ENGINEERING-PDH.com
ONLINE CONTINUING EDUCATION

PROPELLERS & PROPULSORS MAINTENANCE

Main Category:	Naval Engineering
Sub Category:	-
Course #:	NAV-124
Course Content:	41 pgs
PDH/CE Hours:	7

COURSE/EXAM PREVIEW

(HIT BACK TO RETURN TO ENGINEERING-PDH.COM)

WWW.ENGINEERING-PDH.COM
TOLL FREE (US & CA): 1-833-ENGR-PDH (1-833-364-7734)
SUPPORT@ENGINEERING-PDH.COM

NAV-124 EXAM PREVIEW

Instructions:

- Review the course & exam preview below.
- Click "Add to Cart" from the course page on the website. You can "Continue Shopping" to add additional courses, or checkout. Don't forget to apply your coupon code if you have one before checkout.
- After checkout you will be provided with links to download the official courses/exams.
- At your convenience and own pace, you can review the course material. When ready, select "Take Exam" to complete the live graded exam. Don't worry, you can take an exam as many times as needed to pass.
- Upon a satisfactory completion of the course exam, which is a score of 70% or better, you will be provided with your course completion certificate. Be sure to download and print your certificates to keep for your records.

Exam Preview:

1. Flat wire steel brushes may be used to clean painted propeller/propulsor surfaces of minimal curvature and SHALL NOT be used within 1 inch of blade edges, tips, cusps, fillets or other sensitive areas of a unpainted propeller/propulsor.
   a. True
   b. False
2. Hydroblasting (high pressure water jet cleaning) may be used on all painted propellers/propulsors. At NO TIME shall hydroblasting on painted propeller/propulsor surfaces exceed _____ pounds per square inch.
   a. 1,000
   b. 1,500
   c. 2,000
   d. 2,500
3. According to the reference material, minor blade and blade palm damage includes nicks, scratches, grinder marks, gouges, grooves, dents, roughness, waviness, flat spots, ridges, punch marks, cavitation erosion less than ___ inch in depth.
   a. 0.125
   b. 0.25
   c. 0.375
   d. 0.500
4. Significant decreases in the head tank fluid level may be experienced during the initial stages of system shut-down due to fluid cooling. This is a direct result of the cooling contraction of the warm hydraulic fluid in the hub and propulsion shafting.
   a. True
   b. False

5. According to the reference material, if no repairs are required and the ship is to return to service in under ___ days, strippable coating is not required. strippable coating shall not be applied to propulsor assemblies.
   a. 120
   b. 90
   c. 60
   d. 30
6. The shape of the hull influences the fluid flow into the propeller/propulsor and may result in periodic forces on the propeller/propulsor that cause blade rate frequency vibration. Blade rate frequency is equal to the number of blades times the propeller/propulsor rpm or multiples of blade number times rpm.
   a. True
   b. False
7. Qualified divers shall perform a Visual Technical Inspection (VTI) of propellers/propulsors and rope guards at regular intervals. Inspection intervals should be conducted approximately every ______ and coincide with ship in-port periods but may be extended past this time frame based on the ship's scheduled operating and maintenance schedules.
   a. 3 months
   b. 6 months
   c. 8 months
   d. 1 year
8. The operating goal for the hydraulic fluid is "clear and bright" (free of visible contaminants). As part of standard preventive maintenance, the CPP system fluid should be purified for _ hours per day while at sea to maintain a "clear and bright" condition.
   a. 2
   b. 4
   c. 6
   d. 8
9. According to the reference material, if testing of viscosity in the CPP system is below __ CST, discontinue use of the equipment and replace hydraulic system fluid.
   a. 70
   b. 80
   c. 50
   d. 40
10. According to the reference material, after the first three years of CPP hub operation, CBA procedures/inspections are required.
   a. True
   b. False

TABLE OF CONTENTS

TABLE OF CONTENTS - Continued

Chapter/Paragraph | Page

TABLE OF CONTENTS - Continued

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER 245

PROPELLERS AND PROPULSORS

SECTION 1

INTRODUCTION

245-1.1. SCOPE.

245-1.1.1 This chapter provides the general information, guidance and requirements necessary to clean, inspect, and repair monobloc, built-up, and controllable-pitch propellers (CPPs), tailcones, fairwater caps, devices, and propulsors. Points of contact are:

- NSWCPD ISEA - Technical In-Service Agent (ISEA)
  NSWCPD 426 (submarine propeller and propulsor)
  NSWCPD 427 (surface ship propeller)
- NAVSUP WSS - Non-technical (Inventory, Administrative)
  NAVSUP WSS N9634 (surface ship propeller)
  NAVSUP WSS N97121 (submarine propeller and propulsor)
- NAVSEA 05P - Technical Authority

245-1.2. REFERENCES.

a. NAVSEA S9245-AZ-TSM-010, **Technical Manual, Submarine Ducted Propulsor Installation, Inspection, Repair, and Maintenance (C)**

b. NAVSEA S9245-AR-TSM-010/PROP, **Technical Manual for Marine Propeller Inspection, Repair, and Certification**

c. NAVSEA 9245/2, **Visual Preservation Inspection Forms**

d. NAVSEA 9245/3, **Propeller Visual Technical Inspection Forms**

e. NAVSEA 9245/1, **Propeller and Propulsor Major Sub Assembly Certification Form**

f. NAVSEA 9245/12, **Ducted Propulsor Installation/Propulsor Certification Form**

g. NAVSEA 9245/9, **Ducted Propulsor Visual Inspection Forms**

h. NAVSEA Drawing 245-7605783, **Virginia Class Propulsor Scrapers Types 1 Thru 4**

i. MIL-PRF-6799, **Coatings, Sprayable, Strippable, Protective, Water Emulsion**

j. MIL-DTL-2845 (SH), **Propulsion Systems, Boat and Ship; Main Shafting, Propellers, Bearings, Gauges, Special Tools, and Associated Repair Parts; Preservation, Packaging, Packing and Storage of**

k. NAVSEAINST 9245.1, **Ship Propeller and Propulsion Shafts; Procedures for Maintaining**

l. DOD Standard Form 364, **Report of Discrepancy**

m. OPNAVINST S5513.5C, **Submarine Propulsor Security Classification Guide, Enclosure 05-056.04**

n. OPNAVINST S5513.3C, **Surface Ship Propulsor Security Classification Guide, Enclosure 52.2**

o. S9086-HM-STM-010, **NSTM Chapter 243, Propulsion Shafting**

p. NAVSEA Dwg. No. 245-8445981, **Monobloc Propeller Cap and Gland Ring Attachment Hardware**

q. S9086-CQ-STM-010, **NSTM Chapter 081, Waterborne Underwater Hull Cleaning of Navy Ships**

r. NAVSEA S0600-AA-PRO-000, **Underwater Ship Husbandry Manual**

s. DOD-P-24562A(SH), **Propeller, Ship, Controllable Pitch**

t. PMS OPNAV Form 4790/7B, **Technical Feedback Report**

u. OPNAVINST 4790.4, **Ship Maintenance and Material Management**

v. MIL-PRE-17331, **SYM 2190 TEP, Hydraulic Fluid**

w. S9086-H7-STM-010, **NSTM Chapter 262, Lubricating Oils, Greases, Specialty Lubricants, and Lubricating Systems**

x. NAVSEA S6430-AE-TED-010, **Technical Directive for Piping Devices, Flexible Hose Assemblies**

y. OPNAV 4790/CK, **Configuration Change Form**

z. DD1998, **Departure from Specification Form**

245-1.3. PROPELLER/PROPULSOR DESCRIPTION.

