | Mil. Spec. MIL-C-16173c Grade 1 rust preventive. | (c) |
| Catapult launching valves and exhaust tees: lagging on | Epoxy coating, MIL-P-23236, Cl. 1 | (r) |
| Exterior canvas and life floats (rafts). | Gray canvas, preservative, TT-P-595 | (d) |
| Fire plugs and foam discharge valves | 1-117; 1-116; 1-40 | (e) |
| Furniture and joiner doors | As specified in Mil. Spec. MIL-F-902 | (f) |
| Helmets | TT-E-00490 (Haze Grey) | |
| Inaccessible surfaces (galvanized and non-ferrous). | (a) Unpainted | (g) |
| | or | |
| | (b) 1-117; 2-14N | (g) |
| | (c) 1-117; 2-116 | (g) |
| Inaccessible surfaces (ungalvanized steel). | | (h) |
| | (a) MIL-P-23236 Cl. 3 | (r) |
| | (b) 1-117; 2-116 or 2-84 | (i) (s) |
| | (c) MIL-C-11796, C1. 1 or 1A | |
| Messenger buoys | 1-117; 2-116; 2-Intn'l orange (TT-E-490c) | (j) |
| Propellers (composition or corrosion-resistant). | Clean and polish bright | |
| Rings buoys | 3-orange plastic compound | (j) |
| Rudders and skegs (internal surfaces). | Mil. Spec. MIL-C-16173C Grade 1 rust preventive. | (c) |
| Shafting, inboard | 1-117; 2-116; 1-111 | |
| Shafting, outboard | Mil. Spec. MIL-R-15058F or resin-glass cloth coating and anti-fouling as for item 1 for exterior metal surfaces. (see article 9190.111.) | (k) (p) |

**TABLE 16. COATINGS FOR MISCELLANEOUS (Continued)**

| Item | Paint System | Notes |
|---|---|---|
| Shaft tube (internal) | 1-117; 3-14N or 119 | |
| Smoke pipes | 2-Mil. Spec. MIL-P-14276 | (l) |
| Sonar equipment (rubber) | See Note | (m) |
| Sonar equipment (steel) | 117; 119, 121 | (m) |
| Structure behind insulation | 2-116 | |
| Ventilation ducts and trunks (ungalvanized steel) | 1-117; 2-84 or 116 unpainted | (n) |
| Seamless coating for small objects | Plastisols-see art. 9190.168 | |
| Surfaces subject to exposure to MIL-H-19457 hydraulic fluid | See article 9190.170. | |
| Turntable pits (LST's) | Mil. Spec. MIL-P-23236, Class 1 or 2. | (q) |

NOTES TO TABLE 16

(a) To be marked in accordance with requirement of chapter 9260.

(b) Remainder of rigging and insulators should be kept entirely free of paint.

(c) Ventilate after application to remove solvent vapors. If desired, rudders may be coated by floating rust preventive on water, filling rudder and allowing to drain.

(d) Use of haze gray vinyl paint, formula 122-27, over canvas preservative is approved for canvas normally stowed in a vertical or near vertical position, where this color is considered specially desirable. Preservative coating is not required where approved synthetic materials are used in lieu of canvas.

(e) Except for moving parts, use two priming coats and two finish coats on exterior surfaces.

(f) Unpainted aluminum (bright) surfaces should be waxed.

(g) Nonferrous surfaces should not be painted; galvanized and aluminum surfaces in contact with sea water or exposed to the weather should be coated. Use formula 84 for aluminum surfaces.

(h) For bilge wells, peak spaces, machinery and crane foundations, annular void spaces in shaft strut hubs, and void spaces in shaft tubes around the shaft bearing bushings.

(i) For inaccessible portions of steel joiner work and surfaces of areas under built-in furniture and behind insulation. Omit formula 117 in confined spaces where necessary safety precautions are not practical.

(j) International orange plastic compound; apply to clean, dry, grease-free surface, allowing 24 hours drying time between coats. Orange plastic buoys should not be painted. The painting of lifesaving ring buoys is an interim measure. Orange-colored ring buoys will be available for issued when present stocks of gray buoys are exhausted.

(k) See Mil. Spec. MIL-R-15058F for application instructions. No anticorrosive paint should be applied. Nonferrous surfaces should receive 1 coat pretreatment, formula 117, in lieu of rubber covering.

(l) The outer surface of the uptakes and inner surface of the stack should be painted with two coats of heat resistant paint, Mil. Spec. MIL-P-14276, over bare steel. Exterior surfaces should be painted as specified for other exterior vertical surfaces, except that black paint, formula 24, shall be painted on top of stack as prescribed by Fleet and Force Commanders. The following may be used as a guide.

(1) Stacks without watchcaps—The top of each stack should have a black band painted to a depth of one-third of the stack, fore-and-aft, dimension.

(2) Stacks with well defined watchcaps—only the watchcaps should be painted black.

(3) Combined mast/stack configuration--only about 4 feet of the uppermost portion of the stack should be painted black.

Use of black paint on areas which may be subject to combustion exhaust gas discoloration (such as platforms, supports, etc.) is also authorized (see note (j)1. to tables 1 and 2).

(m) See article 9190.148 for details regarding painting of all sonar underwater parts, that is the domes, hoists, transducers, sea chests, and baffles.

(n) Internal ungalvanized steel surfaces of ventilation exhaust ducts or trunks for a distance of 10 feet from the weather terminal and all internal ungalvanized steel surfaces of ventilation supply ducts or trunks should be painted with one coat of wash primer, formula 117, followed by two coats of formula 116. Internal surfaces of aluminum, galvanized steel, or CRES ducts should not require painting, except that surfaces subject to severe exposure conditions, such as may occur on submarines, shall receive 1 coat pretreatment, formula 117, two coats vinyl primer, formula 119, and two coats vinyl-alkyd paint, formula 122. External surfaces should be painted as specified for the surrounding structure. Synthetic rubber coatings (see article 9190.166) or vinyl plastics (see article 9190.168) should be used where acid-resistant coating is required.

(o) Surfaces should be clean, dry and free of rust, paint, oil, grease, and other foreign matter. Sanding, wire brushing, or other means should be used to obtain as clean a surface as practical. Apply coatings as recommended by the manufacturer. Apply epoxy systems to a minimum dry film thickness of 8 mils and coal tar-epoxy systems to a minimum dry film thickness of 15 mils.

(p) Detailed instructions for the application of resin-glass cloth coating is covered in NAVSHIPS 250-634-4 of October 1962 - Instruction Manual, Glass Reinforced Plastic Coatings for Propeller Shafting.

(q) Steel surfaces must be abrasive blasted prior to application of coatings conforming to MIL-P-23236.

(r) When abrasive blasting has been accomplished, apply one coat of MIL-P-23236, Class 3. Overcoating of inorganic zinc coating not required.

### 9190.192 PAINTING OF PARAVANES, TYPES D, M, AND S (TYPE C)

1. **External Surfaces of Paravanes and Related Components.** External surfaces of paravanes and related components, such as unattached planes and tenders (type D) on which paint is required should be prepared and painted as follows:

a. A clean, slightly roughened surface is desired for application of paint. Each coat of paint should completely and evenly cover the surface in a full wet layer. This is particularly important for the pretreatment and prime coats. For spray application of coatings which dry rapidly, care should be taken to avoid conditions which tend to produce "dry spray." Properly applied coats of all paints specified herein will appear wet and shiny when applied. Complete coverage of each coat of paint can best be assured by having each coat of a different color.

b. This system is specified herein. On roughened surfaces it is necessary to apply the paint in sufficient thickness so that all of the high spots (peaks) are covered with at least 2 mils of paint (a mil is 0.001 inch). In general, an overall dry film thickness of 5 mils is sufficient to accomplish this. Use of an "Elcometer" or similar portable paint thickness measuring instrument is recommended. Edges and corners are always difficult to keep painted. They should, whenever practical, be rounded slightly and given an extra coat of primer. Open stowage of paravanes and related components should be such as to prevent water being trapped in recesses. Drain holes should be kept open.

2. **Paravanes and Related Components Being Reconditioned:**

a. Round sharp edges slightly.

b. Remove oil and grease with Mineral Spirits (Fed. Spec. TT-T-291b, Grade 1) or solvent emulsion cleaner (Mil. Spec. MIL-C-20207).

c. Abrasive blast metal surfaces normally painted to remove all old paint, dirt, and rust.

d. Coat cleaned surfaces immediately with one coat of pretreatment, formula 117.

e. Apply so as to obtain relatively good hiding of each, alternate coats of vinyl red lead and vinyl zinc chromate primer (formulas 119 and 120) in heavy wet coats to a total dry film thickness of not less than 3 mils. Apply an additional coat to edges. Coating by spray is recommended.

f. Top coats using two coats of vinyl-alkyd haze gray paint formula 122-27 to a total dry film thickness of not less than 5 mils.

g. Bearing surfaces of moving parts should be kept free of paint.

3. **Touchup Painting of Paravanes Related Components**

a. Remove rust and loose paint to the greatest practical extent by scraping, wire brushing, sanding, or a combination thereof. Use of power tools in advocated.

b. Coat cleaned surfaces immediately with one coat of pretreatment. formula 117.

c. Apply alternate coats of red lead type primer, formulas 116 and 116D, to a total minimum dry-film thickness of 2.5 mils. Apply an additional coat to edges; or apply two alternate coats of formulas 14N and 14ND to a total minimum dry-film thickness of not less than 3.0 mils.

d. Top coat using two coats of haze gray paint, formula 5-H-to a total dry-film thickness of not less than 5 mils.





## SECTION VIII. MATERIALS

### 9190.201 GENERAL

1. Only paints and varnishes which are in accordance with Navy Standard formulas and specifications should be used on board ship. The Revised Master Allowance List, Part III, contains paint allowances for all ships. With few exceptions these are furnished in a form ready for application without the addition of thinners or driers. Materials such as kerosene should never be mixed into paint. Dry pigments should not be added to produce shades; only properly ground tinting pastes should be used for this purpose.

2. Ships should not submit a requisition for paints other than those mentioned herein except for a necessity which must be specifically stated on the requisition (including intended end use of materials). Either the formula or specification number for the purpose for which the paint is to be used should be stated on ships' requisitions. If the formula number only is given, the edition (date) of this chapter should also be given. Ships receiving a standard paint, which in quality or quantity is not satisfactory, should immediately determine exactly and to what extent the defects exist and if possible determine the cause of the defects and report the findings to the Chemistry Laboratory at Norfolk, Naval Shipyard or the Paint laboratory at San Francisco Bay Naval Shipyard (with a copy to NAVSEC). In the case of quality defects, on original unopened container of the material also should be submitted with the report of findings, for laboratory examination. The invoice number under which the paint was received should be stated in the correspondence for identification. The date of manufacture of each particular kind of ready-mixed paint is stamped on the can containing such paint and should also be referred to in reporting unsatisfactory paint. Ship receiving special paint (paints other than those herein mentioned) should, if possible, compare it with a standard paint intended for the same purpose and submit to NAVSEC a complete report covering the results obtained. (See section IX.)

### 9190.202 STORAGE

Paint should be stored in a cool, dry area, in cans kept tightly sealed and marked with the name, formula number, and date of manufacture. Cans should be turned bottom up at least once every three months. When new stocks are obtained, they should be stored so that the oldest paint will be used first. The contents of any cans over two years old shall be inspected and, if unfit, should be surveyed. If it is questionable whether the paint is suitable for reworking, particularly where large quantities are involved, representative samples should be forwarded to a paint laboratory such as Norfolk Naval Shipyard and San Francisco Bay Naval Shipyard for resolution.

### 9190.203 MIXING

1. Paints should not be used until they are thoroughly mixed. Improper mixing is considered to be one of the principal reasons for poor paint performance. Mechanical paint agitators (shakers) should be used wherever possible.

2. When opening a can, if a skin has formed on the surface, it should be carefully removed and discarded.

3. Paint must be thoroughly stirred until all lumps, cake, and sediment are completely dispersed. This can be accomplished in accordance with the following procedure:

a. Pour the top two-thirds into another can.

b. Stir the pigment and liquid left in the first can until smooth. A paint mixing attachment for use with electric or pneumatic drill is suitable for this purpose.

c. Gradually add the contents of the second can to the first can, continuing to stir.

d. Box; i.e., pour the paint between the two cans until uniformly smooth.

4. If any particles and skins do not dissolve after stirring, they should be removed by straining the paint through wire screen or cheese cloth.

5. Tinting pastes, if used, must be mixed similarly before adding to the paint; measured carefully, and stirred in until no streaking occurs and the desired color is obtained.

