before looking for and correcting other causes of excessive speed pulsation such as:

(a) Unbalanced rotor.

(b) Unequal air gaps.

(c) Poorly aligned shaft or bearing.

(d) On diesel engine-driven units, sticking valves, incorrect valve timing, or one or more cylinders not operating satisfactorily.

(3) If the voltage fluctuation at no load is still in excess of the limit specified in article 61–140 (3), adjust the governor to reduce the speed pulsation. If the governor has a hunt or compensation feature, adjust this, if possible, until the speed pulsation is within suitable limits. If the governor has no such feature increasing the speed droop will decrease the speed pulsation.

(4) Apply a light load to the generating unit operating alone, that is, not in parallel with any other. Increase the load to about half rated load; warm up the unit at this load for about 30 minutes; and then gradually build up to full rated load adjusting the field rheostat to maintain full-load rated voltage. Run at full load for one hour and then check the generator voltage, current, and speed. If necessary, readjust the load, governor, and field rheostat until the generating set is operating at full load rated current, voltage, and speed.

(5) Gradually reduce the load on the generator to zero without changing the governor or the field rheostat settings. Note the no-load speed and no-load voltage.

(6) Adjust the shunt field rheostat until the voltage at no load is equal to the rated full-load voltage. Increase the load to full load without changing the governor or field rheostat settings. Note the full load speed and voltage.

(7) Compare the observed speed regulation and voltage rise with table I. The speed regulation is the no-load speed minus the full-load speed expressed as a percentage of full-load rated speed. The voltage rise is the no-load voltage minus the full-load voltage expressed as a percentage of full-load rated voltage. The voltage drop is defined similarly. Note that when measuring voltage rise, the shunt field rheostat is set to give rated full-load voltage when the machine is carrying full load; but when measuring voltage drop, it is set to give rated full-load voltage when the load is zero. In both cases the field rheostat is then left unchanged while the load is changed. The generator operates at different points on the saturation curve in these two cases, which is the reason for the difference between voltage rise and voltage drop as given in the table.

TABLE I

Prime mover	Maximum permissible speed regulation (percent)	Combined unit	
		Voltage rise full load to no load (percent)	Voltage drop no load to full load (percent)
Turbine ----------	3.5	7 to 8	9-12 1/2
Diesel engine[1] -----	4.0	7 to 8	9-12

[1] Certain diesel engines have isochronous or constant speed governors. The speed regulation on these should be practically zero.

(8) Adjust the prime mover governor, if necessary, until the speed at full load is equal to the speed recommended by the manufacturer, the speed regulation is within the limits given in table I, and the voltage fluctuation at no load and any load between 20 percent and 100 percent of full load is not greater than the values given in article 61–140(3). The adjustments should be made gradually. After each small change, apply full load and recheck. It may not be possible to obtain by the speed adjustment alone a voltage rise and drop which are in accordance with table I but the adjustment should be made to approach this condition as closely as possible. For example, if the speed regulation is less than 3.5 percent for a turbine-driven unit and the voltage rise is less than seven percent, adjust the governor to increase the speed regulation (though not to above 3.5 percent) as a change in this direction will increase the voltage rise.

(9) If, after the speed adjustment has been completed, the voltage rise and drop are not within the limits shown in table I, the voltage regulation must be adjusted. Always stop the generator before making an adjustment. Three methods of adjustment are possible:

(a) For machines having adjustable shunts or diverters connected in parallel with the series fields on the generators, satisfactory voltage regulation can usually be obtained by changing the resistance of the diverters. To increase the difference between no-load and full-load voltage, decrease the resistance of the diverter.

(b) For generators without series field diverters, the voltage regulation adjustment must be made by shifting the brushes. The brush position selected by the manufacturer will be indicated by marks or pointers on the brush rigging and corresponding marks on the generator frame. Adjustments will usually be simplified by initially setting the brushes in this position. To increase the difference between no-load and full-load voltage, shift the brushes in the direction of rotation of the generator. Only a small change (about 1/32 inch) should be made in brush position for each adjustment. After the final adjustment, check the commutation. If there is still objectionable sparking after operating under load for one hour, it will be necessary to reset the brushes.

(c) For generators equipped with diverters, method (a) can be supplemented by method (b).

(10) When the generating unit has been adjusted to have the desired speed regulation and voltage rise and drop, operate at no load; adjust the field rheostat to give rated voltage; and then increase the load to rated load in steps of approximately 20 percent of the rated load without changing the governor or field rheostat setting. Note and record the values required in table II under "Voltage Drop." When increasing the load during this test, and when decreasing it (see art. 61–141(11)) to obtain the data for "Voltage Rise," do not bring the load back to a point which has been skipped unless the load change has first been carried to completion, that is, from no load to full load or from full load to no load.

Chapter 9621

Electric Power Distribution System

List of Effective Pages

PAGE NUMBERS	CHANGE IN EFFECT
1–10	Original
11	Change 2
12–20	Original
21	Change 1
22–31	Original
32–32A	Change 3
33–37	Original

Original: 1 April 1966
Change 1: 15 July 1966
Change 2: 15 October 1966
Change 3: 15 April 1967

NAVAL SHIPS TECHNICAL MANUAL
formerly
Bureau of Ships Technical Manual

may be used as feeder breakers in some installations. Since these breakers can interrupt the fault current, they can also replace the ACB "back up" breakers. AQB breakers are used on the load side of AQB-LF breakers. If the AQB breaker has a smaller frame size than the AQB-LF breaker and the AQB breaker cannot interrupt the fault, the AQB-LF breaker will. If there is cable with sufficient impedence and the AQB-LF breaker, the AQB-LF breaker fuses will limit the fault current thereby protecting itself and the AQB breaker in series when the fault current is higher than the AQB breaker can interrupt. A fault at B would trip the feeder breaker, but not the generator or bus tie breakers. A fault at C would trip both bus-tie breakers. A fault at D, on switchboard No. 1, would trip No. 1 generator circuit breaker and one or both of the bus-tie breakers. In each case, the faulted section of the system is isolated, but power is continued on as much of the system as possible in view of the location of the fault. The circuit breaker settings which give best protection are naturally not the same in all installations. For full information on a specific installation, it is necessary to refer to the ship's plan, which shows circuit breaker time-current characteristics for that ship in curves similar to those in figure 9621-9.