245-1.3.1 GENERAL REQUIREMENTS.

245-1.3.1.1 Propellers/propulsors are designed and manufactured to meet specific operating requirements such as speed, revolutions per minute (rpm), endurance, vibration, and noise for a particular ship class. To meet these requirements, the propeller/propulsor must achieve a minimum efficiency, absorb available shaft horsepower at a specific rpm or various rpms for controllable-pitch propellers (CPP), operate within specified vibration and noise criteria, and withstand hydrodynamic loads and stresses during all operating conditions.

245-1.3.1.2 To achieve the required performance, propeller/propulsor geometry must conform to the design hydrodynamic contours. Propellers/propulsors performance can be sensitive to small geometric changes and defects in hydrodynamic contour, in turn affecting the flow of water over the hydrodynamic surfaces. Small geometric changes and defects can cause vibration and cavitation problems, which can result in unsatisfactory performance. Use extreme caution when working with, inspecting, preserving, or handling propellers/propulsors to ensure that the critical hydrodynamic surfaces are maintained within specified tolerances and remain free of defects.

245-1.3.1.3 Because propeller/propulsor performance is sensitive to damage and geometric changes, propeller/propulsor inspection, repair, and certification requirements and procedures have been developed to ensure that propellers/propulsors shall meet ship operating requirements.

245-1.3.2 PROPELLER/PROPULSOR TYPES.

245-1.3.2.1 Monobloc. The blades and hub of a monobloc design are formed of a single integral casting.

245-1.3.2.2 Built-up. The blades and hub of a built-up design are manufactured separately and in some cases are of different materials. The blades are secured to the hub with fasteners.

245-1.3.2.2.1 Controllable-Pitch. Controllable-pitch propellers are built-up propellers that have actuating mechanisms that pivot the blades on the hub. The operator can therefore adjust the pitch from full ahead to full astern without reversing the direction of rotation of the propeller shaft.

245-1.3.2.3 Propulsors. Propulsors have multiple sets of blade rows contained within a contoured structure known as the duct. Propulsors have stator blades that do not rotate and a rotating component called the rotor which is attached to the main propulsion shaft. Details on submarine propellers/propulsors can be found in reference (a). Propulsors are also known as ducted propulsors.

245-1.3.3 PROPELLER/PROPULSOR TERMINOLOGY. Propellers/propulsors are complex, three-dimensional geometric shapes that must be defined in space. To properly understand the propeller/propulsor information in this chapter, it is important to understand propulsor terminology. This terminology is described and defined in references (a) and (c).

245-1.3.4 PRAIRIE SYSTEM. Some surface ship propellers have a PRAIRIE (propeller air internally emitted) system for noise masking. This system has machined channels in the propeller blades and emitter holes in the pressure and suction faces near the leading edge and tip of the propeller. The PRAIRIE system emits air through these holes to provide propeller noise masking. Details and requirements may be found in the applicable ship class technical manuals, propeller drawings, technical repair standards, and reference (c).

245-1.4. PERSONNEL QUALIFICATION AND TRAINING.

245-1.4.1 Only qualified personnel shall perform inspections of propeller/propulsor related components. Personnel are qualified as specified herein:

a. Preservation Inspection. Personnel performing visual preservation inspections for propellers/propulsors shall have successfully completed the Propeller Visual Inspection Course. In order to maintain proficiency and qualification, personnel should participate in performing a visual preservation inspection at least annually.

b. Propeller Visual Technical Inspection. Personnel performing Visual Technical Inspections on propellers/propulsors shall be qualified by successfully completing the NAVSEA Propeller Visual Inspection Course. Personnel who accomplish submarine propeller inspections on SSN 688 and SSBN/SSGN 726 classes shall be requalified every five years unless extended by NSWCPD ISEA. Requalification is accomplished by successfully completing the NAVSEA Propeller Visual Inspection Requalification course. In order to maintain proficiency, personnel should participate in performing a Visual Technical Inspection at least annually.

c. Propulsor Visual Inspection Training. Personnel performing Visual Technical Inspections on propulsors (e.g., SSN 21 and SSN 774 class) shall have completed the NAVSEA Ducted Propulsor Visual Inspection Course. The NAVSEA Propeller Visual Inspection Course is a prerequisite to this training.

d. NAVSEA 05P may designate personnel to perform the inspections listed above.

e. The courses are offered by NAVSEA at the NAVSEA Training Center located at Norfolk Naval Shipyard (NNSY) and are administered by NNSY Code 900T.

f. Propeller/Propulsor Cleaning Training. Personnel who are qualified propeller inspectors are qualified to clean all propellers. Personnel who are qualified propulsor inspectors are qualified to clean propulsors. Other personnel cleaning propellers/propulsors in drydock or waterborne shall be briefed by a qualified VTI inspector for the applicable propeller/propulsor.

245-1.5 INSPECTION REQUIREMENTS FOR PROPELLERS/PROPULSORS.

245-1.5.1 Visual Inspections. Visual inspection is comprised of two components: Visual Preservation Inspection (VPI) and Visual Technical Inspection (VTI). The VPI is performed to verify the preservation is intact and not compromised. Damaged preservation may indicate propeller/propulsor damage. The VTI will identify any mechanical or operational deficiencies which may adversely affect propeller/propulsor performance or acoustic signature. VPI and VTI inspections may only be accomplished by qualified personnel per 245-1.4.

245-1.5.1.1 Propuls/Propulsoror Visual Preservation Inspection (VPI). A propeller/propulsor VPI shall be performed on a propeller/propulsor when it is issued, received, and stored. The requirements for performing a VPI, which are listed in reference (b), shall be strictly adhered to. All propeller/propulsor VPIs shall be documented on the appropriate form (reference (c)). All satisfactory and unsatisfactory VPIs shall be submitted to NSWCPD ISEA by the certified inspector. In addition, the propeller/propulsor certification document (reference (e)) shall be appropriately annotated with the inspection results (either satisfactory or unsatisfactory). An unsatisfactory propeller/propulsor VPI necessitates a Visual Technical Inspection (VTI) (reference (d) or reference (g)) of the damaged area.

245-1.5.1.1.1 All personnel who perform a propeller/propulsor VPI must be qualified in accordance with 245-1.4. VPIs are performed by personnel at storage activities, installation/removal activities, and repair activities.