### 9190.204 LIST OF MATERIALS COVERED BY FORMULA DESIGNATIONS

Formula designations, stock numbers, and specifications for the materials specified are tabulated below:

**TABLE 17. MATERIALS COVERED BY FORMULA DESIGNATIONS**

| Formula No. | Coating | Stock Nos. (size container) | Specification |
|---|---|---|---|
| 5H | Gray, No. 27 (haze gray) | 8010-285-8298 (5 gal.) | MIL-P-15132 |
| 5L | Gray No. 37 (light gray) | 8010-286-7739 (5 gal.) | MIL-P-15181 |
| 5N | Gray No. 7 (Navy gray) | 8010-286-7916 (5 gal.) | MIL-P-15129 |
| 5-0 | Gray No. 17 (ocean gray) | 8010-286-7917 (5 gal.) | MIL-P-1265 |
| 6 | Outside white | 8010-285-8293 (1 gal.), 8010-285-8296 (5 gal.) | MIL-P-1264 |
| 14N | Anticorrosive | 8010-550-8305 (5 gal.) | MIL-P-19453 |
| 14ND | Anticorrosive (dark) | 8010-531-8557 (5 gal.) | MIL-P-19453 |
| 15HPN | Antifouling (hot plastic) | 8010-543-7632 (600 lb.) | MIL-P-19452 |
| 19 | Green deck | 8010-286-3985 (1 gal.), 8010-286-3986 (5 gal.) | MIL-P-18214 |
| 20 | Exterior gray deck | 8010-286-9083 (5 gal.) | MIL-P-699 |
| 20L | Interior gray deck | 8010-285-4870 (1 gal.), 8010-285-4871 (5 gal.) | JAN-P-700 |
| 21 | Flight deck stain | 8010-165-4430 (5 gal.) | (1) |
| 23 | Red deck | 8010-292-1812 (1 gal.), 8010-292-1813 (gal.) | MIL-P-18210 |
| 24 | Black deck | 8010-644-4743 (1 gal.), 8010-285-4896 (5 gal.) | MIL-P-698 |
| 25 | Green shellac | 8010-165-4763 (1 gal.) | MIL-S-18000 |

TABLE 17. MATERIALS COVERED BY FORMULA DESIGNATIONS (Continued)

| Formula No. | Coating | Stock Nos. (size container) | Specification |
|---|---|---|---|
| 30 | White enamel | 8010-286-7744 (1 gal.), 10-286-7745 (5 gal.) | MIL-E-1115 |
| 34 | Antisweat binder | 8010-290-6646 (1 gal.) | MIL-P-15144 |
| 38 | Black striping | 8010-285-4903 (qt.), 10-285-4904 (gal.) | MIL-P-2856 |
| 39 | Green striping | 8010-285-4872 (qt.), 10-285-4873 (gal.) | MIL-P-2854 |
| 40 | Red striping | 8010-286-7742 (qt.), 10-286-7743 (gal.) | MIL-P-2934 |
| 41 | Brown striping | 8010-285-4907 (qt.), 10-285-4908 (gal.) | MIL-P-20090 |
| 42 | Yellow striping | 8010-285-4898 (qt.), 10-285-4899 (gal.) | MIL-P-2853 |
| 43 | Blue striping | 8010-285-4897 (qt.), 10-285-4902 (gal.) | MIL-P-2852 |
| 46 | Gray No. 46 | 8010-290-2866 (5 gal.) | MIL-P-15182 |
| 49 | Cherry stain | 8010-165-4422 (qt.) | TT-S-711 |
| 50 | Mahogany stain | 8010-281-2075 (qt.) | TT-S-711 |
| 51 | Dark oak stain | 8010-281-2072 (gal.) | TT-S-711 |
| 52 | Light oak stain | 8010-597-8226 (qt.), 10-166-0746 (gal.) | TT-S-711 |
| 54 | Walnut stain | 8010-597-8225 (gal.) | TT-S-711 |
| 67 | Slate color putty | 8030-275-8097 (12½ lbs.) | TT-P-791, Type 2 |
| 80 | Phenolic varnish | 8010-234-5176 (qt.), 10-166-1669 (gal.) 8010-251-6980 (5 gal.) | MIL-V-1174 |
| 84 | Zinc chromate primer | 8010-161-7419 (1 gal.), 10-165-8557 (5 gal.) | TT-P-645 |
| 84B | Brown, After Pickling Primer | | MIL-P-23316 |
| 84D | Zinc chromate primer (dark) | 8010-169-7082 (1 gal.), 10-169-7083 (5 gal.) | TT-P-645 |
| 102 | Zinc dust paint | 8010-290-6645 (5 gal.) | MIL-E-15145 |
| 104 | Dull black | 8010-286-7854 (1 gal.), 10-285-8294 (5 gal.) | MIL-P-15146 |
| 105 | Antifouling, red (cold plastic) | 8010-290-6651 (5 gal.) | MIL-P-19451 |
| 109 | Gray, No. 11 | 8010-285-8297 (5 gal.) | MIL-P-15183 |
| 111 | Light gray enamel | 8010-285-4868 (1 gal.), 10-285-4869 (5 gal.) | MIL-E-15095 |
| 116 | Red lead primer | 8010-165-8573 (1 gal.), 10-165-8574 (5 gal.) | MIL-P-17545 |
| 116D | Red lead primer (dark) | 8010-281-7399 (1 gal.) | MIL-P-17544 |
| 117 | Pretreatment coating | 8030-165-8577 (5 gal.) | MIL-P-15328 |
| 119 | Red lead primer (vinyl) | 8010-722-7119 (5 gal.) | MIL-P-15929 |
| 120 | Zinc chromate prime (vinyl) | 8010-753-4714 (5 gal.) | MIL-P-15930 |
| 121/63 | Antifouling, red (vinyl) | 8010-879-1103 (5 gal.) | MIL-P-15931 |
| 122-$R_0$1.8 | Black enamel | 8010-871-3477 (5 gal.) | MIL-E-24306 |
| 122-$R_0$3.6 | Dark gray enamel | 8010-866-8275 (5 gal.) | MIL-E-24292 |
| 122-$R_0$6 | Gray enamel | 8010-998-4813 (5 gal.) | MIL-E-24307 |
| 122-7 | No. 7 gray (Navy gray), (vinyl alkyd) | 8010-285-7013 (5 gal.) | MIL-P-15934 |
| 122-11 | No. 11 gray (vinyl alkyd) | 8010-285-7014 (5 gal.) | MIL-P-15935 |
| 122-17 | No. 17 gray (ocean gray), (vinyl alkyd) | 8010-285-4894 (5 gal.) | MIL-P-16188 |
| 122-27 | No. 27 gray (vinyl alkyd), (haze gray) | 8010-634-7324 (5 gal.) | MIL-P-15936 |
| 122-37 | No. 37 gray (vinyl alkyd) | 8010-290-2859 (5 gal.) | MIL-P-16501 |
| 122-46 | No. 46 gray (vinyl alkyd) | 8010-290-2858 (5 gal.) | MIL-P-16502 |
| 122-82 | White (vinyl alkyd) | 8010-286-9082 (5 gal.) | MIL-P-16738 |
| 124/58 | White (chlorinated alkyd) | 8010-577-4738 (1 gal.), 10-577-4739 (5 gal.) | MIL-E-17970 |
| 125/58 | Pastel green (chlorinated alkyd) | 8010-577-4734 (1 gal.), 10-577-4735 (5 gal.) | MIL-E-17971 |
| 126/58 | Bulkhead, gray (chlorinated alkyd) | 8010-577-4736 (1 gal.), 10-577-4737 (5 gal.) | MIL-E-17972 |
| 129 | Antifouling, black (vinyl) | 8010-290-4247 (5 gal.) | MIL-P-16189 |
| 133 | Rubber Tie Coat | 8010-823-7910 (1 gal.) | MIL-P-22298 |
| 134 | Rubber antifouling | 8010-823-7911 (1 gal.) | MIL-P-22299 |
| 146/50 | Antifouling, black (cold plastic) | 8010-290-8698 (5 gal.) | MIL-P-19449 |

[1] NAVSEC formula sheet.
[2] To be deleted when stocks are exhausted.
[3] Tinted to match formula 111.
[4] Procure commercially as required.
[5] Specification to be assigned.
[6] Stock number to be assigned.





**9190.205 LIST OF MATERIALS NOT COVERED BY FORMULA DESIGNATIONS**

Specifications and stock numbers of materials not covered by formula designations are tabulated in table 18:

TABLE 18. MATERIALS NOT COVERED BY FORMULA DESIGNATIONS.

| Material | Specification | Stock Nos. |
|---|---|---|
| Acetone | O-A-51 | |
| Aluminium past | TT-P-320 type II, Class B. | 8010-247-4347 (1 lb.) 8010-247-4348 (10 lb.). |
| Ammonium hydroxide | A-O-451 | 6810-527-2476 (1 qt.) |
| Asphalt varnish | TT-V-51 | 8010-160-5856 (5 gal.). |
| Calking cotton | MIL-C-269, class 2. | 5330-178-0874 (500 ft/lb.), 5330-223-7230 (420 ft/lb). |
| Single ply. | Type A. | |
| Four ply. | Type B. | |
| Calking compound | MIL-C-18969 | |
| Gun and Knife (metal and wood) | Type I | 8030-550-8652 (5 gal.) |
| | | 8030-577-4740 (1/10-gal. cartridge) |
| Knife (metal only | Type II, Class A | 8030-550-8628 (1 gal.) |
| | Type II, Class B | 8030-753-4982 (4-roll box) |
| Camouflage enamel | MIL-E-5556 | |
| Canvas preservative | MIL-C-15159 | 8030-281-2347 (1 gal.), 8030-281-2714 (5 gal.) |
| Olive drab | | 8030-281-2346 (5 gal) |
| Cement compound | MIL-C-1219 | 8030-250-4666 (5 lb.) |
| Sealing compound, wood bedding | MIL-S19653 | 8030-579-8891 (5 gal) without fabric |
| Cleaning compounds | | |
| Solvent emulsion cleaner | MIL-C-22230 | 6850-292-9700 (5-gal. pail) 6850-292-9701 (55-gal. drum) |
| Steam cleaning compound | P-C-437 | 6850-664-7056 (25 lb. dr.) 6850-256-0157 (125 lb. dr.) 6850-256-0158 (400 lb. dr.) |
| Cleaning solution | TT-C-490 | |
| Corrosion preventive compounds. | See Rust Preventive compounds. | |

TABLE 18. MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (Continued)

| Material | Specification | Stock Nos. |
|---|---|---|
| Deck Covering Compound, non-slip | MIL-D-23003 | |
| Type I (one part compound) | | |
| Dark Gray (Fed. Color 36076 | | 5610-292-9819 (5 gal.) |
| Red (Fed. Color 31136) | | 5610-541-6719 (1 gal.) |
| Haze Gray (Fed. Color 36270) | | 5610-990-1622 (5 gal.) |
| White | | 5610-990-1623 (5 gal.) |
| Yellow (Fed. Color 33538) | | 5610-722-3026 (5 gal.) |
| Type II (two part compound) | | |
| Dark Gray (Fed. Color 36076) | | 5610-857-2453 (5 gal.) |
| Haze Gray (Fed. Color 36270) | | 5610-857-4393 (5 gal.) |
| Red (Fed. Color 31136) | | 5610-857-2451 (1 gal.) |
| White | | 5610-857-2450 (1 gal.) |
| Yellow (Fed. Color 33538) | | 5610-857-4391 (1 gal.) |
| Diammonium phosphate. | Tech. grade | 6810-174-1821 (100 lbs.). |
| Enamel (gloss) | TT-E-489c. class A: | |
| Black | Fed. color 17038 | 8010-527-2050 (1 gal.) 8010-286-7725 (5 gal.) |
| Medium green | Fed. color 14110 | 8010-286-7727 (1 gal.) 8010-286-7748 (5 gal.) |
| Brilliant yellow | Fed. color 13538 | 8010-527-2045 (1 gal.) 8010-616-7488 (5 gal.) |
| Vivid orange | Fed. Color 12246 | 8010-527-3201 (1 gal.) |
| Clear blue | Fed. color 15177 | 8010-577-4225 (1 gal.) 8010-616-7492 (5 gal.) |
| Radiation purple | Fed. color 17142 | 8010-530-5559 (1 gal.) |

TABLE 18. MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (Continued)

| Material | Specification | Stock Nos. |
|---|---|---|
| International orange | Fed. color 12197 | 8010-527-3200 (1 gal.)<br>8010-616-7495 (5 gal.) |
| High-light buff | Fed. color 13578 | 8010-584-3081 (1 gal.)<br>8010-584-3082 (5 gal.) |
| White | Fed. color 17875 | 8010-664-4761 (1 gal.)<br>8010-286-9088 (5 gal.) |
| (Tinting colors for white (chlorinated alkyd) 124/58) | MIL-C-22325 | |
| Beach sand | | 8010-577-4929 (½ pint) |
| Yellow gray | | 8010-577-4930 (½ pint) |
| Green gray | | 8010-577-4931 (½ pint) |
| Rosewood | | 8010-577-4928 (½ pint) |
| Sunglow | | 8020-577-4932 (½ pint) |
| Clipper blue | | 8010-577-4933 (½ pint) |
| Pearl gray | | 8010-899-0685 (½ pint) |
| Pastel blue | | 8010-899-0686 (½ pint) |
| Flight deck compound | | |
| Enamel, semi-gloss, silicone alkyd-color 26270 (Haze gray color 5H) | TT-E-00490 | 8010-917-2256 (5 gal.) |
| Epoxy paint for weapons | MIL-P-22750 | 8010-896-1980 (2 gal.) |
| Epoxy repair compound | MIL-C-24176 | |
| Galvanizing repair paint | MIL-P-21035 | |
| Insulating varnish: | MIL-V-1137 | |
| Black air drying | Grade BA | 5970-166-1675 (1 gal.),<br>5970-166-1676 (5 gal.). |
| Black, baking | Grade BB | 5970-166-1677 (1 gal.),<br>5970-166-1678 (5 gal.). |
| Insulation tape | MIL-I-7798 | 5970-644-3180 (1 in.) |
| Japan drier | TT-D-651, type I. | 8010-165-4784 (1 gal.). |
| Linseed oil (raw) | TT-L-215 | 8010-656-1639 (5 gal.). |
| Neoprene coating[2] | MIL-R-15058 type IV. | |
| Brushing cpd. and accelerator | | 8030-285-3708 (5 gal.). |
| Priming cement | | 8030-891-9702 (5 gal.). |
| Trowelling mat'l and accelerator. | | 8030-285-1568 (1 lb.). |
| Tie cement | | 8030-285-1569 (1 gal.). |
| Oakum | T-0-56, class 1 | 5330-191-5679 (50 ft/lb.). |
| Packing material | | 5330-171-6560 (coil) |
| Paint dryers | TT-D-643 | |
| Cobalt base | | 8010-165-4782 (1 qt.) |
| Leadbase | | 8010-165-4792 (1 gal.) |