6. Attainment of selective tripping requires careful coordination of the time-current characteristics for different circuit breakers. For example, if the system illustrated in figure 9621-8 is operating "split plant" (bus-ties open) and if the bands shown in Figure 9621-9 for the ACB feeder breaker and ACB generator breaker were interchanged, a fault at B in Figure 9621-8 would trip the No. 1 generator off the line, but would leave the feeder connected to the switchboard. This would cut off power to all equipment served by No. 1 switchboard, but would not isolate the faulted section. Consequently, unauthorized changes should not be made in circuit breaker trip settings since the scheme of protection based upon selective tripping could be completely disrupted. Adjustments are made at the factory and sealed.

9621.64. CIRCUIT PROTECTION WITH FUSES

It is not feasible to provide system protection by selective tripping of circuit breakers on all types of naval ships or for all circuits. For instance dc distribution systems on older ships and all lighting circuits use fuses almost entirely. Time delay can be incorporated only insofar as fuse characteristics permit. Progressively larger fuse sizes from load to generator give some degree of selectivity for overload or limited fault protection. Care should be exercised in the replacement of fuses to ensure that:

1. fuses are of the proper voltage rating
2. fuses are of the proper interrupting capacity
3. for special fast acting fuses supplying electronic equipment there may be no equivalent types. In which case, replacement fuses must be identical.

9621.65. VOLTAGE AND FREQUENCY PROTECTIVE MONITORING

Electronic equipment can be damaged by continued operation under abnormal voltage or frequency conditions. The 400-cycle systems on new ships are, therefore, checked by voltage or voltage and frequency monitoring devices. Occasionally, this may also be done on 60-cycle systems. When the voltage or frequency exceeds allowable limits for a predetermined length of time, the power supply circuit breaker is tripped. When the generator bus is being monitored, the device senses both voltage and frequency and is set to trip the generator breaker. When the devices are monitoring the output of a line voltage regulator, the device senses only voltage and is set to trip the circuit breaker supplying that line voltage regulator. When protective devices are installed, they are set to interrupt the supply within 0.25 seconds when the voltage or frequency exceeds the transient limits. Where monitors are installed, interruption will be initiated under the following conditions:

Types I and II Power

- Overvoltage: In excess of 125 percent ± 5 percent of nominal voltage.
- Undervoltage: Below 75 percent ± 5 percent of nominal voltage.
- Overfrequency: 430 ± 5 cycles per second for 400 cycle systems and 65 ± 1 cycles per second for 60 cycle systems.
- Underfrequency: 370 ±5 cycles per second for 400 cycle systems and 55 ± 1 cycles per second for 60 cycle systems.

Type III Power

- Overvoltage: In excess of 115 percent ± 5 percent of nominal voltage
- Undervoltage: Between 85 and 90 percent of nominal voltage
- Overfrequency: 420 cycles or over
- Underfrequency: 380 cycles ± 5 cycles or less

SECTION II. OPERATION

9621.71. CHARACTERISTICS OF ELECTRICAL INSTALLATION

The characteristics built into naval electrical installations are simplicity, ruggedness, reliability, and flexibility to permit continued service after part of the equipment has been damaged. It is the function of those who operate these plants to make full use of their inherent capabilities, and to maintain, as far as possible, uninterrupted availability of electric power where it is needed. To be able to do this, operating personnel should possess:

1. through knowledge of operation and maintenance of the component parts of the electric plan
2. complete familiarity with the electric plant as a whole
3. comprehensive understanding of system operation
4. ability to apply general principles to specific installations
5. knowledge of a few simple rules of system operation which are applicable to all naval installations.

9621.72. INSTRUCTIONS FOR SPECIFIC ITEMS

Instructions for specific items of electrical equipment are to be found in other chapters of this manual and in manufacturers' technical manuals. See particularly:

Chapter 9640.....Tables of Engineering Data

Chapter 9641, Section IV.....Electric Propulsion Installations

Chapter 9600	Electric Plant-General
Chapter 9610	Electric Generators and Voltage Regulators
Chapter 9621	Electric Power Distribution System
Chapter 9622	Portable Storage Batteries and Dry Batteries
Chapter 9623	Submarine Storage Batteries
Chapter 9630	Electric Motors and Controllers
Chapter 9640	Lighting
Chapter 9650	Interior Communication Installations
Chapter 9660	Searchlights
Chapter 9670	Electronics
Chapter 9690	Electrical Measuring and Test Instruments
Chapter 9710	Fire-Control Installations
Chapter 9814	Degaussing Installations
Chapter 9850	Motion Picture Equipment
Chapter 9920	Welding and Allied Processes

9621.73. FAMILIARITY WITH ELECTRICAL SYSTEM

Familiarity with the electrical system as a whole can be gained by study of information relating specifically to that installation. Valuable information on a ship's electrical installation is to be found in the Ship Information Book, Particularly Volume 3 for power and lighting systems and in the book of "onboard plans" carried by the ship, in training old booklets, and in manufacturers' technical manuals supplied with many items of equipment. Study of these should be supplemented by a thorough study of the system itself so that generators, switchboards, distribution panels, and cables are not merely symbols on a plan but physical entities, the location of which is definitely known, whose functions and relations to the rest of the system are thoroughly understood.

9621.74. GENERAL PRINCIPLES OF SYSTEM OPERATION

General principles of system operation serve as a guide to the procedures which should be followed to maintain continuous availability of electric power. The general principles considered here relate to:

1. Split plant operation
2. Choice of power source
3. Prevention of overloads
4. Operation under casualty conditions

9621.75. SPLIT PLANT OPERATION

1. Consider a ship with two or four ship service switchboards, operating under battle conditions with all bus-ties closed and all generators running in parallel. A hit on switchboard No. 1, for example, or on a load center or cables connected to switchboard No. 1 may cause a short circuit. This will draw current from all generators, will momentarily affect the entire system, and may trip all generators off the line and result in a temporary loss of all ship service power. System protection is provided for the purpose of localizing the fault (see article 9621.63), but automatic protective devices, unfortunately, do not always function as intended. In addition, the overcurrent protective systems are not designed on the basis of handling the available fault currents when all the ships service generators are operated in parallel. (Refer to Ship Information Book, Volume 3). For this reason, the best arrangement for preventing loss of all power is to operate "split plant," that is with all bus-ties open. Each switchboard with its generators and loads then forms a system independent of the others. A hit on switchboard No. 1 will result in loss of power for the loads fed from this switchboard, but will not affect the loads fed from the others.