245-1.5.1.1.2 A propeller/propulsor VPI is required as specified below:

a. By the storage activity, upon receipt of all RFI and NRFI propellers/propulsors, every 6 months while in storage and prior to issue of the propeller/propulsor (RFI or NRFI).

b. By the installation/removal activity, upon receipt of an RFI propeller/propulsor and prior to shipment of a propeller/propulsor.

c. By the repair activity, upon receipt, prior to shipment and every 6 months while packaged and preserved.

245-1.5.1.2 Propeller/Propulsor Visual Technical Inspection (VTI). VTIs are performed to assess health of the propeller/propulsor systems. A VTI is required for propellers/propulsors that are damaged in-service, undergoing repair, periodically, and when the VPI indicates the need for a VTI. The VTI shall include the maximum information as to the extent of any propeller/propulsor damage or defects, and all missing accessory parts shall be identified in the report. A propeller/propulsor VTI shall be performed in accordance with reference (a) or (b). If a propeller/propulsor has been in service for more than 5 years since the last liquid penetrant inspection, inspect all unpainted surfaces with liquid penetrant in accordance with reference (a) or (b) as applicable. For propellers, use liquid penetrant testing only as an aid in locating discontinuities. Painted propellers/propulsors do not require paint to be removed to perform a liquid penetrant inspection unless specified by NSWCPD ISEA. If paint is removed for any other reason, perform a liquid penetrant inspection as indicated above. Visually inspect PRAIRIE equipped blades to determine the condition of the PRAIRIE system. Silt, preservative, weld deposits, check-valve rubber, and marine growth can block PRAIRIE system air holes and air channels. Flow tests are required on the PRAIRIE system to verify that the channel and holes are clear. Low-pressure PRAIRIE air is used for installed blades and clean water shall be used for removed blades in accordance with reference (b). Upon completion of the Visual Technical Inspection, submit a propeller/propulsor VTI report (reference (d) or (g)) to the ship's engineering officer, contracting officer and NSWCPD ISEA.

245-1.5.1.2.1 If blades are removed from the hub, then the following CPP blade palm features are also required to be measured and recorded in order to assess the blade palm mating features: bolt grip thickness, seal area porosity limits (palm face and bolt hole), PRAIRIE air inlet hole diameter, dowel pin hole diameter and depth, palm flatness, and palm surface finish. See reference (b) Figure 5-13 attributes: A, D, E, F, G, H, I, and J.

245-1.5.1.2.2 All personnel who perform a propeller/propulsor VTI must be qualified in accordance with 245-1.4. VTIs are performed by personnel at storage activities, divers, shipyards, installation/removal activities, and manufacturing/repair activities.

245-1.5.1.2.3 A propeller/propulsor VTI is required as specified below:

a. By the storage, installation or repair activity, when packaging or preservation of RFI propellers/propulsors is determined to be damaged; only the damaged of area is required to be inspected.

b. By the repair activity, prior to repair of a propeller/propulsor and upon completion of propeller/propulsor repair.

c. By the manufacturing activity, after manufacture of a propeller/propulsor.

d. By the installation or repair activity, upon each scheduled docking. If the propeller/propulsor is removed and replacement is anticipated, the off-loaded propeller/propulsor shall still receive a VTI.

e. By divers when waterborne, approximately every six (6) months, or when propeller/propulsor damage is suspected, when oil leaks are present, or after dock trials.

245-1.6 PROPELLER/PROPULSOR INSPECTION FORMS.

245-1.6.1 NSWCPD ISEA is responsible for all NAVSEA 245 propeller/propulsor Inspection forms. All unclassified NAVSEA propeller/propulsor forms are located at the website: http://www.dcma.mil/NPP/. Classified forms can be obtained by contacting NSWCPD ISEA. References (c), (d), (e), (f), and (g) are the applicable NAVSEA propeller/propulsor forms.

245-1.7 ACTIVITY QUALIFICATION.

245-1.7.1 Activity qualification and level of qualification are determined by NAVSEA 05P. NAVSEA 05P will provide a list of qualified activities upon request. The qualification process includes an assessment of the activity and personnel by NSWCPD ISEA or other designated representatives

SECTION 2

TYPICAL PROPELLER/PROPULSOR PROBLEMS

245-2.1. VIBRATION, CAVITATION, AND NOISE.

245-2.1.1 VIBRATION. The shape of the hull influences the fluid flow into the propeller/propulsor and may result in periodic forces on the propeller/propulsor that cause blade rate frequency vibration. Blade rate frequency is equal to the number of blades times the propeller/propulsor rpm or multiples of blade number times rpm. Blade rate frequency vibration problems are normally a function of the hull, propeller/propulsor, and appendage configuration. It cannot be corrected by repairing the shaft or propeller/propulsor. Shaft rate vibration occurs at a frequency equal to or in multiples of the shaft rpm. It can be caused by mechanical unbalance of the shaft or propeller/propulsor; improper propeller/propulsor installation; a bent shaft; or geometric discrepancies between the propeller/propulsor blades.

245-2.1.2 CAVITATION. Water flow across the blades of an operating propeller/propulsor causes pressure to vary across the blade surfaces. Areas of high curvature on the blade cause an increase in velocity of the water flow across the blade surface. In these areas of high velocity, the pressure decreases. When the pressure at any location falls below the vapor pressure of the water, vapor cavities (cavitation bubbles) are formed that later collapse as they move into areas of higher pressure. The collapse of the cavitation bubbles can erode the blade surface. This erosion begins as a roughening of the surface and develops into craterlike pits that continue to enlarge. Cavitation decreases as the shaft rpm decreases or the depth of operation increases. The areas most likely to cavitate are the suction side of the blades at the outer radii and areas near the leading edge. Physical damage or improper repair to a blade changes the geometry of the blade and as a result increases the probability of cavitation. Since the leading edges are the most susceptible to damage, they are the prime areas affected by cavitation. Cavitation results in noise that is often sharp, random, and crackling when it starts. When the cavitation is further developed, at higher speeds or shallower depths, the noise becomes periodic at shaft frequency and has a variety of sounds. Cavitation noise covers a broad frequency range.

245-2.1.3 SINGING NOISE. Propeller/Propulsor singing is a type of noise. It is characterized by a tone at a relatively constant frequency. At a given speed, the singing tone may include more than one frequency. It may occur on one or several blades simultaneously. Singing is caused by vibration excited by unbalanced vortex shedding from the trailing edge or tip of the blade. Propeller/Propulsor blade singing has been significantly reduced by blade design improvements (e.g., trailing edge or tip knuckles, thicker trailing edges, etc.).

245-2.1.4 MECHANICAL NOISE. Another source of noise in the propulsion system can be a lack of clearance for rope guards and fairwaters, causing mechanical rubbing between the rotating and stationary elements. Wire, cable, or rope wrapped around the propeller/propulsor; loose cap or tailcone cover plates; loose cap or tailcone studs or nuts; and loose gland studs or nuts can also cause mechanical noise in the propulsion system.