TABLE 18. MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (Continued)

| Material | Specification | Stock Nos. |
|---|---|---|
| Paint, heat resisting | MIL-P-14276 | 8010-815-2692 (1 gal.),<br>8010-857-1938 (5 gal.). |
| Paint and Varnish remover | TT-R-251, Type III. | 8010-165-4447 (5 gal.). |
| For horizontal surfaces. | Class A, low viscosity. | |
| For vertical surfaces | Class B, high viscosity. | 8010-286-2860 (1 gal.),<br>8010-286-2861 (5 gal.). |
| Paint stripping pound (silicate type). | C-67 | 8010-169-7091 (300 lb.). |
| Pickling inhibitor | O-I-501 | |
| Plastic compound (orange). | | 8030-281-2721 (5 gal.) |
| Plastic foam | MIL-P-15280 | |
| Plastisol coating (Vinyl) | MIL-P-20689 | |
| Black | | 803-682-6787 (1 gal.) |
| White | | 8030-682-6788 (1 gal.) |
| Gray | | 8030-682-6789 (1 gal.) |
| Dark Green | | 8030-682-6790 (1 gal.) |
| Red | | 8030-682-6791 (1 gal.) |
| Tan | | 8030-682-6792 (1 gal.) |
| Blue | | 8030-682-6793 (1 gal.) |
| Yellow | | 8030-682-6794 (1 gal.) |
| Purple | | 8030-682-6795 (1 gal.) |
| Orange | | 8030-682-6796 (1 gal.) |
| Light Green | | 8030-682-6797 (1 gal.) |
| Chartreuse | | 8030-682-6798 (1 gal.) |
| Primer, quick-drying. | TT-P-664 | 8010-292-1127 |
| Primer coating | | |
| Color T (green) | MIL-P-8585 | 8010-582-5318 (1 gal.) |
| Color Y (yellow) | MIL-P-8585 | 8010-515-2208 (1 gal.) |
| Color Y (yellow) | MIL-P-8585 | 8010-515-2211 (5 gal.) |
| Putty, white | TT-P-791 Type II. | 8030-243-0953 (4½ lb.). |
| Remover, paint, epoxy | MIL-R-81294 | 8010-296-1488 (5 gal.).<br>8010-296-1489 (55 gal.).<br>8010-296-1490 (bulk). |
| Resin compound thermosetting | MIL-R-23461 | |
| Repair Kit, glass reinforced plastic laminate | MIL-R-19907 | 2040-372-6064 |
| Rubber preservative | MIL-C-11520 | 8030-201-1103 |
| Rust retarding (flotation). | MIL-R-21006 | 8030-543-7724 (55 gal.) |
| Rust preventive (spray-on type) | MIL-C-23050 | |





TABLE 18. MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (Continued)

| Material | Specification | Stock Nos. |
|---|---|---|
| Rust preventive (thin film). | MIL-C-16173: | |
| | Grade 1 | 8030-244-1302 (1 gal.), 8030-244-1299 (5 gal.). |
| | Grade 2 | 8030-244-1297 (1 gal.), 8030-244-1298 (5 gal.). |
| | Grade 3 | 8030-244-1296 (1 gal.), 8030-244-1293 (5 gal.). |
| Rust preventive (thick film) | MIL-C-11796 Class 1 | 8030-597-3288 (35 lb.)<br>8030-231-2352 (400 lb.) |
| | Class 1A | 8030-514-1843 (400 lb.) |
| Corrosion preventative oil, nonstaining | MIL-C-22235 Type A | 8030-255-4447 (5 gal.)<br>8030-255-4448 (55 gal.) |
| Rust removing and metal conditioning compound | | |
| Phosphoric acid base | MIL-M-10578 Type 1 | 6850-664-2302 (1 gal.) |
| Petroleum base | MIL-M-15205 Type II (heavy) | 8030-255-4445 (5 gal.)<br>8030-255-4446 (55 gal.) |
| Sealing compound wood bedding fortified | MIL-S-19653 | ([1]). |
| Smoothing cement | MIL-C-24176 | |
| Sodium nitrite | U.S.P. grade | 6505-180-9987 (100 lb.). |
| Solvents: | | |
| Coal tar naphtha. | MIL-N-15178 | 6810-244-1207 (50 gal.) |
| Ethyl alcohol (denatured). | JAN-A-463 | 6810-222-2373 (5 gal.). |
| Lacquer thinner | TT-T-266 | 8010-160-5787 (1 gal.). |
| Methyl ethyl Ketone. | TT-M-261 | 6810-281-2762 (5 gal.). |
| Methyl isobutyl Ketone. | TT-M-268 | 6810-281-2761 (55 gal.). |
| Mineral spirits | TT-T-291, Grade 1. | 8010-242-2086 (5 gal.). |
| Synthetic enamel thinner. | TT-T-306. | 8010-160-5794 (1gal.),<br>8010-160-5795 (5 gal.). |
| Turpentine | TT-T-801. | 8010-290-1180 (5 gal.) |
| Xylol | TT-X-916. | 6810-290-4166 (55 gal.). |
| Stencil paint, black | MIL-P-15149. | 8010-290-4134 (1 gal.),<br>8010-290-4135 (5 gal.). |

TABLE 18. MATERIALS NOT COVERED BY FORMULA DESIGNATIONS (Continued)

| Material | Specification | Stock Nos. |
|---|---|---|
| Vermiculite | MIL-V-15196. | 8010-247-4325 (50 lb.). |
| Wood filler | TT-F-336. | 8010-243-0963 (1 gal.). |
| Wood preservative (oil borne). | MIL-W-18142. | |
| Copper naphthenate | Type A | 8030-281-2724 (55 gal.). |
| Tank coating | MIL-P-23236 | |
| Chlorinated phenol. | Type B | 8030-281-2717 (5 gal.),<br>8030-281-2718 (55 gal.). |
| Zinc yellow primer | TT-0-666 | 8010-161-7339 (1 gal.)<br>8010-161-7254 (5 gal.) |

[1] Stock number to be assigned.

[2] To insure compatability of each item with the components of this system, all items being used must be products of the same manufacturer.

### 9190.206 STANDARD STOCK PAINT APPLICATION EQUIPMENT

The equipment tabulated in table 19 is available in standard Navy stock:

TABLE 19. PAINT EQUIPMENT

| Standard Stock No. | Name and description |
|---|---|
| 8020-282-64696 | 7-inch paint roller applicator. |
| 8020-282-6495 | 9-inch paint roller applicator. |
| 8020-291-0385 | 7-inch replacement roller. |
| 8020-291-0386 | 9-inch replacement roller. |
| 4940-221-446 (AC current) or 4940-221-2445 (DC current). | Paint sprayer outfit, lightweight, Type B consisting of light duty touchup gun, pressure cup, air hose, air compressor, compressor motor and air pulsation tank or chamber; (AC or DC) (Mil. Spec. MIL-S-15297, Type B). |
| 4940-221-2447 | Paint spray outfit, Type A consisting of heavy duty spray gun, 5-gallon pressure tank, 1-quart pressure cup, two 25-foot lengths material hose, two 25-foot lengths air hose (Mil. Spec. MIL-S-15297 Type A). |
| 4940-274-2451 | 2-Gallon pressure tank (Mil. Spec. MIL-S-15297 Type A). |
| 4940-287-8799 | Heavy duty spray gun with removable 1-qt. pressure Type cup with lid and 1 extra 1-qt. cup without lid (Mil. Spec. MIL-S-15297, Type A). |

TABLE 19. PAINT EQUIPMENT (Continued)

| Standard Stock No. | Name and description |
|---|---|
| 4940-287-8800 ..... | Heavy duty spray gun with one 6-foot extension handle and one 8-foot extension handle (Mil. Spec. MIL-S-15297). |
| 4710-189-3429 (3/8-inch female coupling and male connector). | 25-foot lengths material hose with suitable fittings attached. |
| 4720-289-4611 (female coupling and male connector) (¼ female, 3/8-inch male). | 25-foot lengths air hose with suitable fittings attached. |
| 5130-310-2140 ..... | Paint mixing attachment for use with electric or pneumatic drill. |

**NOTE:** Replacement and spare parts for paint spray equipment are carried by Ships Parts Control Center, Naval Supply Depot, Mechanicsburg, Pennsylvania. When ordering parts for paint-spray equipment (other than complete spray gun assemblies, pressure tanks and meterial and air hose), the manufacturer's part numbers as well as manufacturer's name and model number of equipment for which required, must be placed on the requisition or purchase order.

## SECTION IX. COATING PERFORMANCE

### 9190.211 SERVICE TESTS

1. From time to time, NAVSEC authorizes service evaluations of experimental coatings. To be of value, it is necessary that they be inspected and reports submitted regarding performance. This inspections are usually best accomplished during overhaul availabilities.

2. The following procedures should be followed for such experimental applications:

a. Activities making experimental installations should advise the ship and NAVSEC, concerning the work accomplished.

b. Unless otherwise directed by NAVSEC, installing activities should clearly delineate the type and frequency of inspection and report required.

c. The ship concerned should maintain a record of information received in the Current Ship's Maintenance Program file and, where pertinent, the ship should include the required inspections as work items in the Ship's Work Request List.

3. Standard forms for reporting service test applications have been printed as follows:

Surface Preparation–NAVSHIPS 9190/1
Application–NAVSHIPS 9190/2
Performance Evaluation–NAVSHIPS 9190/3

Requests for these forms for specific applications should be addressed to Naval Supply Center, Norfolk or Naval Supply Center, Oakland, California.

4. To obtain data for future identification, at least a one quart sample of each component of the experimental coating system should be forwarded to the Chemical Laboratory, Norfolk Naval Shipyard (East Coast applications) or Chemical Laboratory, San Francisco Bay Naval Shipyard (West Coast applications).

### 9190.212 PAINT FAILURES

1. **Alligatoring and Checking.** This condition 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 to unseasoned wood, over a relatively soft undercoat, over previous coats before they have dried or application of hard drying inelastic paint over a more elastic paint.

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

3. **Flaking, Scaling, and Peeling.** This condition is characterized by the detachment of pieces of paint, generally irregular in shape. When pieces are small, it is termed flaking, when pieces average over ¼-inch, it is termed scaling; when pieces are large (over 1-inch), it is termed peeling. Flaking and scaling generally follow cracking and are due to the same causes. Peeling is often due to the presence of moisture behind film or incompatability of paint films.

4. **Bleeding.** This condition exists when the color of a previous coat is absorbed into the topcoat, and is usually caused by the solubility of the color ingredient of the undercoat in the vehicle of the new coat.

5. **Blistering.** This condition is characterized by the detachment and raising of unbroken areas from the underlying surface, resulting from gases or liquid (usually water) forming beneath the coating.

6. **Chalking.** This condition is characterized by the presence of a loose powder evolved from the film itself, at or just beneath the surface. Chalking may be detected by rubbing the film under the fingertips. Slight chalking is desirable because it makes the surface self cleaning. The degree of chalking is affected by the composition of the paint itself.

7. **Discoloration.** This describes an alteration in the original color and includes yellowing, darkening, fading and mottling.

## SECTION X. RECONDITIONING OF FLOODED EQUIPMENT.

### 9190.221 IMPORTANCE OF THOROUGH RECONDITIONING

Shipboard electronic, electrical, and mechanical equipment may become flooded with fresh water, sea water, fuel oil, or other hydrocarbons or combinations thereof during fire or other casualty. Since reliability is imperative, such equipment should be restored as nearly as possible to new equipment condition. Past experience shows conclusively that reconditioning must be done thoroughly to minimize the possibility of subsequent failure.

### 9190.222 SCOPE

This section covers reconditioning methods applicable to electronic, electrical and mechanical equipment including:





Radio transmitters and receivers.
Audio frequency amplifiers.
Portable electric tools.
Bracket fans.
Pumps.
Motors, 5 horsepower and under.
Galley equipment.
Adding machines.
Electronic test equipment.

This section does not apply to the following types of equipment:

Electrical equipment larger than 5 horsepower or too heavy to be placed in an oven for drying (see section V, chapter 9600).

Motors having taped windings as the primary insulation system (see articles 9600.401 to 9600.492 inclusive, section V, chapter 9600.)

Radiac, infrared and sonar equipment (see chapter 9670.122).

### 9190.223 PRECAUTION

Unprotected ferrous surfaces will rust rapidly when exposed to air (see chapter 9600.403). Therefore, arrangements should be made to proceed immediately with reconditioning operations on exposing the equipment to air.

### 9190.224 CHEMICALS

The following chemicals should be on hand before reconditioning operations begin:

1. A water-displacing formulation having the following composition:

| Chemicals | Percent By Volume |
|---|---|
| Butyl alcohol (- butanol) | 93.75 |
| 2, 6 ditertiary butyl, 4 methylphenol* | 0.25 |
| Basic barium dinonyl naphthalene sulfonate** | 6.00 |
| | 100.0 |

a. The above water-displacing compound can be formulated locally or may be ordered already formulated in drums or pressurized spray cans from the Spra-Dri Company, Division of the Perfecting Service Company, Charlotte 6, N.C. This compound is designated "Spra-Dri Formula No. 1". A similar compound containing only 0.5 percent of the rust inhibitor concentrate is available as "Spra-Dri Formula No. 2." "Spra-Dri Formula No. 2" is effective in removing water but does not leave a film on electronic equipment which would interfere with subsequent switch and relay operation.

b. In preparing the formulation locally, the oxidation inhibitor should be dissolved in the butyl alcohol and then the rust inhibitor concentrate should be added to the solution. The mixed solution should be stirred thoroughly to disperse the inhibitor.

*(This is an oxidation inhibitor supplied under the trade name "Parabar 441" and is available from Enjay Chemical CO., a division of Humble Oil and Refining Co., 15 West 51st St., New York, N.Y. 10019)

**(This is a rust inhibitor concentrate – 50 percent inhibitor in naphtha solution supplied under the trade name "NASUL (BSB)" and is available from R.T. Vanderbilt Co., Inc., 930 Park Ave., New York, N.Y. 10017)

2. A hydrocarbon cleaning emulsion having the following composition:

| Chemicals | Percent By Volume |
|---|---|
| Dry Cleaning Solvent, (140°F Solvent, Type II) | |
| Spec. FED P-S-661 (Available in 5 gallon cans under Stock Number 6850-274-5421) | 44.5 |
| Diesel Fuel Oil (Type I) Spec. MIL-F-16884 (Available in 5 gallon cans under Navy Stock Number 9140-255-7764) | 5.0 |
| Surfactant. Any of the following three surfactants may be used: (a) "Polyethyleneglycol 400, Monooleate S1006", a product of Glyco Products Co. Inc., Empire State Building, New York 1, N.Y.; (b) "Pluronic L-63" supplied by Wyandotte Chemicals Corp., Wyandotte, Michigan; or (c) "Nonisol 100" supplied by Geigy Industrial Chemicals Company, Ardsley, N.Y. | 0.5 |
| Water | 50.0 |
| | 100.0 |

In preparing the oil displacing composition, dissolve the surfactant and the diesel fuel in the dry cleaning solvent to form a hydrocarbon concentrate. Immediately prior to use, add an equal quantity of fresh water to this concentrate.

The hydrocarbon cleaning concentrate can be formulated locally or may be ordered already formulated, ready to be mixed with water, from the Gray Company, Inc., 60 Eleventh Avenue, N.E. Minneapolis, Minn., under the trade name "(CSC) Concentrate Surface Cleaner."