2. Split plant operation should, therefore, be used under battle or other conditions for maximum assurance against loss of all ship service power. If a switchboard is fed by two or more generators and if some of the generators are lost, split plant operation can be continued by using the remaining generators to supply power for some of the loads fed from the switchboard, and shifting other loads normally fed from the switchboard to alternate feeders connecting to other switchboards (see article 9621.12 (6)). If all generating capacity for a switchboard is lost, the bus-tie circuit breakers can be closed to energize the switchboard from one of the others. The chief utility of the bus-tie connection is obtained when all generating capacity for one switchboard is lost, or when operating at light loads at anchor or under cruising conditions such that a temporary loss of all ship service power could not endanger the ship.

3. On ships having diesel generators, split plant operation should not be used unnecessarily, if it results in loads of less than 40 percent rating of the engines. (See article 41-329.)

9621.76. CHOICE OF POWER SOURCE

When both normal and alternate feeders are installed to a load, the normal source of power should be used except when loss of part or all the generating capacity at the switchboard supplying normal power makes it advisable to shift to the alternate source (see articles 9621.75 (2) and 9621.78 (1)).

9621.77. PREVENTION OF OVERLOADS

1. Sole reliance is placed upon the vigilance of the operator to guard against moderate overcurrents and power overloads which, if long continued, would cause excessive heating of generators. Ammeter readings will reveal the presence of overcurrents; wattmeter readings, of power overloads.

2. If a switchboard controls two or more generators and less than the full number is being used to supply power, the load on the switchboard may increase to a point which will overload the generators in use. When the switchboard

instruments reveal this condition, or when it is anticipated very soon, another generator should be added. (See Chapter 9610 of this manual for instructions on the operation of generators.)

3. Emergency switchboards are connected by feeders to loads which may sometime need emergency power. The emergency generators are not of sufficient capacity, however, to provide power for the simultaneous operation of all loads

Chapter 9190

Preservation of Ships Service

Superseded chapter

List of Effective Pages

PAGE NUMBERS	CHANGE IN EFFECT
1, 2	Change 1
3 - 11	Original
12 - 16	Change 1
17	Original
18, 19	Change 1
20	Original
21	Change 1
22	Original
23	Change 1
24 - 28	Original
29	Change 1
30	Original
31	Change 1
32 - 35	Original
36	Change 1
37 - 39	Original
40	Change 1
41	Original
42	Original
43, 43A	Change 1
44	Change 1
45 - 63	Original

Original: 1 November 1965
Change 1: 15 January 1966

Chapter 9190

Preservation of Ships Service

List of Effective Pages

PAGE NUMBERS	CHANGE IN EFFECT
1	Original
2	Change 1
3–6	Original
7	Change 1
8–11	Original
12	Change 1
13–18	Original
19–20	Change 1
21–32	Original
33	Change 1
34–69	Original

Original: 1 April 1967
Change 1: 15 April 1967

NAVAL SHIPS TECHNICAL MANUAL
formerly
Bureau of Ships Technical Manual

CHAPTER 9190–PRESERVATION OF SHIPS IN SERVICE

2/1/67

This printing supersedes Chapter 9190 of 11/1/65 and includes all changes prior to this date

CONTENTS

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 6788A	Topside Painting-Preparation.	13 minutes.
MN 6788B	Topside Painting-Application.	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.

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 Bureau of Ships 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 oftener than is considered necessary for preservation.

2. Soiled interior surfaces must 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 point 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

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

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

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

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

4. Hatch and door rubber gaskets.

5. Identification plates.

6. Insulators.

7. Knife edges of watertight doors and hatches.

8. Porcelainized bulkheads.

9. Threaded parts.

10. Zincs.

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

a. Bins, shelves, dressers, drawers, cabinets, battens, and fittings

b. Interior gratings, hand rails, and floor plates

c. Internal surfaces of ventilation ducts.

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:

1. The total quantity of paint required.

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

3. The difficulty of mixing and handling larger containers.

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

5. 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 understanding of the history, 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 instructions 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, became through necessity, matter of personal judgement. 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 **Bureau of 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 stem 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, scrap-

ing, 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) is recommended for loosening rust and scale and reducing further 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 dip, 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 surface, 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 surface 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. a. 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.

b. 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.

c. 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 ap-

pears to be drying, reapply a small amount. Rinse the surface in a stream of hot water at about 90 to 100 pounds pressure. A Sellers 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 contains 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	G5130-288-6577	115 a.c. d.c.	For shipboard use--to remove rust, paint, scale, etc.
Replacement cutter bundles	G5130-287-5199		
Electric deck scaling machine, Tennant Model K	Open purchase from G.H. Tennant Co., Minneapolis 11, Minn.	220 a.c., 440 a.c., 550 a.c.	For scaling, wire brushing or sanding large deck surfaces
Electric portable deck scaling machine, Tennant Model 2C	Open purchase from G.H. Tennant Co.	230 d.c. 220/440 a.c.	For scaling, wire brushing or sanding large deck surfaces
ES-Electric portable disc sander with three discs	G5130-203-4857 (7-inch) G5130-203-4856 (9-1/8-inch)	Universal Motor 115 v.	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	G5130-224-6504 (5-inch) G5130-540-0120 (6-inch)	Universal Motor 115 v.	Can be used with cup or wheel wire brush
PWG-Pneumatic vertical grinder without wheels or brushes (6-inch)	G5130-184-0090	Air	For use with cup wheels and cup type wire brushes
PG-Pneumatic horizontal aerial grinder without wheels or brushes	G5130-242-0581 (6-inch)	Air	Can be used with radial type or cup type wire brushes
	G5130-190-6434 (8-inch)	Air	
EHS-Electric portable scaling hammer without accessories	G5130-294-9509	Universal Motor 115 v.	For removing rust and paint. (0.495-inch-shank diameter)
PHS-Portable pneumatic scaling hammer	G5130-190-6442	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 possibly 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 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

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° Baumé 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 in 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 one 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 excesive 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 insure 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 used 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, 1160 - 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 HP-30 mils at 30-35 sq. ft. per gallon

9190.42 MEASUREMENT OF FILM THICKNESS

Several measuring devices are available for determing 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.