245-2.2. FOULING AND ROUGHNESS.

245-2.2.1 EFFICIENCY. The efficiency of a propeller/propulsor is affected by the drag and hydrodynamic shape of the blade sections. Roughening of a hydrodynamic surface by cavitation erosion or by fouling with marine growth will increase the power required for a given speed over that required by a clean propeller/propulsor which meets surface finish requirements.

245-2.3. LOSS OF SEAWATER SEALING INTEGRITY

245-2.3.1 LOSS OF FAIRWATER CAP, DEVICE OR TAILCONE. Loss of a propeller/propulsor fairwater cap, device, or tailcone in service is a significant casualty. With the cap gone, the corrosion preventive compound will wash away and subject the propeller nut locking key and shaft to seawater. Shaft corrosion and failure could ultimately result. Divers shall inspect the propeller nut locking key, retaining screw, propeller nut, and shaft threads monthly until the fairwater cap is replaced. A replacement cap, device, or tailcone shall be installed at the earliest opportunity.

245-2.3.2 LOSS OF SEALING RING INTEGRITY. Give special attention to the integrity of the cap and gland seal areas. Seawater exposure can lead to early failure of the shaft and loss of the propeller/propulsor. An assembly pressure test, in accordance with reference (b), can identify a loss of seal integrity. The voids in the propeller/propulsor assembly shall be completely filled with corrosion preventive compound at all times.

SECTION 3

PROPELLER/PROPULSOR AND BLADE CLEANING, INSPECTION, REPAIR, AND REPLACEMENT WHEN SHIP IS DRYDOCKED

245-3.1. GENERAL.

245-3.1.1 CLEANING, INSPECTION, AND REPAIR REQUIREMENTS.

245-3.1.1.1 This section provides cleaning, inspection, and repair requirements for propellers/propulsors while the ship is drydocked. Information on propeller/propulsor replacement is also provided. Information on the CPP hub and servo control system, oil distribution box, hydraulic oil power module assembly and valve rod assembly can be found in NSTM 245 Section 5. During each scheduled availability drydocking, propellers/propulsors shall be cleaned and a VTI performed as outlined within this chapter. Any identified repair of minor damage can be accomplished by NAVSEA qualified activities. See NSTM 245-1.7 for activity qualification and NSTM 245-3.5.4 for definition of minor damage. This work is managed and funded by type commander. It can be performed while the propeller/propulsor is installed, removed and staged within the shipyard activity, or while staged at a repair activity qualified to perform minor repairs. Cleaning requirements are located in NSTM 245-3.2.1. VTI inspectors must be qualified per 245-1.4. If major repairs are required then the propeller/propulsor condition code will typically be downgraded and the propeller/propulsor will be replaced and inducted into the 2S Cog repair program under management by NAVSEA. NAVSEA may permit at their discretion exemptions to repairs that can be accomplished by a qualified repair activity.

245-3.2. CLEANING.

245-3.2.1 GENERAL REQUIREMENTS. Marine growth can affect the efficiency of a propeller/propulsor and cause cavitation. Cleaning shall be performed at every drydocking to remove all sea growth (e.g., calcium deposits, barnacles, etc.). Cleaning propellers/propulsors by processes other than those described herein could damage critical hydrodynamic surfaces degrading acoustic performance or cause conditions favorable for cavitation inception. Only experienced personnel who are familiar with Navy propeller/propulsor critical geometries and characteristics shall clean naval ship propellers/propulsors. Personnel assigned to cleaning shall be briefed by a qualified propeller/propulsor visual technical inspector in the use of proper cleaning tools for propellers/propulsors. Cleaning shall not result in damage to the propeller/propulsor or the removal of propeller/propulsor material. Table 245-3-1 provides a summary of cleaning methods, both acceptable and not acceptable, for unpainted and painted propellers/propulsors.

245-3.2.2 UNPAINTED PROPELLER/PROPULSOR CLEANING. The following methods are acceptable for cleaning unpainted propellers/propulsors in drydock and are listed in order of precedence. When propeller/propulsor cleaning is in progress for CPP systems, maintain an air supply to the PRAIRIE system to prevent foreign material from entering the emitter holes. Note that hydrodynamic surface polishing shall follow the same cleaning process outlined herein to produce the required surface finish.

245-3.2.2.1 Hydroblasting. Hydroblasting (high pressure water jet cleaning) may be used on all unpainted propeller/propulsor and fairwater surfaces. For best results, perform hydroblasting on propeller/propulsor surfaces immediately upon drydocking and before marine growth has dried. At NO TIME shall hydroblasting on propeller/propulsor surfaces exceed **10,000 pounds per square inch.**

245-3.2.2.2 Hand Cleaning (Scraping, Wire Brushes, Pads, Etc.). Plastic, hardwood, or soft metallic (bronze or brass which is softer than the propeller/propulsor surface material) scrapers are acceptable for cleaning all unpainted propeller/propulsor surfaces. Hand held plastic conditioning pads (e.g., Scotch-Brite “green” and “maroon”), nylon and polypropylene brushes (e.g., A-1 and A-2), and silicon carbide impregnated nylon brushes (e.g., type D) may be used to clean all unpainted propeller/propulsor surfaces. Flat wire steel brushes may be used to clean painted propeller/propulsor surfaces of minimal curvature and SHALL NOT be used within 3 inches of blade edges, tips, cusps, fillets (excluding hub to blade) or other sensitive areas of a unpainted propeller/propulsor. Flat wire steel brushes SHALL NOT be used to clean propeller/propulsor surfaces. It is preferred that the final cleaning operation of propeller/propulsor blade edges (within 3 inches) be cleaned by hand with plastic surface conditioning pads. Do not attempt to round the edges of the blades with brushes and discs.

245-3.2.2.3 Powered Cleaning Processes. Per Table 245-3-1, selected powered surface brushes and discs are acceptable for cleaning unpainted propellers/propulsors. DO NOT use powered cleaning methods within 3 inches of blade edges, tips, cusps, fillets (excluding hub to blade interface), areas of high curvature, or other sensitive areas of an unpainted propeller/propulsor. The following powered brushes and discs may be used on less sensitive areas of unpainted propellers/propulsors; nylon and polypropylene brushes (e.g., A-1 and A-2), non-abrasive plastic surface conditioning discs (e.g., Scotch-Brite “green”), silicon carbide impregnated nylon brushes (e.g., type D) and silicon carbide marine cleaning pads. Powered abrasive plastic discs (e.g., Scotch-Brite “maroon”) may be used to clean unpainted propellers but SHALL NOT be used to clean unpainted propulsors. DO NOT use metal or multi-brush units to clean propellers/propulsors. When cleaning the outer periphery of the propeller/propulsor blades, the brushes and discs must be kept flat on the blade surface. Alternative propeller/propulsor cleaning methods are permitted provided that they are approved in advance by NSWCPD ISEA.