### 9190.225 RECONDITIONING EQUIPMENT

The following reconditioning equipment should be on hand before reconditioning operations begin:

1. Oil or spray paint guns suitable for operation at approximately 75 pounds per square inch. Note that a lower value of pressure may be required to avoid damaging certain equipment.
2. Portable hot and cold blowers.
3. Drying ovens with temperature control.
4. Ultrasonic cleaning tank with associated oscillators and amplifiers.
5. Steel tanks.

### 9190.226 RECONDITIONING PRDCEDURE

The following reconditioning procedure shall apply (the capacity and quantity of these items required will be dependent on the size and amount of equipment to be reconditioned):

1. If equipment to be reconditioned is contaminated with oil or other hydrocarbon, proceed with step 2 and subsequent steps. If not so contaminated, omit steps 2 and 3 and proceed directly to step 4 and subsequent steps.
2. Mix the hydrocarbon cleaning concentrate, article 9190.224.2 above, with an equal volume of water.

3. Spray the exterior of the equipment thoroughly with the cleaning emulsion to remove as much contaminant as possible. Flush the equipment with fresh water. Repeat the cycle if necessary until all the contaminant is removed. If access can be gained to the interior of the equipment, spray the interior thoroughly, then flush with fresh water. If the contruction of the equipment prevents access to the interior, partial disassembly for inspection and service may be required.

4. After these contaminants have been removed, flush the equipment thoroughly with fresh water to remove all traces of seawater and cleaning formulation. If possible, several cycles of alternate immersion in fresh water and draining between cycles should be employed to remove seawater not reached by flushing process.

5. Remove the last traces of sea water and contaminant from complicated equipment by the following ultrasonic treatment:

a. Disassemble the equipment as far as necessary to gain ready access of liquid to all remote locations.

b. Immerse the parts in a tank containing the hydrocarbon cleaning emulsion and an ultrasonic generator. Operate according to the instructions supplied by the manufacturer of the ultrasonic apparatus. A minimum ultrasonic power level of 300 watts per cubic foot of solution is recommended.

c. After ultrasonic treatment in the presence of the cleaning formulation, process the equipment in an ultrasonic bath in another tank using fresh water to remove the excess cleaning formulation. If another tank equipped with an ultrasonic generator is not available, flush the equipment thoroughly with fresh water.

6. Blow as much water as possible from the equipment with clean compressed air not to exceed 50 pounds per square inch pressure.

7. Spray all parts of the equipment with the water-displacing formulation, article 9190.224.1 above. This fluid must penetrate to all parts of the equipment that have been wet with water. After spraying, allow 20 minutes for the water-displacing formulation to penetrate and displace the water remaining in the equipment.

8. The residual mixture of water and water-displacing fluid should now be evaporated from the equipment by blowing with clean, heated compressed air, or heated air from an electric blower, or by placing of the equipment in an electric oven (160°F.) with good air exchange, or by simply allowing sufficient time for the equipment to air dry. (No further corrosion will take place on the equipment after it has been sprayed with the water displacing fluid.)

9. Mechanical equipment is ready for operation after drying and a thorough lubrication. On small electric motors, and other electrical equipment, operation should not be attempted until the circuit to ground resistance exceeds 8000 ohms. This resistance shall be determined by null balance methods. High potential insulation resistance measurements should **never** be made while insulating systems are wet or damp. After starting any equipment at reduced voltage, it should be operated for several hours under no load or very light load to secure gentle internal heating to complete the drying. This treatment should return the equipment to its original electrical characteristics. Operation at low voltage should be continued until the resistance between the circuit and ground exceeds the following:

1 megohm for equipment rated 450 volts and less.

A value of megohms equal to rated voltage divided by 500 for equipment rated more than 450 volts.

When the proper resistance between the circuit and ground is achieved, the equipment may be operated at its rated capacity. Electronic equipments, because of their various individual biasing resistances, do not have a fixed circuit to ground resistance value. Therefore, electronic equipment may be energized at low voltages for gentle internal heating as soon as the drying process has progressed to where all components are operable. The voltage should be increased gradually over an extended period of time until normal operating power levels are achieved. If in an unusual case, any equipment cannot be returned to operational condition by this procedure, it should be sprayed again with the water-displacing fluid and the drying process repeated as before.

10. The following precautions should also be observed in all recondition operations:

a. **Journal bearings** - remove waste packing in bearing chambers, clean as directed for other equipment above, add new packing and saturate with a suitable lubricant.

b. **Ball and roller bearings** - remove grease either by disassembly and cleaning or by forcing new grease through bearings until all old grease has been displaced.

c. **Contact brushes** - replace all electrical contact brushes and carbon contacts.

d. **Contact points in switches and relays** - remove rust inhibitor film left from the water displacing fluid on contact points, with lintless cloth soaked in naphtha solvent or ethyl alcohol.

## SECTION XI. CATHODIC PROTECTION

### 9190.231 CORROSION CONTROL

1. **General**—Although coatings are used as the principal corrosion preventive on metal surfaces, a supplemental method of protection is needed for the underwater hull and appendages of ships to safeguard against paint failures such as 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.

Corrosion resulting from a flow of current caused by potential differences between local anodes and cathodes on a metal surface in sea water, can be arrested by impressing a current of sufficient magnitude on the metal so that the potential on the cathode is essentially equivalent to that on the cathodes. If this condition is established, no current will flow between local anodes and cathodes, hence no corrosion occurs. This phenomenon is known as polarizing the cathodes or simply as polarization.

2. **Cathodic Protection Systems**—The types of cathodic protection used by the Navy are as follows:

a. Sacrificial (galvanic) Anode System

b. Impressed Current System

3. **Sacrificial Anodes**—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 the periodic replacement of anodes required. Also, in some installations the additional weight and location of anodes cannot be tolerated.

4. **Impressed Current**—In lieu of sacrificial anodes, an impressed current system can be used. This system utilizes an external source of electrical power such as that supplied by generators or rectifiers. The protective current is distributed by specially designed anodes such as platinum, lead-platinum or lead-silver. The principal advantage of the Navy's impressed current systems are the automatic control feature which continuously monitors and varies the current as required for corrosion protection.

### 9190.232 SYSTEM DESIGN-HULL

1. **General Requirements**

a. A complete galvanic (aluminum, magnesium, or zinc) anode system or an automatically controlled impressed current system should be installed on thin hull ships such as LST's, destroyers, and destroyer escorts.

b. A stern galvanic system or an automatically controlled impressed current system should be installed on heavy hull ships such as cruisers, carriers, and floating drydocks.

c. For boats and wood hull ships see 9190.238, 9190.239, and 9190.240.

2. **Wetted Hull Area**

a. Surface ships—Approximate wetted surface area (including appendages) may be calculated by the following simplified formula:

$$W = 1.7Ld + \frac{V}{d}$$

W = Wetted surface of the hull, appendages is sq. ft.
L = Length between perpendiculars, ft.
d = Molded mean draft at full displacement in ft.
V = Molded volume of displacement, cu. ft. (Approximately 35 cu. ft. per long ton for sea water).

**NOTE:** All values used are determined at full load displacement.

Example: Calculation of the wetted surface of the LST-1171.

Displacement = 7084 tons

L = 426 ft.
d = 12.2 ft.
V = 7084 X 35 = 247,940 cu. ft.

Formula for wetted surface:

$$W = 1.7Ld + \frac{V}{d}$$

$$= 1.7 \times 426 \times 12.2 + \frac{247,940}{12.2}$$

= 29,158 sq. ft. of wetted surface

b. Submarines—Approximate submerged area may be calculated by using largest diameter and treating as a cylinder taking the area of the circular surfaces only.

$W = \pi DL$
$\pi = 3.1$
D = Largest diameter of ship (bottom of keel to top of hull), ft.
L = Length, ft.

Example: D = 21 ft. bottom of keel to top of hull
L = 210 ft. length

$W = DL$
$= 3.1 \times 21' \times 210'$
= 13,700 sq. ft.

5. **Impressed Current**—Impressed current cathodic protection equipment approved by NAVSEC shall be provided. The overall system shall be capable of maintaining a uniform hull potential of 0.85±0.02 volts in sea water at 25 knots measured against a silver-silver chloride reference cell. Table 20 lists basic equipment requirements and maximum current output capabilities with respect to underwater area. Anodes shall be fabricated of platinum and tantalum in a NAVSEC approved design. Anodes and reference cells shall be located at least 5 feet below the light load waterline in areas most protected against mechanical damage. Neither anodes nor reference cells shall be located aft of the propeller plane (except for a 4 propeller ship). For four-screw ships, two anodes shall be located between the forward and aft propeller planes, one port, one starboard, and if practicable, in an area where turbulence will be minimal. In choosing locations of anodes about the underwater hull a uniform current distribution shall be the principal consideration. Secondary considerations should be given to avoiding fuel and ballast tanks, and of locating anodes in areas most protected from mechanical damage. Internal electrical components (controllers, power supplies, etc. shall be located in dry areas protected from excessive vibration and from temperatures above 125 degrees F. Controllers are to be bulkhead mounted in an accessible area for viewing.

Silver-silver chloride reference cells, conforming to MIL-E-23919 shall be equally divided port and starboard. Reference cells are to be mounted in stuffing glands conforming to MIL-S-23920.

A shaft grounding assembly conforming to NAVSHIPS drawing 805-1749216 or other NAVSEC approved equivalent, shall be provided for each shaft. It is required that the surface of the assembly ring (pc.1) on which the silver graphite brush (pc.2) makes contact shall be electroplated with 4 mils, minimum, of hard plate silver. Ships utilizing propellers of carrier size or larger shall be fitted with two brush assemblies (pc.2) on the assembly ring (pc.1).

Rudders are normally grounded, but a positive ground is assured by brazing a braided tinned copper grounding strap at least 1½ inches wide between the rudder stock and the hull.

Dielectric shields are specified about and beneath all anodes to assure good current distribution. A coal-tar epoxy coating, conforming to MIL-P-23236, Class 2, applied to a thickness of 22 mils (or other NAVSEC approved dielectric material) shall be used. The minimum length and width of

Table 20—Cathodic Protection Requirements (Surface Ships Only)

| Approx. Underwater Wetted Surface Area, Square Feet | No. of Anodes Type I, Minimum | No. of Anodes Type II, | Current Required, Amps., Minimum | No. of Controllers, Minimum | No. of Reference Cells, Minimum |
|---|---|---|---|---|---|
| 0– 10,000 | 2 | – | 150 | 1 | 2 |
| 10,000– 15,000 | 3 | – | 225 | 1 | 2 |
| 15,000– 23,000 | 4 | – | 300 | 1 | 2 |
| 23,000– 30,000 | 5 | – | 375 | 1 | 2 |
| 30,000– 40,000 | 3 | 2 | 500 | 1 | 2 |
| 40,000– 50,000 | 4 | 2 | 600 | 1 | 2 |
| 50,000– 60,000 | 6 | 2 | 700 | 1 | 2 |
| 60,000– 70,000 | 7 | 2 | 775 | 1 | 2 |
| 70,000– 80,000 | 8 | 2 | 875 | 1 | 2 |
| 80,000– 90,000 | 7 | 3 | 1000 | 2 | 4 |
| 90,000–100,000 | 8 | 3 | 1100 | 2 | 4 |
| 100,000–105,000 | 8 | 4 | 1200 | 2 | 4 |
| 105,000–115,000 | 10 | 4 | 1300 | 2 | 4 |
| 115,000–125,000 | 11 | 4 | 1400 | 2 | 4 |
| 125,000–135,000 | 8 | 6 | 1500 | 2 | 4 |
| 135,000–145,000 | 10 | 6 | 1600 | 2 | 4 |
| 145,000–155,000 | 11 | 6 | 1700 | 2 | 4 |
| 155,000–165,000 | 8 | 8 | 1800 | 2 | 4 |
| 165,000–185,000 | 10 | 8 | 2000 | 2 | 4 |

(1) For the purpose of definition, an "anode" or "anode site" refers to either a single anode or an anode array which is supplied current through a single hull penetration.

TYPE I anode–an anode designed to operate at currents up to a maximum of 75 amperes.

TYPE II anode–an anode designed to operate at currents up to a maximum of 150 amperes.

(2) The number of Type I and II anodes are additive. If the quantity of Type II anodes permitted is not installed, install a sufficient number of Type I anodes to obtain the required protective currents.

(3) The maximum current output of an anode is based on 25 ohm–centimeter sea water at the maximum operating voltage of the system.

the shields are defined by the following distances around the periphery of the anodes:

a. Four foot shield–for anodes operating up to and including 12 volts only.

b. Six foot shield–for anodes capable of operating at voltages above 12 volts.

Impressed current systems for submarines are treated as a special case. Impressed current systems designated for submarines will be limited to minimum current requirements pending the development of "SUB-SAFE" fittings. Therefore, Table 20 is not applicable to submarines.

6. **Magnesium Anodes**–Magnesium anodes shall comply with MIL-A-21412. The characteristics of magnesium are such that a dielectric shield is required in the vicinity of an anode or anode group to prevent paint damage. A coating conforming to MIL-P-23236 (Type I, Class II), or other NAVSEC approved equivalent shall be used as the dielectric shield beneath and at least two feet around the periphery of each anode group.

Magnesium anodes shall not be used (1) to protect aluminum in sea water; or (2) where more than twenty-four months of corrosion protection is required.

Magnesium anodes are preferred for the protection of steel in brackish or fresh water (in lieu of zinc or aluminum anodes) because of the higher driving potential of the magnesium.

The number (N) of magnesium anodes (36" X 10½" X 6½") required on the underwater hull is determined from the wetted area (W) as follows:

(a) Stern system (2 years protection)

$$N = \frac{0.29W}{1000}$$

(b) Complete system (2 years protection)

$$N = \frac{0.87W}{1000}$$

General information on magnesium anodes is given in Table 21.

7. **Zinc Anodes**–Zinc anodes shall comply with MIL-A-18001. Their lower driving potential and current limiting characteristic 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 on the hull beneath the zinc anodes to act as a barrier. Bolt-on ZHC type anodes should be used to facilitate replacement, unless welding of anodes, type ZHS, is specified.