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 Bureau of 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 half-way 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 undisturbed.

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 trigger 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 mainte-

nance 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 figure 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.

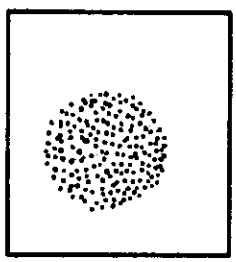

FIG. 9190-1
NORMAL

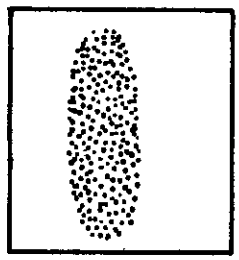

FIG. 9190-2
NORMAL

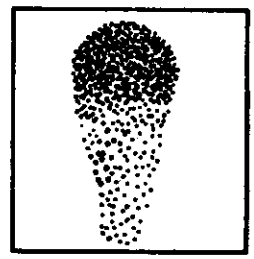

FIG. 9190-3
HEAVY TOP

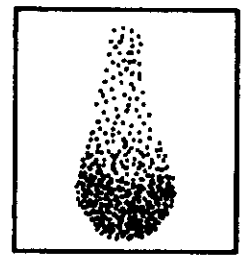

FIG. 9190-4
HEAVY BOTTOM

FIG. 9190-5
HEAVY RIGHT SIDE

FIG. 9190-6
HEAVY LEFT SIDE

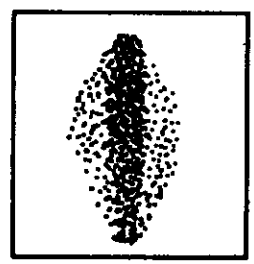

FIG. 9190-7
HEAVY CENTERED

FIG. 9190-8
SPLIT SPRAY

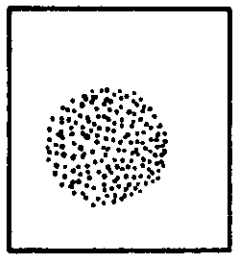

FIG. 9190-1
NORMAL

FIG. 9190-2
NORMAL

FIG. 9190-3
HEAVY TOP

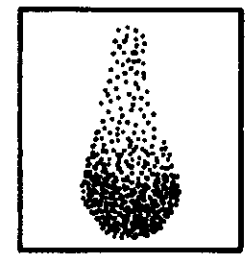

FIG. 9190-4
HEAVY BOTTOM

FIG. 9190-5
HEAVY RIGHT SIDE

FIG. 9190-6
HEAVY LEFT SIDE

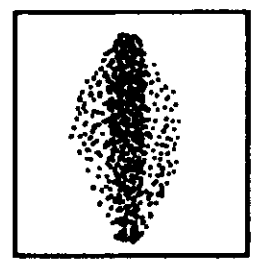

FIG. 9190-7
HEAVY CENTERED

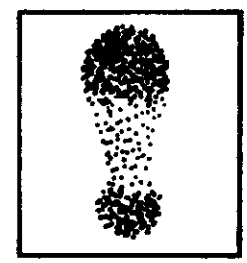

FIG. 9190-8
SPLIT SPRAY

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 thicknesses 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 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 9190.170 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 9190.170 or with resin-glass cloth supplied 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 9190.170 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.

ing 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, Cl 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 9190.7 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 Bureau-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 insulotion tape is required for joints in dry spoces, 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 BUSHIPS 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 (p)), 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.

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 METAL SURFACES

Item	Surface	Paint system (number of coats-formula No.)	Paragraphs
1	Keel to lower boottopping limit	a. 1-117; 3-14N; 1-15 HP or	(a) (b) (c) (d) (e) (f)
		b. 1-117; 3-14N 3-105.	(a) (b) (d) (e) (f)
		c. 1-117; 4-119 or 120; 2-121.	(a) (b) (d) (e) (f) (v)
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	(g) (q)
3	All exterior and near vertical surfaces from upper boottopping limit	1-117; 2-116; 2-54	(b) (e) (h) (j) (k) (u)
4	Exterior horizontal surfaces and waterways.	1-117; 2-116; 2-20	(b) (e) (h) (j) (k) (l) (r) (t)
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.)	Paragraphs
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.	(p).
4	Exterior vertical surfaces (includes near vertical).	1-Aluminum paint; 2-5H	(j) (p).
5	Exterior horizontal surfaces and waterways.	1-Aluminum paint; 2-20	(j) (l) (p).
6	Masts and spars	2-Aluminum paint; 2-5H	(f).
7	Accommodation ladders.	4-80	
8	Fittings	1-Aluminum paint; or 20.	(j) (n).

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 underwater 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. 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 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 Bureau 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 19.191, table 13.

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.

(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 horizontal 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 coal tar-epoxy systems, MIL-P-23236, Class 2 paint system, or 2 coats of any of the following coal tar-epoxy systems ("TARSET", CORRO-BAN's "TAREP 401", Amercoat Corporation's "AMERCOAT No. 78", "AMERCOAT No. 79", De Soto Chemical Coatings "KOROPON CT", Inertol 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-paint system specified in item 1, table I: 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 paste with 1 gallon varnish. 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 9190.166 for application instructions.)

(q) Synthetic rubber-base exterior deck coating (Minnesota Mining and Manufacturing Company EC-2089 or equal) may be used in lieu of primer and formula 20, particularly in areas subject to heavy traffic. Dry film thickness of coating should be approximately 6 mils (requiring 3 coats; with 4 hours minimum drying between coats), and should be applied to clean, unpainted metal. For maintenance, synthetic rubber coating or formula 20 should be used. (Formula 20 is compatible with synthetic rubber coating.) Where durability and a non-skid surface are required, nonskid compound Mil. Spec. MIL-D-23003 should be used.

(r) Where adhesion is a problem, one coat of formula 119 or 120 may be added as a tie coat over formula 117.