245-3.2.3 PAINTED PROPELLER/PROPULSOR CLEANING. Certain ship classes of propellers/propulsors are painted with marine anti-corrosive and/or anti-fouling paint. Specifically, these are MCM 1 class, SSN 21 class, and SSN 774 class propulsors. A limited number of LSD 41/49 class ship propellers have been painted to assess the performance of various coating products. Special approval is required before painting LSD 41/49 propellers. The following methods are acceptable for cleaning painted propellers/propulsors.

245-3.2.3.1 Hydroblasting. Hydroblasting (high pressure water jet cleaning) may be used on all painted propellers/propulsors. At NO TIME shall hydroblasting on painted propeller/propulsor surfaces exceed **2,000 pounds per square inch.**

245-3.2.3.2 Hand Cleaning (Scraping, Wire Brushing, Pads, Etc.). Plastic or hardwood scrapers are acceptable for cleaning all painted propeller/propulsor surfaces. DO NOT use bronze, brass, or flat wire steel brushes or metallic scrapers on painted propeller/propulsor surfaces. Nylon and polypropylene brushes (e.g., A-1 and A-2) and non-abrasive plastic conditioning pads (e.g., Scotch-Brite “green”) may be used to clean all propeller/propulsor surfaces. DO NOT use abrasive plastic conditioning pads (e.g., Scotch-Brite “maroon”) on any painted propeller/propulsor surfaces.

245-3.2.3.3 Powered Cleaning Processes. Per Table 245-3-1, selected powered surface brushes and discs are acceptable for cleaning painted propeller/propulsor. Powered cleaning methods SHALL NOT be used within 3 inches of blade edges, tips, cusps, fillets (excluding hub to blade interface), areas of high curvature, or other sensitive areas of a painted propeller/propulsor. Only nylon and polypropylene brushes (e.g., A-1 and A-2) and non-abrasive plastic surface conditioning discs (e.g., Scotch-Brite “green”) may be used with power tools on less sensitive areas of painted propeller/propulsor. Alternative propeller/propulsor cleaning methods are permitted provided that they are approved in advance by NSWCPD ISEA.

Table 245-3-1. Propeller/Propulsor Cleaning Requirements

Method		Unpainted Propulsor	Unpainted Propulsor	Painted Propeller/ Propulsor
	Hydroblast	Yes (up to 10,000 psi)	Yes (up to 10,000 psi)	Yes (up to 2,000 psi)
Hand Cleaning	Plastic, hardwood, & soft metallic[1] scrapers	Yes	Yes[2]	Yes (except metallic scrapers)
	Nylon & polypropropylene brushes (e.g., A-1 & A-2)	Yes	Yes	Yes
	Non-abrasive plastic surface conditioning pads (e.g., Scotch-Brite ″green″)	Yes	Yes	Yes
	Abrasive plastic surface conditioning pads (e.g., Scotch-Brite ″maroon″)	Yes	Yes	No
	Flat wire steel brushes (e.g., Type C)	Yes (except 3″ from critical areas[3])	No	No
	Soft bronze, brass brushes	Yes	No	No
	Silicon carbide impregnated nylon brushes	Yes	Yes	No
Power Cleaning	Nylon & polypropropylene brushes (e.g., A-1 & A-2)	Yes (except 3″ from critical areas[3])	Yes (except 3″ from critical areas[3])	Yes (except 3″ from critical areas[3])
	Non-abrasive plastic surface conditioning discs (e.g., Scotch-Brite ″green″)	Yes (except 3″ from critical areas[3])	Yes (except 3″ from critical areas[3])	Yes (except 3″ from critical areas[3])
	Abrasive plastic surface conditioning discs (e.g., Scotch-Brite ″maroon″)	Yes (except 3″ from critical areas[3])	No	No
	Flat wire steel brushes (e.g., Type C)	No	No	No
	Soft bronze, brass brushes	No	No	No
	Silicon carbide impregnated nylon brushes (e.g., type D) and silicon carbide marine cleaning discs (e.g., D3, D5)	Yes (except 3″ from critical areas[3])	Yes (except 3″ from critical areas[3])	No

[1]″Soft metallic″ is defined as a material with yield strength less than 24 ksi (e.g., ASTM B36 UNS C22000)

[2]For unpainted propulsor surfaces, metallic scrapers shall be in accordance with reference (h).

[3]Critical areas include edges, tips, MAF, cusps, fillets, areas of high curvature and some tailcone surfaces.

245-3.3. INSPECTION AND ASSESSMENT.

245-3.3.1 VISUAL INSPECTION AND EVALUATION. After docking, conduct a pre-repair Visual Technical Inspection (reference (d) or (g)). Submit the VTI report to the contracting activity and NSWCPD ISEA as applicable. NSWCPD ISEA performs an engineering assessment on all submarine VTI reports and recommends corrective actions, if necessary. Surface ship VTI report assessments are conducted by NSWCPD ISEA on case-by-case basis. If NSWCPD ISEA determines only minor damage is present then repairs may be performed in accordance with paragraph 245-3.5.5. Any repairs to submarine propellers/propulsors require prior approval by NSWCPD 426. If NSWCPD ISEA determines that a replacement propeller/propulsor is warranted, then a requisition shall be submitted.

245-3.3.2 NRFI PROPELLER/PROPULSOR. When the propeller/propulsor is removed for induction into the 2S COG repair program, it shall be preserved, packaged, and stored in accordance with reference (j). Additional preservation and packaging requirements for propulsors are defined in reference (a). NAVSUP WSS will provide direction for packaging, preservation, and shipment instructions of the NRFI propeller/propulsor. Installation and removal activities (shipyards) are responsible for ensuring preservation and packaging of removed propellers/propulsors as specified in reference (j) for “F” condition equipment and returned complete with all eyebolts and eyebolt hole plugs; gland ring; gland ring studs and nuts; and fairwater cap studs and nuts. In accordance with 245-1.5.1.1.1, a VPI shall be performed by the removal activity prior to shipping NRFI propeller/propulsor. A VPI shall be included with the propeller/propulsor and copies sent to contracting officer and NSWCPD ISEA. A turn-in document citing “F” condition shall accompany the removed propeller/propulsor to the storage activity designated by NAVSUP WSS. Type commander is responsible for funding preservation and packaging of propulsors/propellers.

245-3.3.3 REQUISITION OF A PROPELLER/PROPULSOR. Once it has been deemed that an in-service propeller/propulsor requires replacement, the supply officer may requisition a replacement RFI “A” condition propeller/propulsor via supply system with destination address, POC, phone number, and firm Required Delivery Date (RDD). NAVSUP WSS verifies propeller/propulsor replacement need with NSWCPD’s VTI evaluation. NAVSUP WSS will release replacement propellers/propulsors from stock, if available. NAVSUP WSS will provide disposition instructions for the removed propeller/propulsor. Upon receipt of the replacement propeller/propulsor, if it is determined that preservation, packaging, marking or shipping deficiencies exist, the inspector shall generate a Report Of Discrepancy (ROD), reference (l). RODs shall also be used when equipment is not shipped as specified in reference (j).