Table 21. Magnesium Hull Anodes

| Type | Specific Type | End date | Size (in.) | Weight (pounds) | Current output (amps.) | Stock No. |
|---|---|---|---|---|---|---|
| MHP-135 | A | Rectangle | 36 X 10½ X 6½ | 135 | 3.0 | KZ5340-680-4051 |
| MHP-135 | B | Single Bevel | 36 X 10½ X 6½ | 135 | 3.0 | KZ5340-680-4052 |
| MHP-135 | C | Double Bevel | 36 X 10½ X 6½ | 135 | 3.0 | KZ5340-680-4053 |
| MHB-135 | A | Rectangle | 36 X 10½ X 6½ | 135 | 3.0 | KZ5340-680-4054 |
| MHB-135 | B | Single Bevel | 36 X 10½ X 6½ | 135 | 3.0 | KZ5340-680-4055 |
| MHB-135 | C | Double Bevel | 36 X 10½ X 6½ | 135 | 3.0 | KZ5340-680-4056 |

Key to symbols:
First Letter: M–Magnesium
Second Letter: H–Hull
Third Letter: B–Bolt core; P–Pipe core

The number (N) of zinc anodes, ZHS or ZHC (6" X 12" X 1¼"), required on the underwater hull is determined from the wetted area (W) as follows:

(a) Stern system ONLY (2 year life)

$$N = \frac{2.2W}{1000}$$

(b) Complete hull system (2 year life)

$$N = \frac{6.5W}{1000}$$

(c) Stern system ONLY (3 year life)

$$N = \frac{3.3W}{1000}$$

(d) Complete hull system (3 year life)

$$N = \frac{9.8W}{1000}$$

W = wetted surface area, sq. ft.

General information on zinc anodes is given in Table 22.

Table 22–Zinc Hull Anodes

| Type | Size (in.) | Weight (pounds) | Current output (amps.) | Federal Stock number |
|---|---|---|---|---|
| ZHC | 6 X 12 X 1¼ | 23.5 | 0.4 | KZ5340-813-6058 |
| ZHS | 6 X 12 X 1¼ | 23.5 | 0.4 | KZ5340-277-7559 |
| ZHB* | 6 X 12 X 1¼ | 23.5 | 0.4 | KZ5340-662-9827 |
| ZSS | 3 X 12 X 1¼ | 11.8 | 0.2 | KZ5340-290-8243 |
| ZTS | 3 X 9 X 1-3/8 | 5.0 | 0.1 | KZ5340-811-0639 |

* For wood boats (bronze fittings)

Key to Symbols:
First Letter: Z–Zinc
Second Letter: H–Hull anode; S–Submarine anode; T–Teardrop shape
Third Letter: B–Brass straps; C–Core straps; S–Steel straps

8. **Aluminum Anodes**–Aluminum anodes are currently under evaluation. Their use is being specified on a case basis.

**9190.233 INSTALLATION-HULL**

1. **Impressed Current**–Complete details for the installation should be obtained from applicable drawings and in-

structions. The following item should be emphasized during installation:

(a) Before a ship is waterborne, installation of anodes, reference cells, cofferdams, conduit in tank, stuffing tubes, and dielectric shields must be complete.

(b) Cold plastic underwater hull coating (formula 105) should not be used with the impressed current system.

(c) Anodes and reference cells may be faired with a NAVSEC approved hull smoothing compound conforming to MIL-C-24176 for minimization of noise.

(d) Antifouling paint specified for the underwater hull shall be applied over the dielectric shield, with any required tie coats.

**CAUTION!** Anodes and reference cells must not be coated or abrasive blasted. These should be masked during the drydocking period to protect them from paint and abrasives and the masking removed prior to undocking.

(e) If the anode connection or cable leads are located within fuel or water tanks, the installation shall conform to the requirements of chapter 9621.

(f) Anode-to-power supply cables are d. c. carriers and should be the shortest length practicable to minimize power losses. Voltage drops in the anode cable leads, at maximum current output, should be limited to six volts. All anode cable leads from the same power supply must be maintained within a 2-volt differential, at maximum current output. In all cases, it is desirable to maintain the lowest value possible. A type I anode frequently uses SHOF-75 cable and a type II anode, SHOF-150.

(g) Before connecting anode leads to the power supply, and prior to ship's undocking, a check should be made for shorts. Resistance between ground and any cable lead (including reference cell lead) should be at least 1 megohm.

With the hull waterborne (sea water) voltage readings between the anode leads and the hull should be between 1.0 and 2.0 volts (20,000 ohms/volt voltmeter). Check with the anode lead plus (+) and the ground minus (-). Before the system is activated the reference cell lead normally will read about 0.6 volt. Higher voltages indicate that some cathodic protection is being provided. Lower voltages, as low as 0.45 volts, may occur occasionally indicating an accelerated corrosive condition. Zero voltage of anodes or reference cells indicates an unintentional ground or short. Lead voltages between 0.2 volts and 0.5 volts indicate that a copper wire may be exposed to sea water. Locate and isolate the exposed wire.

(h) If the controller is not equipped with a switching device to change controller input from one reference cell to another, a double throw, single pole switch should be installed for this purpose.

(i) The system should be activated, as soon as practicable after the ship is waterborne, unless an adequate temporary cathodic protection system is provided. The system should then be activated upon removing the temporary protective system.

2. **Magnesium System**—The quantity of anodes specified for the system should be installed in accordance with the details of NAVSEC plan nos. 805-1749052 and 805-1749053.
**CAUTION!** Mask the magnesium anodes prior to any hull painting; remove masking prior to undocking.
Anodes shall be located so as to clear docking block location. Table 23 should be used for the installation of a complete magnesium system.

**Table 23—Location of Magnesium Anodes**

| If total quantity of anodes required is | Install in stern area | Install on port bilge keel | Install on starboard bilge keel |
|---|---|---|---|
| 10 | 4 | 3 | 3 |
| 11 | 5 | 3 | 3 |
| 12 | 4 | 4 | 4 |
| 13 | 5 | 4 | 4 |
| 14 | 6 | 4 | 4 |
| 15 | 5 | 5 | 5 |
| 16 | 6 | 5 | 5 |
| 17 | 7 | 5 | 5 |
| 18 | 6 | 6 | 6 |
| 19 | 7 | 6 | 6 |
| 20 | 8 | 6 | 6 |
| 21 | 7 | 7 | 7 |
| 22 | 8 | 7 | 7 |
| 23 | 9 | 7 | 7 |
| 24 | 8 | 8 | 8 |
| 25 | 9 | 8 | 8 |
| 26 | 10 | 8 | 8 |
| 27 | 9 | 9 | 9 |
| 28 | 10 | 9 | 9 |
| 29 | 11 | 9 | 9 |
| 30 | 10 | 10 | 10 |
| 31 | 11 | 10 | 10 |
| 32 | 12 | 10 | 10 |
| 33 | 11 | 11 | 11 |
| 34 | 12 | 11 | 11 |
| 35 | 13 | 11 | 11 |

(a) Anodes required for bilge keel installation shall be in accordance with MHB type. Anodes should be positioned on the top center portion of each bilge keel butted end to end. The forward and aft anode of each group should be the single bevel type. The dielectric shield should be applied beneath each anode group and extended two feet up the side of the hull from the bilge keel-hull junction. It also should extend from the anodes to the underside of the bilge keel to the junction of the bilge keel and the hull. The shield should extend at least two feet beyond the fore and aft end of the anode groups.

(b) The hull type MHP anodes shall be installed in the stern areas. Anodes should preferably be located on the stern baseline keel plate beginning approximately five feet forward of the propeller plane and extend forward. If this location interferes with docking block positions, anodes may be equally divided between the port and starboard sides of the hull as indicated on NAVSHIPS Plan No. 805-1512557. The leading and trailing anodes of a group should be beveled for streamlining purposes (type MHP single bevel). Anodes shall be butted end to end with long axis fore and aft. Dielectric shields shall be applied beneath and extend 2 feet about the anode as with the bilge keel installation. Before application of the hull antifouling paint, the surface of the dielectric shield shall be roughened (brush blasted or light sanding) to remove any gloss.

3. **Zinc System**—The quantity of anodes specified for the system shall be installed in accordance with NAVSHIPS Plan No. 805-921865. The hull surface beneath the zinc should be properly coated with the complete anticorrosive system specified for the hull. Attachment straps and painted areas blistered from welding shall be painted the same as the hull.





**CAUTION!** Do not paint the zinc anode surface. Studs, welded to the hull or bilge keels for bolting zincs shall be fabricated from mild or medium steel. Galvanized studs are acceptable. Monel or corrosion resistant steel should not be used. Studs should be cut flush with the top of the nut to minimize turbulence in service.

(a) Midships Area.—Two thirds the calculated quantity of zinc anodes necessary to give complete protection shall be equally divided into 2 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, 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. In no case, however, should the spacing between rows be less than four feet. Begin all rows at least five feet forward of the propeller plane and extend forward. Zinc locations shall be such that the anodes are always totally immersed under light load and do not interfere with docking block positions. In addition, if ZHS anodes are attached by welding, at least 25 percent of the stern anodes installed shall be bolted. ZHS-type anodes may be modified by drilling holes through the straps to accommodate studs welded to the hull, or preferably, the ZHC-type zinc (bolt-on type) should be used. Anodes shall not be attached to propellers, propeller shafts, rudders, diving planes, rudder skegs, strut arms, strut barrels, or on the exterior of the stern or strut tube fairwaters.

## 9190.234 DISSIMILAR METALS PROTECTION

1. **Requirements**—Zinc anodes of an appropriate style or type should be installed at concentrations of dissimilar metals (e.g. bilge pump strainers, valves and piping) which are immersed in or frequently flooded with sea water (greater than 50 percent of the time).

(a) Stagnant areas or areas subject to low velocity conditions (under 5 knots), should be provided with one square foot of zinc surface for each 50 square feet of bare metal (steel, stainless steel (CRES), aluminum, bronze, or other copper base alloys). Use one square foot of zinc for 400 square feet of well-painted metal.

(b) Under velocity conditions (above 5 knots), use one square foot of zinc surface for each 25 square feet of bare monel, stainless steel (CRES), bronze, or other copper base alloys. Use one square foot of zinc for each 50 square feet of bare steel, aluminum, or aluminum alloy. Use 1 square foot of zinc for approximately each 200 square feet of painted metals.

2. **Installation**—Zinc anodes should be bolted to facilitate replacement and should be located near and at approximately the same level as the dissimilar metal junction.

## 9190.235 MACHINERY PROTECTION

1. **Stern Tubes and Strut Bearing**—Zinc anodes, type ZEP, should be installed within the fairings as shown in NAVSHIPS Drawing No. 805-921865. The maximum quantity and size permitted by the space available should be installed.

2. **Heat Exchangers and Condensers**—Where required, zinc anodes of appropriate style and type should be installed in accordance with Chapter 9460.

3. **Sea Chest**—(a) As specified in ship's plans, medium or flange steel protectors shall be fitted to prevent deterioration of the hull due to galvanic action.

(b) 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 well down into the sea chest and be of such length that it can be removed for replacement through the opening resulting from the removal of the valve, or alternately may be fitted in sections which may be removed from the exterior of the ship through the sea chest as indicated on NAVSHIPS hull standard plan No. 805-1749026.

(c) In addition to steel waster pieces, zinc anodes type ZHS or ZSS, should be installed in accordance with NAVSHIPS dwg. 805-921865 and the requirements of section 9190.234.

(b) Medium steel protector rings are fitted on the shell plating around openings for nonferrous sea chests.

(c) Medium steel protectors, 10 inches in diameter and of 15-pound plate, are fitted in submarines under the ends of fuel compensating piping in all tanks to which compensating lines connect.

(d) Steel protectors shall not be painted on their outside surfaces.

4. **Submarine Equipment**—In general, zinc anodes shall be installed in free flooded areas, under the superstructure, in the fairwater, in ballast tanks in way of lead ballast, in torpedo tubes, sea chests, and in areas where dissimilar metals are concentrated. Class plans shall be used as a guide for quantity, location, and type of anodes required.

(a) Zinc anodes shall be installed on AN/BPQ-1 and AN/BPQ-2 radar antennas. Recommended anode types, quantity for each antenna, and stock numbers are listed in Table 24. The zincs should be located in the feedhorn assembly in such a manner as not to interfere with the operation of the reflector and associated equipment.

(b) Bolted anodes shall be used if service by the fleet is required.

(c) Locations, quantity, size, and type of zincs installed, including zinc anodes required to protect machinery, should be tabulated for inclusion in ship's records. Reference shall be made to applicable plans.

## 9190.236 SONAR DOMES

1. **Requirements**

(a) One square foot of exposed zinc should be installed in the sonar cavity to protect each 400 square feet

**Table 24. Anodes for Radar Supports**

| Anode type | Size | Weight (pounds) | Quantity required | Stock Number |
|---|---|---|---|---|
| ZEP | 5″ dia. x 1″ thk. | 5 | 3 | KZ 5340–527–2366 |
| ZEP | 4″ dia. x 1″ thk. | 3.2 | 4 | KZ 5340–582–2011 |
| ZEP | 3″ dia. x 1″ thk. | 1.8 | 5 | KZ 5340–582–2012 |
| ZEP | 2″ dia. x 1″ thk. | 0.8 | 10 | KZ 5340–427–2368 |
| ZSS | 3″ x 12″ x 1¼″ | 12 | 2 | KZ 5340–290–8243 |
| ZHS (Half size) | 6″ x 6″ x 1¼″ | 12 | 2 | KZ 5340–277–7559 |

of steel or 50 square feet of stainless steel regardless of any painting within the dome. Zincs are additive.

(b) In the cast of AN/SQS-26 and other similar domes, 12 additional hull zinc anodes shall be installed on the underwater hull.

2. **Installation**

(a) The zinc anodes should be mounted on welded stud attachments and should be as evenly distributed as practical on or throughout the surface being protected. If possible, they should be centered in void spaces in convenient locations within the cavity so as not to interfere with sonar operations.

(b) If it becomes necessary to group the anodes less than two feet apart, another anode type should be selected, particularly one with a larger surface area.

(c) Underwater hull anodes for sonar dome protection shall be installed in 2 rows, port and starboard, approximately 30 feet forward of the leading end of the bilge keel and just above the keel line if it were extended.

### 9190.237 INTERNAL BILGE AREAS

1. **Requirements**–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 or ZHS type) should be installed for every 250 square feet of steel surface in accordance with NAVSHIPS Drawing 805-921865. Bolt-on ZHC anodes should be used for this installation so that depleted anodes can readily be replaced by crew members.