(s) Pending satisfactory service performance of other zinc-rich coatings, the use of "Dimetcote No. 3" is approved for weather decks which are subject to severe abrasion and operating conditions as encountered on LST tank decks and weather decks of ARS, ARSD, and ATF type ships.

For steel weather decks on other ships subject to "normal" usage, the following zinc rich coatings are approved: Dimetcote No. 3, Rust-Ban 190/195, Rust-Ban 191, Carbo-zinc No. 11 (red or gray), and Cathacoat 301 and Cathacoat 302. These coatings should provide reduced maintenance as compared with the standard deck paint system or the coatings in Note (r) above. Application should be over abrasive blasted surfaces prepared to a uniform gray appearance in accordance with manufacturers' specifications. Initial application should be by the shipyard. Touch-up may be accomplished by ships' force. Zinc-rich coatings may be overcoated with formula 20, for appearance, or with MIL-D-23003 to provide non-slip properties where required. Formula 117 should be used as a tie coat after removal of any deposits formed during curing.

(t) Inorganic zinc coatings in the foregoing note (t) also are approved for vertical weather surfaces from the waterline and above. Application and touchup should be as described in note (t). Inorganic zinc coating should be overcoated with the top coat normally used on the surface involved.

(u) Vinyl System shall 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.

(v) Ships utilizing an impressed current system require the standard Navy vinyl paint system or other Bureau 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. One coat pretreatment, formula 117 (use primer formula 116 in lieu of formula 117 where necessary safety precautions are not possible); use 2 finish-coats 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.

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 allowed 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 subject to sweating in accordance with article 9190.165, 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 porcelainized 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. **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. Interior 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.

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

Item	Color	Formula	Specification	
1	White	124/58	MIL-E-17970C	1
2	Pastel green	125/58	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.

8. 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 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	Green, 125/58	Green, 125/58
	f. Secondary conn	Green, 125/58	Green, 125/58
	g. Other spaces	Green, 125/58	White, 124/58

TABLE 4.–Cont'd.

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

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

10. 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]BUSHIPS 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.)	Paragraphs
1	Catapult gravity tank	1-117;2-119; 2-132X	(a)(b)
2	Chain locker	Class 2 or 3 of MIL-P-23236	(d)(d)(j)
3	Drainage tanks	Class 1, 2, or 4 of MIL-P-23236	(a)(d)(j)
4	Feed water tanks	Bureau approved coating	(a)(t)
5	Floodable but normally empty voids	Mil. Spec. MIL-C-16173, gr. 1	(c)(g)(h)
6	Fresh water tanks	Bureau approved coating	(a)(d)(f) (t)
7	Fuel and ballast		(c)
8	Fuel oil tanks	None	(c)
9	Cargo gasoline and JP-5 tanks on oilers.	5-113, Class 1, 3, or 4 of MIL-P-23236	(a)(i)(j)
10	JP-4 tanks on carriers	See art. 9190.169	(a)
11	Gasoline tanks on carriers	None	(a)
12	JP-5 emergency tanks	Class 1, 3, or 4 of MIL-P-23236	(d)
13	Lubricating oil tanks	None	(a)
14	Nonfloodable voids	1-117;1-116;1-30	(c)(d)(e) (g)(k)
15	Peak tanks	2-116;2-30	(c)(d)(g)(k)
16	Salt water tanks:		
	a. LSD's and LST's	Class 1, 2, or 4 of MIL-P-23236	(c)(j)(s)
	b. Other ships	1-117;2-14N	(c)(d)(e)(l) (j)
17	Sanitary tanks	Class 2 of MIL-P-23236	(a)(d)(j)
18	Small inaccessible voids	Mil. Spec. MIL-C-16173, gr. 1	(c)(d)(m) (u)
19	Structure and fittings below floor plates in machinery spaces (bilges, bilge wells and sumps).	1-117;2-14N or 116; 2-23 or Mil. Spec. MIL-P-23236, class 1 or 2	(c)(e)(n) (r)
20	Silicon bronze diesel fuel-oil tanks	5-113	(q)

TABLE 7.–TANK COATINGS (WOOD STRUCTURE)

Item	Space	Coatings (number of coats-formula No.)	Paragraphs
1	Chain locker	2-aluminum paint	(o).
2	Bilges	Unpainted	(p).

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. Until stocks are available, procure aluminum vinyl paint formula 132X commercially in accordance with formulation obtainable from the Bureau.

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 9190.172. 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.

(f) See article 9190.164 for application instructions.

(g) 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. Non-floodable (dry voids) are cofferdams and inner bottom compartments not piped for flooding. Substitute

TABLE 7.–TANK COATINGS (WOOD STRUCTURE)

Item	Space	Coatings (number of coats-formula No.)	Paragraphs
1	Chain locker	2-aluminum paint	(o).
2	Bilges	Unpainted	(p).

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. Until stocks are available, procure aluminum vinyl paint formula 132X commercially in accordance with formulation obtainable from NAVSEC.

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 9190.171. 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.

(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. Non-floodable (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) Use rust preventive compound for complete preservation; this requires only removal of loose rust and scale and deteriorated paint. For touchup, use coatings previously applied.

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

(i) Surfaces must be blasted to bare steel.

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

(k) Tanks used exclusively for salt water.

(l) Small inaccessible voids include those in which application of paint by brush or spray is impractical. Coat by filling and emptying.

(m) Includes bottoms and edges of floor plates.

(n) Prepare aluminum paint by mixing 2 pounds aluminum paste with one gallon varnish.

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

(p) All oil residues must be removed and the tank surfaces must be as clean and dry as possible. Removal of oil residues shall be accomplished in accordance with BUSHIPS INSTRUCTION 9000.15. After all oil is removed and after the final sea water rinse (step 11 of 9000.15), the tank shall be thoroughly rinsed with 150° fresh water and dried. Tanks should be roughened by sanding to provide a toothed surface to improve adhesion. Sandblasting is not necessary.

(q) 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 practicol. 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.

(r) Approved tank coatings which form hard films, as described in article 9190.168, are preferred. However, flotation type, MIL-R-21006(SHIPS), or spray-on-type, MIL-C-23050(SHIPS), ballast tank preservatives are approved as alternates. 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.