245-3.3.4 INDUCTION INTO 2S COG REPAIR PROGRAM. NAVSEA 05P/NSWCPD ISEA determines when propellers/propulsors are inducted based on need, repair activity workload, and funding availability. Induction of propellers/propulsors into the 2S COG repair program is performed by NAVSUP WSS in accordance with reference (k). NAVSUP WSS will direct the induction of defective propellers/propulsors into repair or direct the equipment into storage as required to support the assigned stock levels based on input from NAVSEA 05P and NSWCPD ISEA.

245-3.4. HANDLING REQUIREMENTS FOR PROPELLERS/PROPULSORS.

245-3.4.1 MONOBLOC PROPELLER AND CPP BLADE HANDLING. Before handling the propellers or CPP blades, protect the blade edges with edge guards in accordance with reference (j). Most monobloc propellers have threaded holes on their forward and aft hub faces and on the outside diameter of the propeller hub for installing eyebolts used for handling the propeller. When these holes are present, propellers shall be handled by eyebolts. Screw in the eyebolt(s) until the eyebolt shoulder firmly contacts the propeller hub. To prevent blade edge or sling damage when handling propellers or CPP blades, do not allow the lifting slings and cables to contact the blade edges. Protect the blade fillets, blade edges and slings with chafing gear or soft wood blocking, as appropriate. In areas where the sling could contact the blade edges, nylon or Kevlar slings shall be used and shall be connected to shackles placed in the eyebolts. If the propeller does not have eyebolt holes on the outer diameter of the hub, the propeller or CPP blade will require special handling fixtures or specialized lifting arrangements. The appropriate fixture or lifting arrangement may be identified on the applicable propeller drawing or reference (r). Methods of turning propellers and CPP blades shall be developed by activities handling propellers.

245-3.4.2 PROPULSOR HANDLING.. Propulsor components have special handling requirements and lifting and handling fixtures. Details on handling propulsors are in reference (a).

245-3.4.3 EYEBOLTS. The RFI monobloc propeller/propulsor eyebolts may be used for handling purposes during NRFI propeller/propulsor removal and during RFI propeller/propulsor installation. Eyebolts shall be returned with the NRFI propeller/propulsor.

245-3.5. REPAIR.

245-3.5.1 Most propellers/propulsors are Navy designed. Some of these may have design features that are proprietary to the commercial vendor, and some designs are classified in accordance with references (m) and (n). Inspection and repair of propellers/propulsors shall be performed only by qualified repair activities per 245-1.7.

245-3.5.2 CPP hubs and oil distribution boxes have specified overhaul cycle requirements defined in the applicable CPP technical manuals and technical repair standards. However, NAVSEA has transitioned from a time-based approach to a condition based approach (CBA) for CPP systems. Section 5 provides specific periodicities for maintenance inspection for all CPP systems to support CBA inspections. CPP equipment is generally proprietary, except blades, to the original equipment manufacturer (OEM) and shall be repaired by the OEM. If the CPP blades are determined to be in acceptable condition based on a VTI and acoustic performance is satisfactory (if applicable), it is not necessary to have the blades repaired, regardless of the need to repair the hub and oil distribution box. If this is the case, remove the blades from the hub and store or preserve, as required, until a replacement hub is received.

245-3.5.3 LEVEL OF REPAIR. Acceptable performance of a propeller/propulsor is based on structural integrity, vibration characteristics, powering performance and acoustic performance, all of which vary in importance depending upon ship class. Defects, which have compromised or degraded the operational performance of a propeller/propulsor as determined from operational reports, visual inspection results, machinery operation logs, instrumented evaluations, etc., shall be repaired to reestablish an acceptable level of performance based upon engineering assessment consistent with the performance and operational requirements for the ship class.

245-3.5.4 DEFINITION OF MINOR DAMAGE. Minor blade and blade palm damage includes:

- Nicks, scratches, grinder marks, gouges, grooves, dents, roughness, waviness, flat spots, ridges, punch marks, cavitation erosion less than 0.25 inch in depth.
- Existing porosity is acceptable, if service and subsequent inspection confirm that there are no cracks in the casting or welded areas.
- Minor bends and curling within 10% of the local blade section width or within the tip region and are limited region where blade thickness is less 1.25 inches and when deflected less than 15 degrees.
- Minor cracks and tears less than 2 inches in length, located in the base casting or in weld repairs and are less than 2 inches from the blade edge or within the blade critical area. Minor cracks in structural welds shall be less than 10 inches in length.
- Minor missing material area is less than 2 square inches and repair may be made entirely by added weld metal without resulting in the need for localized straightening.
- Total anticipated weld area should not exceed 10 square inches per blade unless agreed upon by the contracting officer.

245-3.5.5 REPAIR OF MINOR DAMAGE. Repairs accomplished during a docking are very good way of improving propeller/propulsor performance at a reasonable cost without adversely affecting ship schedule. These repairs do have some limits versus repairs accomplished on inducted 2S COG propeller/propulsor which utilize the appropriate equipment (e.g., blade gauges, pitchometer, etc.) and markings (e.g., radius lines, offset stations, etc.) because the actual geometry is compared and corrected against the intended design geometry. Always consider the following before deciding whether to repair a propeller/propulsor while docked:

a. The condition of the propeller/propulsor based on a Visual Technical Inspection. The propeller/propulsor may require removal if there are bends requiring straightening or cracks requiring welding.

b. Reports, if any, of operational problems (e.g., cavitation, vibration, noise, etc.) related to the installed propeller/propulsor.

c. The time required to remove and repair the propeller/propulsor relative to the ship's availability schedule.

d. The availability of a replacement propeller/propulsor from the stock system, and the time to ship and install it relative to the ship's schedule.

e. The effect on propeller/propulsor balance. Any work that will significantly affect balance will require removal of the propeller/propulsor for rebalancing.

f. Ship operational requirements (e.g., submarine, noise-critical combatant, auxiliary, etc.).

g. The likelihood of creating additional damage while performing the repair.

h. The location of the defect and the potential for further damage during subsequent operation.

In cases of minor damage, light grinding, filing, or welding can be accomplished during the docking by a qualified repair activity per 245-1.7. Approval for any work on submarine propellers/propulsors shall be obtained from NSWCPD 426 prior to the start of work. Repair of unsatisfactory CPP blade palm features shall be accomplished during dockings. Limit metal removal to that necessary to make the repairs. At a minimum, a liquid penetrant aided inspection shall be performed on the localized repaired areas during post-repair inspection; paragraph 245-3.6 applies. If a CPP blade was previously replaced waterborne, then balancing of the set is required per 245-3.7.2.

245-3.5.6 ADDITIONAL REPAIR. When the damage exceeds the definition of minor, NAVSEA 05P and NSWCPD ISEA have the final decision to determine if all repairs can be accomplished during the docking, if an engineering repair per 245-3.5.7 is necessary, or if propeller/propulsor replacement is warranted. When propeller/propulsor deficiencies require additional repair, NSWCPD ISEA and NAVSUP WSS shall be contacted to induct the propeller/propulsor into the 2S COG repair program and a replacement propeller/propulsor shall be requisitioned as outlined in 245-3.3.4.