2. **Installation**–If ZHS type anodes are used in the bilges, holes should be drilled in the straps to accommodate bolting. Proper functioning of the anode depends upon complete immersion in sea water, a clean anode surface and a positive contact between the anode and the surface requiring protection.

(a) Anodes should normally be located on the garboard strake close to the centerline keel.

(b) For 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.

(c) For dissimilar metal junctions, install anodes near the junction.

(d) Care should be taken to mask anodes when painting bilge spaces so as not to coat 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) Internal bilge anodes shall be installed in locations where the anodes will be submerged at all time water is present in the area, generally near the bilge pump input. Each compartment where water is held shall be considered for cathodic protection. It is recommended all stringers be provided drain holes (large enough to avoid clogging) which drain into the immediate keel area.

### 9190.238 WOOD HULL SHIPS

1. **Requirements**

(a) On wood hull ships, one 6″ x 12″ x 1½″ anode should be installed for each 25 square feet of underwater metal area.

(b) A minimum of one zinc per rudder face, strut face, or sea chest should be fitted.

2. **Installation**

(a) Anodes may be installed by welding or brazing to the protected fitting.

(b) Areas too small for a 6 by 12 inch zinc anode, shall be fitted with a 6 by 6 inch anode formed by cutting a 6 by 12 inch anode in half.

(c) Rudder anodes should be located outside of the propeller flow, if possible.

(d) Zinc anodes used to protect struts should not be attached to the strut arms. Metallic contact may be made at the strut arm by a brass or bronze strap brazed from the anode to the metal to be protected. NAVSHIPS Drawing 805-921865 may be consulted for installation details.

(e) Skegs, where fitted and in metallic contact with a protected fitting, should be considered part of the fitting.

(f) The attachment straps protruding from the anode, **but not the zinc metal**, should be painted the same as the hull.

### 9190.239 PREVENTION OF ELECTROLYTIC CORROSION TO BOATS (except aluminum hulls)

1. **Requirements**–Zinc protectors must be installed on all steel boats and some nonshipborne types of wood and plastic boats having large amounts of electronic equipment installed (such as torpedo retrievers, air rescue boats, and minesweepers). For aluminum hulls, see 9190.240.

(a) For steel, wood, and plastic hull boats, the ZHS and ZHB anodes shall be cut in half to form a 6″ by 6″ by 1¼″ anode prior to installation.

(b) The ZTS type zinc anode is designed for small steel hull boat applications where streamlining and lightness of weight are desired.

(c) For quantities required, consider the above as ½ of an anode and calculate anode requirements in accordance with ship calculations.

(d) No less than two zinc anodes equivalent to the ZHS type anode shall provide the protection to any steel hull boat.





(e) In addition to hull anodes, one ZSS or 6″ x 6″ anodes shall be provided for each sea chest or other appendage.

(f) Hull cathodic protection is not normally required for wood or plastic hull boats. Fittings and fasteners are generally fabricated from corrosion resistant materials and require cathodic protection only if specified in the applicable detailed plans. If evidence of excessive corrosion exists on underwater metal fittings, fasteners, propellers, struts, etc., the Naval Ship Engineering Center should be notified.

(g) The use of dissimilar metals shall be avoided whenever possible. Where not practical, care should be taken to insulate the dissimilar metals from each other with gaskets, washers, sleeves, and bushings of insulating materials such as "Neoprene," "Nylon," "Micarta," etc. Faying surfaces between wood and active metals such as aluminum shall be protected by using a bedding compound plus a coat of zinc chromate primer applied to the metal surface.

2. **Installation**–NAVSHIPS drawing 805–921865 should be consulted for general installation details.

(a) All zincs installed on wood or plastic boats shall be attached to the underwater hull and not to the metallic appendage(s) other than the rudder(s). Metallic contact shall be made by brazing a copper or bronze strap to the metallic appendage to be protected and to the strap of the zinc installed on the hull. The strap, but not the zinc, should be painted the same as the hull.

(b) Zincs with brass straps should be brazed to rudders, if required. Zincs installed on rudders shall be located outside the propeller flow insofar as practical.

### 9190.240 CATHODIC PROTECTION FOR ALUMINUM HULLS

1. **Requirements**–Cathodic protection shall be applied to aluminum hull boats and ships in sea water. Zinc anodes conforming to MIL–A–18001 shall be installed, unless specific NAVSEC approval is granted for other systems.

(a) Corrosion protection for the hull and appendages shall be provided by type ZTS, ZHS or ZHC zinc anodes.

(b) Calculate the quantity of hull anodes required for 2 years by using the formula

$$N = \frac{6.5W}{1000}$$

N = No. of ZHS or ZHC anodes
W = wetted surface area (sq. ft.)

The ZTS or ZSS type anodes shall he used for small boats in lieu of ZHC or ZHS anodes if three or less ZHC anodes are required. Use four ZTS anodes or two ZSS for each ZHC or ZHS anode.

(c) In addition to the hull anodes, one ZTS anode shall be provided for each five square feet, or the proportion of five square feet, for each sea chest or other areas of dissimilar metals.

(d) **Caution!** Magnesium anodes and mercury bearing aluminum anodes shall not be used on aluminum hulls.

(e) Internal bilge areas shall be protected by one 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, ZSS, ZEP, shall be used as best meet the requirements of the area to be protected.

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

2. **Installation**–The following instructions provide the necessary supplementation to NAVSHIPS Dwg. No. 805–921865 for installation of zinc anodes on aluminum hull boats and ships.

(a) All anodes installed shall be attached with aluminum studs, CRES lockwashers, CRES lock-nuts; use an acceptable antiseize compound (a compound consisting of equal parts by weight of petrolatum and zinc dust of 200 mesh fineness may be used).

(b) Where basic thickness of the hull is not considered adequate to support the attaching studs and anodes, a doubler or insert plate of the same composition as the hull should be welded to the hull beneath the anodes. The studs can then be welded to the doubler plate. The doubler plate should be coated with the same paint system as the hull prior to attaching the anodes.

(c) ZTS anodes can be modified for stud attachment by drilling a 3/8 inch hole centered ½ inch from each core end. Aluminum studs, ¼ inch minimum diameter should be used.

(d) On hard chine planning hulls, install anodes on the transom; on all other boats distribute anodes about the hull similar to steel hull ships (9190.233); that is, 1/3 in the stern area and the remaining anodes equally divided, port and starboard approximately midships.

Anodes shall be butted long axis fore and aft. ZTS type anodes shall be installed with the long axis fore and aft and the wide end of the anode forward.

(e) Anodes shall not be installed in locations interfering with the operation of struts, propellers, propeller shafts, or rudders.

Installation in paths of high velocity water flow should be avoided whenever possible. Anodes should be installed in the vicinity of dissimilar metal junctions. In addition, anodes shall be installed in locations which are always submerged under light load conditions.

(f) Install internal bilge anodes in accordance with sections 9190.237.

### 9190.241 PLAN FOR MAINTENANCE-GALVANIC SYSTEM (If PMS is installed, use periodicities established by cards)

1. **General**–The galvanic anode system installed in accordance with these instructions require maintenance on a continuing basis. The galvanic systems specified herein are designed to last two or three years to conform with normal overhaul periods (see article 9190.232). The actual service life is dependent upon a combination of many factors.

2. **Semi-annual**–A semi-annual inspection of the underwater stern area by divers is recommended to determine the extent of anode deterioration in this area. Replacement of the bolted anodes should be made by the divers if they are more than 80 percent deteriorated and drydocking is not scheduled within a six month period.

3. **Drydock Overhaul (two and three year schedule)**

(a) Upon entering drydock the ship shall be inspected to determine the need for anode replacement. Anodes shall

NAVSHIPS 9195/1 (REV. 7-67)
(Formerly NAVSHIPS 4498)
S/N-0105-634-3000

NAVSHIPS REPORT 9190-1

## CATHODIC PROTECTION LOG

(SHIP) _____ (MONTH) _____ (YEAR) _____

DAILY — CONTROLLER ☐ FORE SYSTEM ☐ AFT SYSTEM

WEEKLY — POWER SUPPLY

| DATE | SPEED KNOTS | CHECK IF ALONGSIDE PIER | AUTOMATIC CONTROL SETTING | REFERENCE CELL CHECK | OUTPUT CHECK | NO. | NO. | NO. | NO. | NO. | NO. |
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POWER SUPPLY READINGS AMPERES

AUTOMATIC CONTROL AND REFERENCE CELL READINGS - VOLTS

COMMENTS:

THIS DATA SHALL BE FORWARDED QUARTERLY TO:

NAVAL SHIP ENGINEERING CENTER
(SEC 6101C)
WASHINGTON, D.C. 20360





be renewed when they will not last until the next scheduled or anticipated maintenance period involving a drydocking of the ship. This will assure maximum service life from the anodes. Normally, stern anodes deteriorate more rapidly than those installed midships. However, this may not be the case for LSTs 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 row. Therefore, spot replacement of certain anodes may be required from time to time without the expense of complete replacement of the system. As a general criteria, anodes should always be replaced during an interim drydocking when they are approximately:

(1) 50% or more deteriorated and the next scheduled drydocking is 18 months or longer

(2) 65% or more deteriorated and the next scheduled drydocking is one year or longer

(3) 80% or more deteriorated and the next scheduled drydocking is six months or longer.

Occasionally a zinc anode may develop an oxide film which renders it inactive. Although this is the exception rather than the rule, this passivated state can readily be detected by comparing the anode with others in the system. The inactive anode usually will have a hard tenacious, dark grey or black film on the surface and the anode manufacturer's identification will still be prominent on the surface. Such anodes should be replaced. Magnesium anodes have not been known to form such passivating films. A light colored soft deposit on the surface, even though quite thick, is normal and may be prevalent under conditions of low velocity.

The inspection should include the dielectric shield about the magnesium anodes. Repair or replace depending upon condition of shield.

(b) In replacing the zinc anodes, care shall be exercised to ensure that an adequate coating exists between the anode-back and the hull. If the hull coating where the anode is to be located is satisfactory, the anode may be installed directly over this. The straps and welds or studs shall then be either touch-up painted or coated with the remainder of the hull after anode masking.

**CAUTION!** Do not paint anode surfaces.

If the hull coating under the anode is unsatisfactory, the area shall be painted in a manner similar to that provided on the hull. Following installation of the anode, the straps and weld spots or studs shall be touched up with the hull coating.

Use the same procedure with core type anodes, but fill holes with hull smoothing compound (see 9190.171).

Remove all masking on anodes prior to undocking.

Anodes installed on bare surfaces may be embedded in zinc oxide paste or have the anode backside coated with dielectric shield material as specified for the hull beneath the magnesium anodes. (See 9190.232)

4. **Periodic**—Inspect and replace as necessary based on past experience bilge anodes, machinery anodes in areas of dissimilar metals, heat exchangers (generally one-two month periods), and condensers (generally one-two month periods), where installed.

### 9190.242 PLAN FOR MAINTENANCE—IMPRESSED CURRENT SYSTEM (If PMS is installed, use periodicities established by cards)

1. **Daily**—NAVSHIPS Form 9195/1 (Figure 9190-11) shall be used to record daily the following information. The ships speed or an indication that the ship is at pier shall be recorded at the time readings are made. The "automatic control setting" shall be recorded and reset to 0.85 volts, if necessary. Also, the reference cell check and the output check shall be recorded on the form. If reference cell voltage is outside the range 0.75-.92 volts, see paragraph 6 below.

2. **Weekly**—As well as the daily reading, the power supplies' d.c. current readings shall be recorded on Form 9195/1 in the space allotted.

3. **Monthly**—Inspect the propulsion shaft grounding assembly/ies for wear, cleanliness, and brush tension. Replace all worn or noisy brushes.

**CAUTION!** Replace only with copper-graphite or silver graphite ½ " x ¾ " x 1½ " long brushes.

(a) To remove oil and dirt accumulations, wipe brushes and brush contacting surfaces with a clean rag.

(b) Adjust spring tension on each brush between 5 and 10 pounds per square inch of surface area. (Approximately 2 to 4 pounds based on a 3/8 square inch contact area of brushes conforming to NAVSHIP Dwg. No. 805—1749216).

4. **Drydock Availability**

(a) The inspection of the hull should include anodes and dielectric shields for physical damage.

(b) Upon completion of the anode inspection, all anodes and reference cells shall be immediately masked for protection against sandblasting and painting. Dielectric shields need not be masked, but shall be only lightly blasted to permit application of antifouling coatings and tie coats. Navy vinyl paint inadvertently applied on an anode surface may be removed with any of the following solvents: acetone, acetone and toluene mixture (1:1 by volume), methyl ethyl ketone (MEK), or methyl isobutyl ketone (MIBK). The Safety Officer or Industrial Hygienist should be consulted prior to using these solvents to determine flammability, and health and safety precautions.

(c) Replace all damaged anodes and make necessary repairs to the dielectric shield. (See 9190.232) for shield materials). Ships cathodic protection plans will indicate manufacturer and model number for replacement anodes.

(d) Inspect and maintain, as necessary, all grounds to the equipment.

(e) Inspect and replace as necessary, machinery galvanic anodes, used to supplement the impressed current system. These should be inspected in accordance with the galvanic anode maintenance schedule 9190.240.

(f) Remove all anode masking prior to undocking.

5. **Five to seven year period**—At the nearest drydock availability to this interval, the reference cell shall be removed and the silver-silver chloride element replaced. Figure 9190—12 shows the assembly of the MIL. SPEC. (MIL—E—23919) reference electrode. The following procedure shall be used in the replacement of the element.

(a) Remove the six round head machine screws attaching the cell to the hull. If potted, drill or chip out potting compound in locations as shown on Figure 9190-12.

(b) Disassemble unit by removing the 3 flathead screws on the base. The depleted electrode element may then be removed by cutting the silver wire lead near the

fused junction at the lead center. (See figure 9190-12 at Section B-B).