(s) Approved coatings are listed in article 9190.168.

(t) 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.

2. **Locked-in fresh water ballast.** –In lieu of the approved coatings in art 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 Numbers - 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 of coats-formula No.)	Paragraphs
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 122-3	(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 122-3) 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 subject to camouflage should be dull black, formula 122-3.. Surfoces subject to camouflage shall receive topcoats 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 o tender will not result in high concentrations of vapor. Natural ventilation will usually be adequate provided standord precautions pertaining to inflammable material such os no smoking, burning, welding in immediate areas, elimination of chipping ond 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 250-374 of January 1953, "Ship Concealment Camouflage Instructions" 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 system may be used when weather conditions permit (minimum temperature 50° F.), as follows over bare steel; 2 coats of DEVRAN 201 primer and two coats of DEVRAN 219 to a minimum dry-film thickness of 10 mils on exterior superstructure, and two coats of DEVRAN 201 and one coat DEVRAN 219 (appropriate color) on areas underneath superstructure to a minimum dry-film thickness of 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, Formula 116 or 84, and two coats of fire retardant paint 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.

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	Paragraphs
1	Bow buoyancy and main ballast tanks	5-113 plus 2-121 to 2 feet above flood valve opening.	6 mils plus 4 mils.	(a) (c) (d) (f).
2	Fuel oil ballast and expansion tanks; negative tank and safety tank.	5-113	6 mils	(a) (c) (d) (f).
3	Water round torpedo and round mines; trim and auxiliary tanks.	5-113		(c) (f).
4	Normal fuel oil, clean fuel oil, collecting fuel oil, and variable fuel oil tanks.	None		(b).
5	Lubricating oil sump and lubricating oil tanks.	None		(a).
6	Poppet valve drain tank	1-117; 2-116 or 14N; 2-23	5 mils	(b) (e) (h).
		5-113 or	6 mils	(a) (c) (d).
7.	Sanitary tank	Class 2 of Mil-P-23236 Bureau approved coating	10 mils	(a) (g)
8	Potable tanks	Bureau approved coating or 5-113 (white)	6 mils	(a) (i) (a) (c) (d).
9	Surge tanks	2-Dampney Co. Apexior No. 1		(g)
10	Reserve feed tank	Bureau Approved Coating		(a) (i)
11	Drain collecting tank	Bureau Approved Coating		(a) (i)
12	Bilges, drainage trenches, and missile tube eject chamber interiors	1-117, 2-116, or 2-14N; 2-23	5 mils	(b) (e) (h)

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. For application instruction, see article 9190.163.

(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 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 in lieu of saran.

(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 9190.169, 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) Additional approved coatings are listed in article 9190.173.

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.)	Paragraph
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).
Piping, fitting, and valves	1-117 and 2 finish coats or	(a) (i) (j).
	1-117; 2-116 or 14N; 2-23.	(e) (i).
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) (i).
Oxygen piping	1-117; 1-116; 2-39	(h) (i).

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) See NAVSHIPS 250-648-6.

(g) 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.

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

(i) 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.

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

9190.132. 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 piping and components of reactor plant systems.
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. Rudder 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 piping and components in reactor compartments, on corrosion resisting piping and components in reactor plant systems outside reactor compartment or on nuclear support facility system, corrosion resisting piping and components on Tenders. Corrosion resisting materials include corrosion resisting steels, nickel-copper alloy, copper-nickel alloy, nickel-chromium-iron alloy. Brass, bronze, gun metal, and copper where used in submarine systems are to be included. 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-W-556 except that the wire should be stainless. Acetone should be unused or redistilled in accordance with Fed. Spec. O-A-51.

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 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 point 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 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 d.c. installations may be painted. Electric propulsion cables for a.c. 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 Bureau standard plans, and enclosures for electric equipment in general (except electronic, interior communication and fire contral equipment) for which painting is not otherwise specified in purchase specifications, shall be coated in accordance with table 12 as follows:

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-664a 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.

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. 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.

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

6. 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.

7. 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
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

8. 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-20207 (GF-6850-249-8024), diluted with two to ten parts of 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 250-374.

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.

9. 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 shoud 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. Bureau of Ships 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 Bureau of Ships 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 markings on aircraft carriers should be in accordance with the latest applicable Naval Air Engineering Facility plans listed below:

Carriers	NAEF Plan No.
CVA 16, 31, 38	607004
CVA 41–42	607005
CVA 59, 60, 61, 62	607028
CVA 36 C1	607041
CVS 11, 14, 19	607044
CVA 9, 15, 20 CVS 10, 12, 18, 33	607296
CVA 34	607895
CVA 43	607914
CVS 10 C1; CVS 13 C1	608368

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.

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).
(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) Operations	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"	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).

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

2. Letters should be block-type shaded on the right sides and lower edges with black, formula 38, as shown on BUSHIPS 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 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.

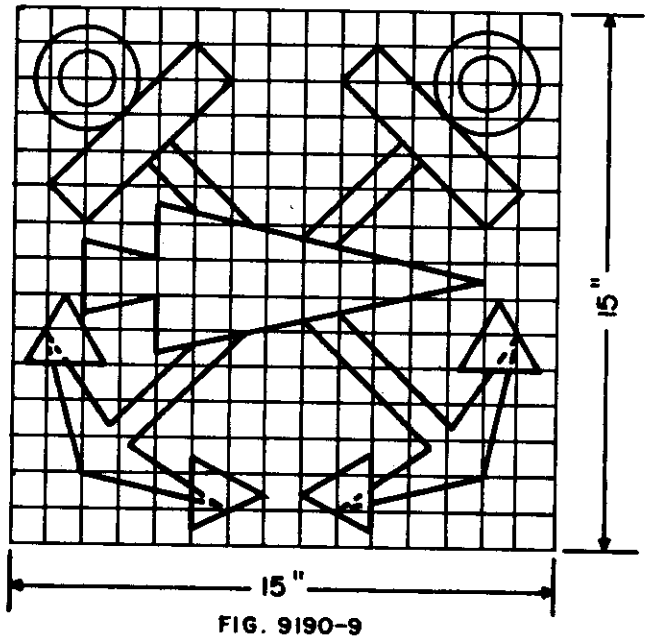

FIG. 9190-9

ASSAULT BOAT INSIGNIA

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

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. Boats 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 at 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. Each 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 by a transformer, located on the pressure kettle, 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 chassis 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 temperature under any weather condition. 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 at 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 facilitate 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 oil-fired 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-HP 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 top 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 250°F. and 275°F. for formula 15HP, and 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 or 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. 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 alchohol 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 art. 9190.163 for detail safety precautions.)

a. All the safety precautions of chapter 9920, section VI, of the **Bureau of 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 enforced.