245-3.5.7 ENGINEERED REPAIR. There are cases when an engineered propeller/propulsor repair is required. Engineered repairs may incorporate a "limited" dimensional inspection in order to more closely examine and correct some specific defects. They are accomplished on a case-by-case basis. NSWCPD ISEA determines the need for engineered repairs and writes the Statement of Work to outline the inspections and repairs to be accomplished.

245-3.6. POST REPAIR INSPECTION.

245-3.6.1 After docking repairs have been completed, conduct a post repair Visual Technical Inspection (reference (d) or (g)). Submit the VTI report to NSWCPD ISEA and the contracting activity. Dimensional inspection and recertification of the propeller/propulsor are not required. All deficiencies which were not repaired during the docking shall be noted via a Departure From Specification (DFS), reference (z).

245-3.7. REMOVAL AND INSTALLATION.

245-3.7.1 MONOBLOC PROPELLER. Monobloc propeller removal and installation requirements shall be in accordance with references (b), (o), and (p). New or replacement propellers/propulsors shall not be installed unless the certification document is attached to the propeller/propulsor. Contact NAVSUP WSS if it is not attached.

245-3.7.2 BUILT-UP AND CPP. Built-up and CPP blades are repaired and balanced as a hub set, to the requirements of reference (b). The blade position, as installed on the hub, is identified by the blade serial number stamped on each blade palm. Sometimes blade sets are separated as a result of individual blade replacements. In these cases, contact NSWCPD 427 to identify replacement blades that can be properly matched to the remaining blades to achieve an acceptable set. NSWCPD 427 maintains a record of all built-up and CPP blade weights. Guidance for replacement of built-up and CPP blades is provided in reference (b), the CPP technical repair standards, shipyard procedures, and drawings. Refer to the class maintenance plan for appropriate documents. New or replacement blades shall not be installed unless the certification document is attached to the blade. Contact NAVSUP WSS if it is not attached. When individual blades are replaced within a set, an Interim Class Maintenance Plan (ICMP) task shall be created which requires the blade set to be balanced with serial number and position restamped at the next docking.

245-3.7.3 PROPULSOR REMOVAL AND INSTALLATION. Propulsor and propulsor component removal and installation requirements shall be in accordance with references (a) and (o). New or replacement propulsors shall not be installed unless the certification document is attached to the propulsor. Contact NAVSUP WSS if it is not attached.

245-3.8 PRESERVATION. If the ship is to be inactive for longer than 30 days after undocking, coat the unpainted surfaces of propellers/propulsors with a strippable compound specified by reference (i) in accordance with reference (j). Cover PRAIRIE emitter and inlet holes prior to coating in accordance with reference (j). If no repairs are required and the ship is to return to service in under 30 days, strippable coating is not required. Strippable coating shall not be applied to propulsor assemblies.

SECTION 4

PROPELLER/PROPULSOR AND BLADE CLEANING, INSPECTION, REPAIR, AND REPLACEMENT WHEN SHIP IS WATERBORNE

245-4.1. GENERAL.

245-4.1.1 This section provides cleaning, inspection, repair, and replacement information for propellers/propulsors while the ship is waterborne. Inspection and repair shall be performed only by qualified divers in accordance with NSTM 245-1.4. NSWCPD ISEA can provide assistance to activities performing approved waterborne propeller/propulsor inspection, maintenance, and replacement.

245-4.2. CLEANING.

245-4.2.1 Waterborne propeller/propulsor cleaning shall be performed, in accordance with reference (q), using cleaning methods outlined in Table 245-3-1.

245-4.2.2 All personnel performing propeller/propulsor cleaning waterborne shall meet the requirements of NSTM 245-1.4.

245-4.3. INSPECTION.

245-4.3.1 Qualified divers shall perform a Visual Technical Inspection (VTI) of propellers/propulsors and rope guards at regular intervals. Inspection intervals should be conducted approximately every 6 months and coincide with ship in-port periods but may be extended past this time frame based on the ship's scheduled operating and maintenance schedules. Perform a VTI of the propeller/propulsor immediately when abnormal noise or vibration is observed. If oil spots (slick or sheen) are seen off the stern of the vessel, examine the blade and hub seals for oil leaks. If the propeller/propulsor has been operated dockside (training or testing) for periods longer than those associated with normal ship arrival and departure (e.g., dock trials), perform a VTI of the propeller/propulsor and rope guards before getting under way. Examine them for damage, fouling, roughness, nicks, dents, and loose or missing parts. Also, inspect for items such as wire, rope, hose, or cable that may be entangled or wrapped around the propeller/propulsor shaft, or under the rope guards or fairwaters. When necessary, utilize the diver access panel in the forward rope guard of propulsors in order to perform inspections of the cavity for rope, hose, cable, and other debris. For propellers with PRAIRIE systems, apply low-pressure air and visually inspect the PRAIRIE emitter holes to determine the condition of the PRAIRIE system and verify that the holes are clear.

245-4.4. REPAIR.

245-4.4.1 If possible, avoid waterborne propeller/propulsor repairs. When necessary, repairs shall be performed in accordance with references (a), (b) and/or (r) by qualified divers in accordance with NSTM 245-1.4. The following minor repair actions may be taken to improve propeller/propulsor performance and prevent further damage when authorized by NSWCPD ISEA or NAVSEA:

a. Nicks and dents on blade edges may be filed smooth while ensuring that the design contour of the blade edge is maintained (i.e., no flat spots are introduced). Approval for any work on submarine propellers/propulsors shall be obtained from NSWCPD 426 prior to the start of work.

b. Small bends or curled edges may be tapped back to the correct shape, taking care not to cause further damage. The use of wood blocking is recommended rather than impacting the blade directly. Take care on leading edges not to create ridges and flat spots. On trailing edges, take care to prevent rounding off the break of the knuckle. Approval for any work on submarine propellers/propulsors shall be obtained from NSWCPD 426 prior to the start of work.

c. Rope guards or fairwaters that have loosened may be secured. If this is impossible, remove them to prevent their coming off when underway and damaging the propeller/propulsor.

245-4.5. REMOVAL AND INSTALLATION.

245-4.5.1 Removal and installation requirements for propellers/propulsors are defined in reference (a) for propulsors or reference (o) for monobloc, built-up, and CPP. Waterborne removal and installation procedures for monobloc and built-up propellers shall be in accordance with reference (r). Waterborne replacement of CPP blades shall be in accordance with reference (r) and paragraph 245-5.6.8. New or replacement blades shall not be installed unless the certification document is attached to the blade. Contact NAVSUP WSS if it is not attached. When individual blades are replaced within a set, an ICMP task shall be created which requires the blade set to be balanced with serial number and position restamped at the next docking.

SECTION 5

CONTROLLABLE-PITCH PROPELLER SYSTEMS

245-5.1. GENERAL.