(c) New elements can be purchased commercially to specification MIL–E–23919 or manufactured in a chemical laboratory in accordance with the following instructions. The electrode element consists of a treated silver-gauze wrapped in saran cloth and connected to the contact pin lead by a silver wire. The No. 40 mesh silver gauze has dimensions of 16 inch by 4 inch (each strand is approximately 10 mils in diameter). The silver gauze shall be folded with an accordion pleat to form a 4 inch square. A 3/32 inch diameter silver wire (99.95% pure) shall be swaged or fused by tungsten inert-gas arc-welding along one edge of the gauze using no solder or flux (see figure 9190-12). The element shall then be treated as follows before insertion in the plastic holder. The gauze shall be cleaned by boiling in a 5 percent by weight sodium hydroxide solution for one-half hour. After boiling, it shall be rinsed thoroughly in running tap water for one hour, followed by a distilled water rinse for one-half hour. The gauze shall be handled with a stainless steel tong after rinsing to prevent contamination. After rinsing, the gauze shall be dried thoroughly for at least 12 hours in an oven at a temperature of 100 plus or minus 5° Centigrade (C.). After drying, the gauze shall be dipped in molten chemically pure (CP grade) silver chloride, maintained at slightly above 455° C. for a sufficient period of time for the gauze to reach the temperature of the silver chloride and to result in a deposition of silver chloride on the gauze of 20 parts of silver chloride by weight to 100 parts of silver. The deposited silver chloride shall be cathodically reduced to silver by electrolyzing the gauze in a chemically pure 3 percent sodium chloride solution at approximately 100 milliamperes until no further weight change is apparent. The silver shall then be anodically rechloridized in the same 3 percent sodium chloride solution at approximately 100 milliamperes until the weight increase indicates a ratio of 20:100 silver chloride to silver. A platinum anode shall be used in this process. The treated gauze shall be wrapped in a 1-inch wide fine wire saran screen woven of saran wire (copolymer of vinylidene chloride and vinyl chloride) approximately 15 mils in diameter, and shall be enclosed in a pouch-type bag with a draw-string made of saran screen, woven of saran wire of approximately 15 mils in diameter.

Attach the element silver wire lead to the base lead by swaging the leads metal to metal. Reassemble the holder as shown in Figure 9190–12.

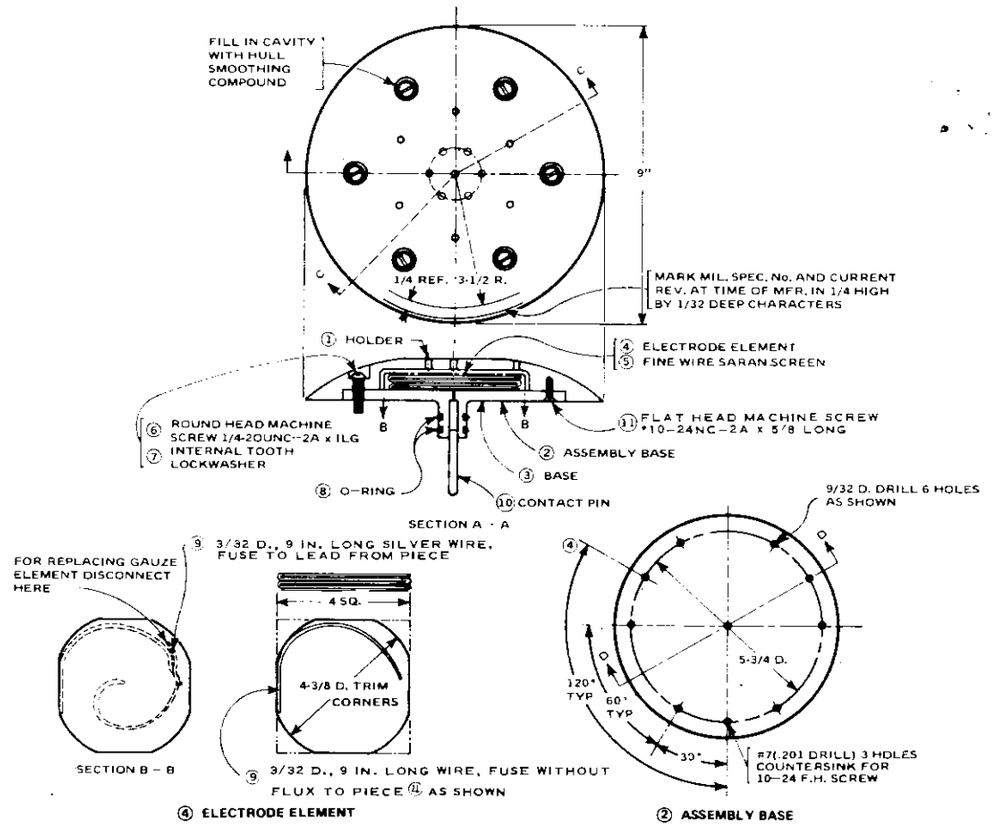


FIGURE 9190-12. REFERENCE ELECTRODE – SILVER – SILVER CHLORIDE





(e) Replace O-rings on the hub with new rings conforming to Class B of MIL–P–5516. Size and shape shall be AN 6227-13 as specified in AN 6227.

(f) Reinstall the reference cell on the hull. Pot the 6 bolt holes with an approved plastic repair compound (9190.169).

6. **General maintenance instructions**–

(a) The automatic control setting shall be maintained at 0.85 volts on all steel hull ships. In the special case of aluminum hulls protected by automatic impressed current set the automatic control setting at 0.92 volts.

(b) If the system is operating normally, the reference cell check will be close to the automatic control setting of 0.85 volts. Short term deviations may occur (temperature changes, water salinity changes, speed-changes etc.) in the range of 0.75–0.92 volts without serious damage to the hull. However, if values persist out of this designated range for more than 2 days, consult the appropriate trouble-finding sections of the manufacturer's manual. Insure condition is same about the hull by switching to the second reference cell. NAVSEC (Code 6101C) should be notified if the problem persists.

(c) Cathodic protection data older than 2 years may be discarded.

## 9190.243 ADDITIONAL INFORMATION

1. **Training films**–Training films entitled "Cathodic Protection, Part I: Fundamentals and Principles," and "Cathodic Protection, Part II; Operation and Maintenance" are available from Naval Film Libraries. The films are numbered U.S. Navy–"MN–10146–A" and U.S. Navy–"MN-10146-B" respectively.

2. Detailed plans are included in ships plan files on all cathodic protection provided to the ship.

# NAVAL SHIPS TECHNICAL MANUAL

## CHAPTER 9190—PRESERVATION OF SHIPS IN SERVICE

### INDEX

## APPENDIX A
### Chemical Cleaning and Painting of Ships' Bilges

## Part 1. Procedure for Chemical Cleaning of Ships' Bilges

This method is applicable to the cleaning of metal surfaces of ship's bilges, except in submarines or in ships whose hulls are constructed of aluminum, prior to repainting.

MATERIALS

Solvent-Emulsifer, Oil Slick
Specification MIL-S-22864
FSN 6850-875-6917, 5-gal pail
FSN 5850-886-6512, 55-gal drum

Sodium hydroxide, technical
Specification O-S-598, Type I, Flake
FSN 6810-174-6581, 100-lb drum

Sodium gluconate, technical
Local purchase

Detergent, General Purpose, Liquid, nonionic
Specification MIL-D-16791E, Type I
FSN 7930-282-9701, 5-gal pail

EQUIPMENT

Carbon-steel tank, portable, closed top, of sufficient capacity and fitted with a caustic resistant recirculating pump and a chemical injection system.

Wheeler Machine.

Hose, caustic-resistant.

Agitator, pneumatic motor, fitted with steel paddle for agitating hot caustic solution (motor available from Ingersoll-Rand).

Steam-heating coils—1-1/4 inch steel tubing formed to 2-foot diameter coils. May be formed in variety of sizes and shapes to conform to configuration of space.

Temporary air, steam and water with suitable lines, manifolds, and connections.

Exhaust ventilation blowers and ducts.

Remote-reading thermometers.

Safety clothing.

Portable Shower.

Hydrogen Detector.

SAFETY PRECAUTIONS

Alkaline powders and solutions constitute an extreme personnel hazard if improperly handled. Concentrating or heating solutions aggravate the problem.

a. Solutions may:
   1. Cause permanent damage or burns to the eyes.
   2. Cause severe skin burns and tissue damage.
   3. Cause death or severe injury if swallowed.
   4. Cause skin irritation with prolonged or repeated contact.

b. Mists and dusts may:
   1. Cause severe irritation of the eyes, nose and throat.

The following precautions shall be observed:

a. Exposed personnel shall be thoroughly instructed regarding the hazards.

b. Persons working in areas where solutions are being used, prepared, or transferred shall be dressed in chemically impervious clothing.

c. Treadle actuated, whole-body showers shall be provided where caustic solutions are prepared, stored or used.

d. Caustic solutions shall not be prepared or stored in wide-open steel tanks. Tank openings shall be small, and shall be closed during storage.

e. Caustic solutions shall be transferred through alkali-resistant pumps and lines.

f. Entry to a bilge shall not be permitted when caustic solution is in the bilge. If entry becomes imperative, the caustic shall first be removed.

PREPARATION OF SOLUTION

Materials required to prepare 1000 gallons of Caustic-Sequestrant solution:

| | | |
|---|---|---|
| Sodium hydroxide, lb | 1200 | (Approximately 19 oz/gal) |
| Sodium gluconate, lb | 800 | (Approximately 13 oz/gal) |
| Detergent, nonionic, water-soluble, gal | 1 | |

Fill tank to 600-gallon level with fresh water. Add sodium hydroxide (lye) slowly to cold water with continuous mechanical agitation. When all lye has dissolved, slowly add sodium gluconate with mechanical agitation. When the sodium gluconate has completely dissolved, add the detergent. Add water to the 1000-gallon level. Stir until thoroughly mixed.

CLEANING PROCEDURE

**Preparation of Bilge**

Remove deck plates to provide access to bilge area. Install plywood planking. Drain all piping in bilge. Blank-off open ends of piping. Remove electrical equipment and cables, pipe lagging, aluminum handwheels and all other material and equipment which will be damaged by caustic solution. Cover equipment which cannot be removed to provide protection against chemical solution and vapor damage. Air test tanks and voids below bilge at 2 psi to ensure water-tight integrity. Provide ventilation and connections for air, steam and water. Provide facilities for pumping solutions from bilge.

**Oil and scale removal**

Spray all bilge surfaces with Solvent-Emulsifier, Oil Slick compound. Permit to soak for thirty minutes. Wash down with warm, 120° F. high velocity stream of water Pump out bilge. Inspect for adequacy of oil and grime removal. Reclean as necessary. Inspect bilge surfaces, particularly tank top, for heavy iron oxide scale. Oil impregnated rust and/or thick scale will not be adequately removed by the method described herein. If necessary, chip to remove heavy scale. Remove loosened scale and other debris from bilge before introducing caustic solution.

**Installation of Equipment**

Install a sufficient number of heat exchanger coils to maintain a uniform solution temperature of 190° F. in all parts of the bilge. The heat exchangers shall be so fitted that they may be used as heating coils by the introduction of steam or as coolers by circulation of cold water. Install a sufficient number of solution agitators to produce vigorous stirring of the solution in all parts of the bilge. Install ventilation exhaust blowers and ducting. Install necessary piping and connections for air, steam and water.

**Chemical Treatment**

a. Pump cold caustic-sequestrant solution to bilge to height of top of deck plate supports. Using hydrogen detector periodically check for evolution of hydrogen. If hydrogen is detected, there should be no smoking, welding, burning, or other source of ignition. Heat solution to 190° F. Agitate solution during the entire treatment period. Maintain temperature at 190° F. for twenty-four hours.

a.1. An optional step, which prolongs the useful life of the caustic-sequestrant solution, is to pretreat the bilge with a hot caustic soda solution to remove paint. The caustic-sequestrant treatment described above is then used to remove rust. A spent caustic-sequestrant solution may be used for this purpose provided that it is refortified with caustic soda. A twelve-hour treatment with a 16 oz/gal caustic soda solution at 180° F. removes paint effectively.

b. Cool solution by circulating cold water through the heat exchangers. When cold, pump the caustic-sequestrant solution from the bilge. Collect the used solution in a storage tank or barge for refortification or disposal, or pump directly to an adjacent bilge. Disposal shall be in accordance with local regulations.

c. Fill bilge with fresh water. Add one gallon of liquid, nonionic, water-soluble detergent for each 1000 gallons of water. Heat detergent solution to 180° F. Agitate solution vigorously while maintaining temperature for thirty minutes. While continuing agitation, pump hot solution overboard.

d. Immediately after removal of detergent solution, wash all surfaces with a high velocity stream of warm fresh water to remove residual scum and corrosion residue.

e. Dry bilge surfaces with combination air blast, and exhaust ventilation and hand drying.

f. Inspect to determine if surfaces are suitable for application of paint. Any remaining coating which is removable by chipping or scraping must be removed before application of paint. A thin, adherent magnetite film, not exceeding 0.005 inch in thickness, is considered a suitable base for the application of the epoxy-polyamide system described in part (2), attached.

g. Apply paint in accordance with part 2, attached as soon as possible. Surfaces will develop flash rust if contacted by water.

**Refortification and Reuse of Cleaning Solution**

The following information is presented as a guide to refortification and reuse of cleaning solutions:

**Solution Testing Procedures**

a. Reagent Preparation

1. Methyl Orange indicator. Dissolve 1 g of methyl orange in 1 liter of water.

2. 0.5N Sulfuric Acid. Add 14 ml of reagent grade, concentrated sulfuric acid to approximately 800 ml of distilled water in a one-liter volumetric flask. Fill the flask to the mark with distilled water, mix well, and cool to room temperature. Standardize with primary, standard grade, sodium carbonate using methyl orange indicator.

3. Orange-G indicator. (National Aniline Division, Allied Chemical Corporation) Dissolve 0.5 g of Orange-G in 100 ml of distilled water.

4. 0.1M Copper Sulfate solution. Weigh 25 g of reagent grade copper sulfate ($CuS04.5H_20$), and transfer to a one-liter volumetric flask. Add 500 ml of distilled water and dissolve salts. Fill the flask to the mark with distilled water and mix thoroughly.

5. 2.5N Sodium Hydroxide. Weigh 100 g of reagent grade sodium hydroxide and transfer to a one-liter volumetric flask. Add 800 ml of distilled water, dissolve, and cool to room temperature. Fill the flask to the mark with distilled water and mix thoroughly.

b. Determination of Sodium Hydroxide. Pipette 2 ml of the sample solution into a 250-ml Erlenmeyer flask. Add 50 ml of distilled water and 10 drops of Orange-G indicator. Titrate rapidly with 0.5N sulfuric acid to the color of a control prepared by adding a slight excess of sulfuric acid titrant to a blank prepared as above.

$$NaOH, oz/gal = ml \times normality \times 2.668$$

c. Determination of Sodium Gluconate. Pipette 2 ml of sample solution into a 150-ml beaker. Add 10 ml of 2.5N sodium hydroxide and 10 ml of distilled water. While stirring, slowly add 0.1M copper sulfate until the precipitate formed will not redissolve when the solution is stirred.