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. APPLICATION OF "SARAN", FORMULA 113 (White and Orange)

1. The equipment and facilities for safety precautions required during application of saran coating are generally not available to the ship. Complete painting or touchup by ship's force is not approved where specified safety precautions cannot be followed.

2. Thorough surface preparation by blasting to completely clean steel is necessary to obtain adhesion of the coating. Saran should not be applied to galvanized or nonporous surfaces. Grit or shot blasting is preferred because there is less dust and better visibility than when sandblasting. Slight after rusing may be removed by washing surfaces with 2 percent phosphoric acid solution. All traces of previously applied, different coatings (other than vinyl or saran) and oil or grease must be removed. Application of the coating should be started as soon as possible after surface preparation is completed. All traces of dust and debris must be removed and the surface must be dry. Formula 117 should not be used.

3. Saran, formula 113, is stocked in two colors, "white" and "orange." Both colors are required in the application to assure uniform film coverage by color contrast between coats. Five or more coats are applied directly to the cleaned surface, alternating between "white" and "orange" until a dry film thickness of no less than 6 mils is obtained. Where practical, final coat should be white. For hot-spray application, a minimum of three coats is acceptable.

4. Saran may be applied by brush or spray. Before large scale application in any given area, one coat of saran should be applied to all edges, seams, welds, rivet heads, and corners of structural members to assure adequate protection of these critical corrosion areas. After such touchup, the overall coats of saran should be applied. In both brush and spray applications, saran is applied as received in the container after thorough stirring and without further thinning. In brush applications, saran is "flowed-on" rather than "brushed-out" in order to "fill-in" the metal without unduly causing sags, drips, or runs. In spray applications, the spray equipment and operating techniques described in article 9190.166 for vinyl paint application apply. Formula 113 does not require thinning and is used as received in the container.

5. To estimate the quantity of saran required to obtain the minimum film thickness of 6 mils, divide the square feet of surface to be coated by 20. This value will approximately represent the gallons of saran needed.

6. Apply one coat to all edges, stiffeners, and in the corners as the first coating operation. Five coats of contrasting colors (or three coats for hot spray application) should next be applied and should yield a film thickness of 6 to 8 mils. Where practical, final coat should be white. In well ventilated tanks, a drying period of one hour between coats is sufficient. Total film thickness should be measured with a film gage. If less than 6 mils at any point, additional coats should be applied as necessary. After painting has been completed, tanks should be ventilated until gas free.

7. Following is a discussion, together with specific safety precautions, in connection with the application of coatings containing highly volatile and flammable solvents and supplements article 9190.5. Typical coatings of this type are vinylidene resin coating (Formula 113), vinyl paints (Formula 119, 120, 121, 122, and 129) and pretreatment (Formula 117). The precautions outlined hereinafter apply specifically to spray and brush painting in tanks. However, these same precautions apply to the painting of exterior surfaces except that ventilation would probably be taken care of to a large degree by natural air movement in exterior areas.

8. **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 ex-

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 or 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 alchohol 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 art. 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 enforced.

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 HAZARDS FROM THE USE OF LOW FLASH POINT COATINGS (BELOW 100°F.)

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 Bureau of Ships 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 practicable 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)	Gauge 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

by means of spark-proof hooks and should never be wrapped around 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.

(1) 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 ZINC-DUST PAINT, FORMULA 102

1. Zinc-dust paint, formula 102, is issued as a two-package unit. One unit comprises 55½ pounds of dry zinc dust and 5 gallons of the base paint.

2. The mixing instructions below must be strictly followed:

To 1 gallon of the liquid portion, the zinc dust should be added in increments of 2-1/2 to 5 pounds, and the mixture stirred with a paddle until no lumps or dry particles of zinc dust remain. The remaining 4 gallons of liquid should be added in increments of one-half gallon and stirring continued after each addition until the mixture is homogeneous. Zinc dust should not be mixed with the liquid portion until just before application. Only enough paint should be mixed for immediate use.

3. Mixed paint should not be stored. (After the material is mixed, a gas pressure may build up within the closed containers.)

4. Zinc-dust paint should be applied in conformance with the following instructions:

The tank should be thoroughly cleaned of all old paint coatings. (It is especially important to remove entirely the zinc chromate after-pickling paint in drinking water tanks.) Removal of the paint coatings should be done by abrasive blasting (shot or grit is preferred), if practical. A power wire brush may be used. One coat of zinc dust paint should be applied. Unheated air should be circulated through the tank for 12 hours and a second coat applied. Unheated air should again be circulated for 12 hours. Tanks should be flushed twice with fresh water before being placed in service.

9190.165. 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 (stock number 8010-247-4325 (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 1/4-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 1/2-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-451 (27 percent minimum NH_3) 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 ovoid the loss of ammonio. These steps are best performed in a tank equipped with a high speed propeller-type agitator. The soap solution should always be odded 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.

9190.166. 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 o 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 spirits 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.

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 paints..	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 excercised 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 pottern. 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 menthyl 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.

d. Application should be made with a continuous stroke parallel at all times and overlapping preceding stroke at least two inches. Care should be excercised not to pause at the end of the stroke since this will cause piling up at the laps, causing an uneven oppearance 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 ovol 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 particulary suitable for application of vinyl primers and saran 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 structual 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 manufacturers. To date, recommendations have been received as follows. (Similar information received from manufacturers of other equipment will be disseminated upon receipt.)

	Combinations					
Model-Binks gun	Material nozzle		Air nozzle		Needle value	
	Part No.	Size	Part No.	Size	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

DeVilbiss 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	AV640	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 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.)

9190.167 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 practicable 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-S-15058.

9190.168 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.

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).