Dilute to approximately 80 ml with distilled water. Heat just below the boiling point for five minutes. Cool to room temperature and transfer to a 100-ml volumetric flask. Fill to the mark with distilled water and mix thoroughly. Transfer to a 100-ml centrifuge tube and centrifuge for fifteen minutes at 1500 RPM. Determine the transmittance of the clear solution at the wavelength of maximum absorption (620-680mu). Use distilled water to determine a blank. The concentration of sodium gluconate is determined by referring the difference between the blank and the sample solution readings to a curve prepared by plotting the spectrophotometric readings of known concentrations of sodium gluconate.

**Reclamation of Cleaning Solution**

The bilge cleaning solution may be reclaimed for the next use by physical separation of the insoluble material, followed by chemical refortification. On setting, the contaminated solution separates into three layers. The top layer is a scum consisting largely of insoluble soaps, the middle layer is clear solution, and the bottom layer is principally paint pigments and magnetite. Settling may be accomplished by pumping the solution to a settling tank and letting it stand long enough for separation, after which the clear solution is pumped to a holding tank. The solution may then be refortified by additions of sodium hydroxide and sodium gluconate in the quantities that tests indicate will restore it to its original strength. Nonionic wetting agent should be added at the rate of one quart per thousand gallons of solution. The caustic-sequestrant solution can be used indefinitely. Experience has demonstrated that there is no discernible reduction in cleaning efficiency after six uses.

## Part 2. Coating System for Ships' Bilges (Application Instructions)

A. COATING SYSTEM

| Coating System | | Recommended Film Thickness (Mils) | | Approx. Spread Rate at Specified Thickness (Sq. Ft./Gal.) | Recoat Time (Hours) |
|---|---|---|---|---|---|
| Coat | Formula | Wet | Dry | | |
| First | 1B-30 HF* Green Primer | 3-4 | 2.0 | 350 | 16 |
| Second | 1B-40 Red** | 6.0 | 3.0 | 250 | 16 |
| Third | 1B-40 Red | 6.0 | 3.0 | 250 | 16 |

*See Part 3
**See Part 4

B. MIXING AND INDUCTION PERIOD PRIOR TO APPLICATION: (applicable to Formula 1B-30

1. Stir both Component A and Component B thoroughly before mixing together. Mix equal volumes of both components, and stir thoroughly.

2. Mix-up only the amount of material that can be used during the expected pot-life. (Pot-life 16 hours at 50° F, 7-8 hours at 70° F; 2-3 hours at 90° F). It is suggested that amount of paint mixed should be for a six hour work period when the ambient temperature is less than 70° F, and for a three-hour work period for temperatures above 70° F.

3. The following stand in times (induction period) should be carefully followed:

a. Two hours at 50°–60° F.
b. One to one and one half hours at 60°–70° F.
c. One-half to one hour at 70° F. and above.
d. Touch-up batches (½ gallon or less) allow two hours at 60°–70° F.

4. Coating should not be applied at temperatures below 50° F.

C. APPLICATION

1. Over chemically cleaned and dried surface as previously described, apply by brush one coat of 1B-30 HF Green Primer. (Spaces inaccessible by brush should be coated by spray). Permit primer to cure 16 hours at 50° F – 70° F ambient temperature.

2. Apply second coat, 1B-40 Red, and permit 16 hours dry. (Repairs on machinery or structure, if necessary, should be completed before application of the third coat. Thoroughly clean damaged paint and touch-up using a brush application of 1B-30 and 1B-40).

3. Apply third coat, 1B-40 Red. Allow 4 to 7 days curing at 60°–70° F, or 7 to 10 days at 50°–60° F before placing in service.

4. Clean equipment with butyl alcohol and xylene mixed 1:1 by volume.

## Part 3. Purchase Description-Primer, Interior-Exterior, Polyamide-Epoxy, Green (Formula 1B-30HF)

1. **Scope**

1.1 This description covers the requirements for a primer, a low gloss green, two-component epoxy type, high flash, formula 1B-30HF for coating freshly cleaned metal either sandblasted or chemically cleaned.

2. **Materials List**

General Mills, Versamid X-280
General Mills, Genamid 2000
Shell Chemical Co., Epon Resin 815
Baker Castor Oil Co., Thixotrol ST
Johns Manville, Celite 289
Butyl Alcohol, Normal (99%)
Amsco Super Hi-Flash Naphtha

3. **Requirements**

3.1 **Manufacture**—The raw materials for component A and component B shall be mixed and ground as required to produce a product which is uniform, homogeneous, free from grit, entirely suitable for the purpose intended, and in full conformity to the requirements of this purchase description. Component A should be manufactured using a roller mil in order to obtain the required viscosity.

3.2 **Composition**

3.2.1 **Formulas**—Component A and component B shall consist of the ingredients in the proportions specified in Tables I and II, respectively.

TABLE I–COMPONENT A

| | Lbs. |
|---|---|
| Baker Castor Oil, Thioxtrol ST | 5 |
| General Mills, Versamid X-280 | 280 |
| General Mills, Genamid 2000 | 20 |
| Magnesium silicate, MIL-M-15173 | 500 |
| Titanium dioxide, TT-P-422, type III, grade B | 100 |
| Copper-phthalocyanine-blue, TT-P-355 | 1 |
| Yellow iron oxide, TT-P-00458a | 20 |
| Butyl alcohol, Normal (99%) | 264 |
| TOTALS | 1188 |

TABLE II–COMPONENT B

| | Lbs. |
|---|---|
| Baker Castor Oil, Thixotrol ST | 5 |
| Shell Chemical Co., Epon 815 | 500 |
| Johns Manville, Celite 289 | 150 |
| Magnesium silicate, MIL-M-15173 | 100 |
| Amsco Super Hi-Flash Naphtha | 258 |
| TOTALS | 1013 |

3.3 **Quantitative Requirements**

3.3.1 Component A and Component B shall meet the requirements specified in Tables III and IV, respectively.

TABLE III COMPONENT A

| Characteristics | Requirements |
|---|---|
| Pigment (percent by weight) | 52.1 ± 2.0 |
| Non-vol vehicle (percent by weight) | 42.3 ± 2.0 |
| Total solids (percent by weight) | 72.2 ± 2.0 |
| Total solids (percent by volume) | 52.2 ± 2.0 |





TABLE III–COMPONENT A (Continued)

| Characteristics | Requirements |
|---|---|
| Pigment volume concentration, percent | 47.3 |
| Fineness of grind (N. S.) (Min.) | 5 |
| Consistency-Krebs Units (at 77° F) | 110 ± 4 |
| Flash point, Pensky-Martens (Min.) | 99°F |

TABLE IV COMPONENT B

| Characteristics | Requirements |
|---|---|
| Pigment (percent by weight) | 25.2 ± 2.0 |
| Non-vol vehicle (percent by weight) | 60.0 ± 2.0 |
| Total solids (percent by weight) | 68.5 ± 2.0 |
| Total solids (percent by volume) | 64.8% |
| Pigment volume concentration (percent) | 20.8 |
| Fineness of grind-N.S. (Min.) | 4 |
| Weight per gallon–pounds | 9.8 ± 0.2 |
| Consistency, Krebs Units (at 77°F) | 80 ± 4 |
| Flash point-Pensky-Martens (Min.) | 115°F |

3.3.2 **Finished paint**—Finished paint prepared by mixing equal volumes of components A and B shall meet the requirements specified in Table V.

TABLE V FINISHED PAINT

| Characteristics | Requirements |
|---|---|
| Flash Point (Pensky-Martens) (Min.) | 99° F. |
| Total solids by volume | 58.5 |
| Consistency K.U. at 77° F. | 82 ± 4 |
| Gloss 60° specular (Max.) | 5% |
| Pot life, hours, at 77° F. (Min) | 6-8 |
| Spreading rate of 200-230 sq. ft/gal. will yield 4 mils dry film | |
| Drying time (hours), 2 mils dry film at 77° (Max.) | 8 |

4.0 **Inspection of preparation for delivery.** The packaging, packing and marking shall be examined and tested in accordance with TT-P-143 to determine compliance with Section 5 of this specification.

5.0 **MARKING INSTRUCTIONS**

All containers shall be marked as follows:

1. Suppliers standard identification label with the following printed or stenciled on the label:

"Mare Island Experimental Formula 1B-30 HF Polyamide-Epoxy Paint Interior-Exterior Primer, Green"

with Component A (Polyamide) or Component B (Epoxy)

2. The container shall be stenciled with the following:
a. Batch number and date of manufacture
b. Purchase order number
c. Mixing and application instructions as follows:
(1) DO NOT USE BELOW 50° F.
(2) Mix only amount for six hours work
(3) Stir A and B thoroughly
(4) Mix A and B 1 to 1 by volume
(5) Allow paint to stand one hour before applying

## Part 4. Purchase Description-Coating, Interior Bilge, Polyamide-Epoxy, Red (High Flash Formulation 1B-40)

1. **Scope**

1.1 This description cover the requirements for a topcoat, a semi-gloss red, two component epoxy type formula 1B-40 for coating interior bilges of surface ships and submarines.

2. **Materials List**

General Mills, Versamid X-280
General Mills, Genamid 2000
Shell Chemical Co., Epon Resin 815
Baker Castor Oil Co., Thixotrol ST
Johns Manville, Celite 281
Amsco Super Hi-Flash Naphtha (F. P. 115° F)
Pfizer Pigments, Yellow Iron Oxide, YO-3587
Pfizer Pigments, Red Iron Oxide, RO-6097
Magnesium silicate, MIL-M-15173
Titanium dioxide, TT-P-442, type III, grade B
Butyl alcohol, Normal (99%)

3. **Requirements**

3.1 **Manufacture**—The raw materials for Component A and Component B shall be mixed and ground as required to produce a product which is uniform, homogeneous free from grit, entirely suitable for the purpose intended, and in full conformity to the requirements of this purchase description. Component A should be manufactured using a roller mill in order to obtain the required viscosity.

3.2 **Composition**

3.2.1 **Formulas**—Component A and Component B shall consist of the ingredients, and in the proportions specified in Tables I and II, respectively.

TABLE I–COMPONENT A

| | Lbs. |
|---|---|
| General Mills, Versamid X-280 | 320 |
| General Mills, Genamid 2000 | 20 |
| Magnesium silicate, MIL-M-15173 | 250 |
| Titanium dioxide, TT-P-442, type III, grade B | 100 |
| Pfizer YO-3587, yellow iron oxide | 50 |
| Pfizer RO-6097, red iron oxide | 300 |
| Butyl alcohol, Normal (99%) | 253 |
| TOTALS | 1293 |

TABLE II–COMPONENT B

| | Lbs. |
|---|---|
| Baker Castor Oil, Thixotrol ST | 10 |
| Shell Chemical Co., Epon 815 | 586 |
| Johns Manville, Celite 281 | 150 |
| Magnesium silicate, MIL-M-15173 | 50 |
| Amsco Super Hi-Flash Naphtha | 205 |
| TOTALS | 1001 |

3.3 **Quantitative Requirement**

3.3.1 Component A and Component B shall meet the requirements specified in Tables III and IV, respectively.

TABLE III–COMPONENT A

| Characteristics | Requirements |
|---|---|
| Pigment (percent by weight of Comp. A) | 54.0 ± 2.0 |
| Non-vol vehicle (percent by weight of Comp. A) | 43.8 ± 2.0 |
| Total solids (percent by weight of Comp. A) | 74.2 ± 2.0 |
| Total solids by volume, percent | 50.6 ± 2.0 |
| Pigment volume concentration, percent | 43.3 |
| Fineness of grind–N. S. (Min.) | 5 |
| Weight per gallon, pounds | 12.6 ± 0.2 |
| Viscosity, Krebs units (at 77° F.) | 74 ± 4 |
| Flash point-Pensky-Martens (Min.) | 86°F |

TABLE IV–COMPONENT B

| Characteristics | Requirements |
|---|---|
| Pigment (percent by weight of Comp. B) | 20.0 ± 2.0 |
| Non-vol. vehicle (percent by weight of Comp. B) | 74.0 ± 2.0 |
| Total solids (percent by weight of Comp. B) | 79.6 ± 2.0 |
| Total solids by volume, percent | 72.6 |
| Pigment volume concentration, percent | 15.6 |
| Fineness of grind N. S. (Min.) | 4 |
| Weight per gallon, pounds | 9.7 ± 0.2 |
| Viscosity, Krebs units (at 77°F.) | 68 ± 4 |
| Flash point-Pensky-Martens (Min.) | 115° |

3.3.2 Finished paint–Finished paint prepared by mixing equal volumes of components A and B shall meet the requirements specified in Table V.

TABLE V–FINISHED PAINT

| Characteristics | Requirements |
|---|---|
| Total solids by volume Min. percent | 61.6 |
| Viscosity (K.U.) at 77° F. | 72 ± 4 |

TABLE V FINISHED PAINT (continued)

| Characteristics | Requirements |
|---|---|
| Gloss, 60° specular | 35-50 |
| Pot life, hours. at 77° F. (Min.) | 6-8 hours |
| Flash point (Min.) | 95° F. |
| Spreading rate of 200-230 sq. ft./gal will yield 4 mils dry film | |
| Drying time (hours), 3 mils dry film at 77° F. (Max.) | 8 |

4.0 **Inspection of preparation for delivery.** The packaging, packing and marking shall be examined and tested in accordance with TT-P-143 to determine compliance with Section 5 of this specification.

5.0 **MARKING INSTRUCTIONS**

All containers shall be marked as follows:

1. Suppliers standard identification label with the following printed or stenciled on the label:

"Mare Island Experimental Formula 1B-40 Polyamide-Epoxy Paint Interior Bilge Paint, Red"

with "Component A (Polyamide)" or "Component B (Epoxy)"

2. The container shall be stenciled with the following:
   a. Batch number and date of manufacture
   b. Purchase order number
   c. Mixing and application instructions as follows:
      (1) DO NOT USE BELOW 50° F.
      (2) Mix only amount for six hours work
      (3) Stir A and B thoroughly
      (4) Mix A and B 1 to 1 by volume
      (5) Allow paint to stand one hour before applying.