(4) If Formula 113 was applied, repaint with Formula 113 or Class 1 or 4 coating systems.

TABLE 15 – MIL-P-23236 QPL COATINGS*

Spec. Type and Class	Coating System	Total Dry Film Thickness (Mils)	Manufacture.
Type I, Cl. 1	DEVRAN 203* 1-202 Primer 2-Tank Coating 203	8 Min.	Devoe & Raynolds Co. Rutherford & Delancy Sts. Newark, N. J. and Riverside, Calif.
Type 1 Cl 1	DEVRAN 215 1-202 Primer 1-Tank Coating 215	8 mils	Devoe & Raynolds Co. Newark, N. J. and Riverside, Calif.
Type 1, Cl. 2	AMERCOAT No. 78 1-No. 78 Black 1-No. 78 Red	16 mils	Amercoat Corp.

Table 15 Cont'd

Spec. Type and Class	Coating System	Total Dry Film Thickness (Mils)	Manufacturer
Type 1, Cl.2	AMERCOAT No. 79 1-No. 79 Black 1-No. 79 Red	16 mils	Amercoat Corp.
Type I, Cl.2	TARSET-2cts[1]	15 min.	Pittsburgh Chem. Co. Neville Island Pittsburgh 25, Pa.
Type I, Cl.3	DIMETCOTE No. 3[3] 1-Dimetcote 2-D-3 Nonflammable[2] Curing Solution	2 to 3	Amercoat Corp. 4809 Firestone Blvd. South Gate Calif. and Buffalo, N.Y.
Type 1, Cl.3	DIMETCOTE No. 4 - (1 coat)	3-5 mils	Amercoat Corp.
Type 1, Cl.3	ZINCILATE 101-C	3-5 mils	Industrial Metal Protective Co., Inc.; 401 Homestead Ave., Dayton, Ohio; 414 Wilson Ave., Newark, N.J.; and Xenia, Ohio.
Type 1, Cl 3	ZINKOTE-(1 coat)[3]	3-5 mils	Amercoat Corp. South Gate, Calif. and Buffalo, N.Y.
Type 1, Cl 3	CARBO ZINC No. 11-HFP-(1 coat)[3]	3-4 mils	Carboline Co. 32 Hanley Ind. Ct. St. Louis 17, Mo.
Type I, Cl.3	RUST-BAN 190/195[3] 1-Rust-Ban 190 1-Rust-Ban 195[2] Nonflammable Curing Solution	2 to 4	Humble Oil and Refining Co. 8230 Stedman St. Houston, Tex.
Type I, Cl.3	CATHA-COAT 300[3] 1-Catha-Coat 300 1-MD-2599 Curing Solution[2]	2 to 4	Devoe & Raynolds Co. Rutherford & Delancey Sts. Newark, N.J. and Riverside, Calif.
→ Type 1, Cl.4 ↳	DEVRAN 203W System 1-202 Primer 2-Tank Coating 203W	7 mils	Devoe & Raynolds Co., Inc. Rutherford & Delaney Sts. Newark, N.J. and Riverside, California
Type I, Cl.4	LAMINAR X-500 1-Primer (Yellow-green) 4-G-14 1-White 4-W-1 1-Gray 4-X-13 1-White 4-W-1	6 min.	Magna Coatings & Chem Co. 1785 N. Eastern Ave. Los Angeles, Calif.
→ Type 1, Cl 3	RUST-BAN 191[3] (1 Coat)	3-5 mils	Humble Oil and Refining Co.

[1]Tarset not recommended for aviation fuel tanks - may discolor clear fuel.

[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 sonitary or drainage tanks) or where acid cleaning is used. Where white powder and crystals formed during coring 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 olso be used if necessary.

*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 to be 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.

9190.169 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 organisol. 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 may 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 Bureau of Ships 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 aluminun, 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.

9190.170 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 **Bureau of 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. The compounds listed below have been laboratory tested and shall be used pending the development of a specification.

a. The following epoxy smoothing compounds which are resistant to alkali are approved for general use, and for application in way of cathodic protection (magnesium anodes, and impressed current).

Compound	Manufacturer
Devcon A	Devcon Corporation, Danvers, Mass.
Epoxit No. 6003A with 403 Hardener	Palmer Products, Incorporated, Montgomery County, Worcester, Pa.
Poxy putty (blue) Energizer (black)	Permalite Plastics Corporation, 608 Terminal Way, Costa Mesa, Calif.
Hysol 5115 with 3639 Hardener	Hysol Corp. Olean, N.Y.
Hysol X A9-C630 with X H2-C631 Hardener (short pot life)	Hysol Corp Olean, New York
Hysol X A9-C612 with X H2-C613 Hardener (long pot life)	Hysol Corp. Olean, New York

b. The compounds listed below are not alkali resistant, and should be used only in areas not affected by cathodic protection (magnesium anodes and impressed current).

Compound	Manufacturer
Devcon F	Devcon Corporation, Danvers, Mass.
X237A 1237B	Dolphin Paint & Varnish Co., 922 Locust Street, Toledo 3, Ohio
Epocast 158 Curing Agent No. 9815	Furane Plastics, Inc., 4516 Brazil Street, Los Angeles 39, California
Base Material EC1751 Curing Agent EC1752	Minnesota Mining and Manufacturing Co., 411 Piquette Avenue, Detroit 2, Michigan

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 Bureau of Mines, 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.

9190.171 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 (see article, 9190.169 for approved coatings and dry film thickness). Application should be in accordance with manufacturers instructions.

2. Mil. Spec. MIL-P-22808 hydraulic fluid resistant epoxy paint (flash point 75° F. min.).

e. Phenoline 372 system consisting of one coat Phenoline 372 primer and one coat Phenoline 372 finish coat, applied to a totol 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.

9190.172 TANK COATING SYSTEMS FOR FRESH WATER

1. 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.

a. 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.

b. 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.

9190.173 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 92.

5. In cases where the salt water ballast discharge is located close to the distilling plant suction, the distilling plant should be secured during debollasting 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:

$Q = L \times W \times T \times 5/8$ where L = average length, W = average width, and T = 3/4 inch thickness of preservative compound.

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

$20 \times 17 \times 3/4 \times 5/8 = 160$ 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 ISD 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