245-5.1.1 INTRODUCTION. This section provides an overview and general information on the various types of controllable pitch propeller (CPP) systems. Refer to the applicable technical manuals listed in Table 245-5-1 for more detailed information on specific CPP systems. Although the terms CPP, controllable reversible pitch (CRP), and controllable pitch (CPCH) are sometimes used interchangeably, the term "CPP" will be used throughout this section to identify controllable-pitch propeller systems. Definitions are provided in the Glossary for terms directly associated with CPP systems or where a particular term has a specific meaning within this chapter.

245-5.1.2 BASIC DESIGN. A CPP system consists of a CPP with associated mechanical, hydraulic, pneumatic, or electronic pitch controls. Controllable-pitch propeller systems are used on surface ships, where rotation of the propulsion shaft is usually limited to one direction, either by design or by necessity. Controllable-pitch propeller systems are also designed so that rotation of the propulsion shaft in a direction opposite the normal should not result in damage to the propeller. Such rotation can occur when using a jacking gear, when wind milling, or under abnormal circumstances.

245-5.1.3 BASIC CONTROL SYSTEM. The control system positions the propeller blades, permitting a range of thrust from full ahead to full astern while the main propulsion machinery continues to operate in the same direction of shaft rotation. Pitch commands can be made from various locations and may be electrical, mechanical, or pneumatic.

245-5.1.4 BASIC PRINCIPLES OF OPERATION. The pitch command signal (Figure 245-5-1) is translated by the pilot or control valve to hydraulic pilot or auxiliary servo control pressure that positions the servo valve. The servo valve ports high-pressure (HP) hydraulic fluid to the servomotor. The resultant servo piston linear movement is mechanically translated to rotation of the propeller blades by the blade-turning mechanism, creating the corresponding change in pitch ordered by the pitch command. The system is designed to hold any pitch setting from full ahead to full astern under all operating conditions within the limits imposed by the main engines.

245-5.2. CONTROLLABLE-PITCH PROPELLER SYSTEM TYPES.

245-5.2.1 VARIATIONS IN DESIGN. The U.S. Navy uses various designs of CPP systems for a variety of ship missions. The CPP system design specification, reference (s), covers general requirements and lists the various styles, types, and blade designs of CPP systems. Table 245-5-1 provides a listing of the CPP ship system technical manuals by ship class. The basic types of CPP systems currently in use are the Hub Servomotor type and the Cycloidal type.

Table 245-5-1. Controllable-Pitch Propeller System Documentation

Ship Class/ Group	Manufacturer	Publication Number/Title
CG 47-65	ROLLS ROYCE NAVAL MARINE INC. (CAGE 07309) (Bird-Johnson Co.)	S9245-AH-MMA-010, Controllable Reversible Pitch Propeller for CG 47 Class Ships S9CGO-BP-POG-010/CG 47, Propulsion System Operating Guide S9262-AF-MMA-010, CRP Propeller Oil Cooler
CG 66 & FOLLOW	ROLLS ROYCE NAVAL MARINE INC. (CAGE 07309) (Bird-Johnson Co.)	S9245-AV-MMA-010, Controllable Reversible Pitch Propeller for CG 66 and Follow Ships
EDD 964 (Former DD 963/ DDG 993 Class)	ROLLS ROYCE NAVAL MARINE INC. (CAGE 07309) (Bird-Johnson Co.)	S9245-BF-MMM-010, Controllable Pitch Propeller in DD 963 Class, DDG 993 Class, and DD 997 (This manual supersedes S9245-AC-MMA-010, S9245-AL-MMA-010, and 0944-LP-006-3010) S9245-AE-TRS- 010 /DD 963/DDG 993 CL. TRS Propeller Hub Assembly & Blades DD 963 & DDG 993 Class TRS Oil Distribution Box Assembly 0944-LP-006-3011 Instructions for Changing Blades Underwater, Controllable Reversible Pitch Propeller for DD 963 Class Ships
DDG 51 Class	ROLLS ROYCE NAVAL MARINE INC. (CAGE 07309) (Bird-Johnson Co.)	S9245-AM-MMA-010/07309, Controllable Pitch Propeller System, DDG 51 Class, Model 156, Type S1/5 S9245-AT-TRS-010/07309, TRS Overhaul Procedures Propeller Hub & Blade Assembly S9245-AU-TRS-010/07309, TRS Oil Distribution Box Assembly & Temperature Compensated Pitch Indicator Assembly Overhaul Procedures
FFG 7 Class	ROLLS ROYCE NAVAL MARINE INC. (CAGE 07309) (Bird-Johnson Co.)	0941-LP-053-7010, FFG 7 Class CP Propeller and Propulsion Shafting System 2451-086-607, TRS Oil Distribution Box Assembly 2451-086-608, TRS Pressure Control Assembly S9245-AF-TRS-010/FFG 7 CL, TRS Propeller Hub Assembly and Blades FFG 7 Class
LSD 41 Class	ROLLS ROYCE NAVAL MARINE INC. (CAGE 07309) (Bird-Johnson Co.)	S9245-AD-MMA-010, Technical Manual for CP Propeller and Propulsion Shafting System for LSD 41 Class Ships
LST 1179 Class	ROLLS ROYCE NAVAL MARINE INC. (CAGE 07309) (Bird-Johnson Co.)	0944-LP-007-2010, Controllable Pitch Propellers LST 1179, LST 1180, LST 1181 0944-LP-007-1010, Controllable Pitch Propellers LST 1182 through LST 1198 S9245-AG-TRS-010, TRS Propeller Hub Assembly and Blades LST 1179 Class 0905-LP-485-8010, Propulsion Systems Information and Troubleshooting Guide for LST 1182-1198
MCM 1 Class	ROLLS ROYCE NAVAL MARINE INC. (CAGE 07309) (Bird-Johnson Co.)	S9245-AE-MMO-010, Non-magnetic Controllable Pitch Propeller Equipment S9245-BJ-TRS-010, TRS Propeller Hub Assembly & Blades, MCM 1 Class Overhaul Procedures
PG 92-101 Patrol Gunboat	Liaaen Propulsion Systems, Inc.	0944-LP-004-3010, Instruction Manual for Liaaen Propulsion Controllable Pitch Propeller, Double Crank, Serial Number 185-204, for Motor Gunboat PG Class Vessel

245-5.2.2 HUB SERVOMOTOR-TYPE CPP SYSTEM. The most common CPP system in the U.S. Navy is the “hub servomotor” type (Figure 245-5-2). In this type of CPP system, the blade pitch is actually changed by a servomotor in the hub assembly. There are two basic hub servo-motor design variations.

245-5-2.2.1 Bird-Johnson Design. The basic Bird-Johnson Co. (now Rolls Royce Naval Marine) components and system configurations are the same, with the size of the components being the primary variation between the hub servomotor-type systems. In addition, the DDG 51 class CPP system is the first to feature a different OD box design and improvements to the pitch-indicating system.

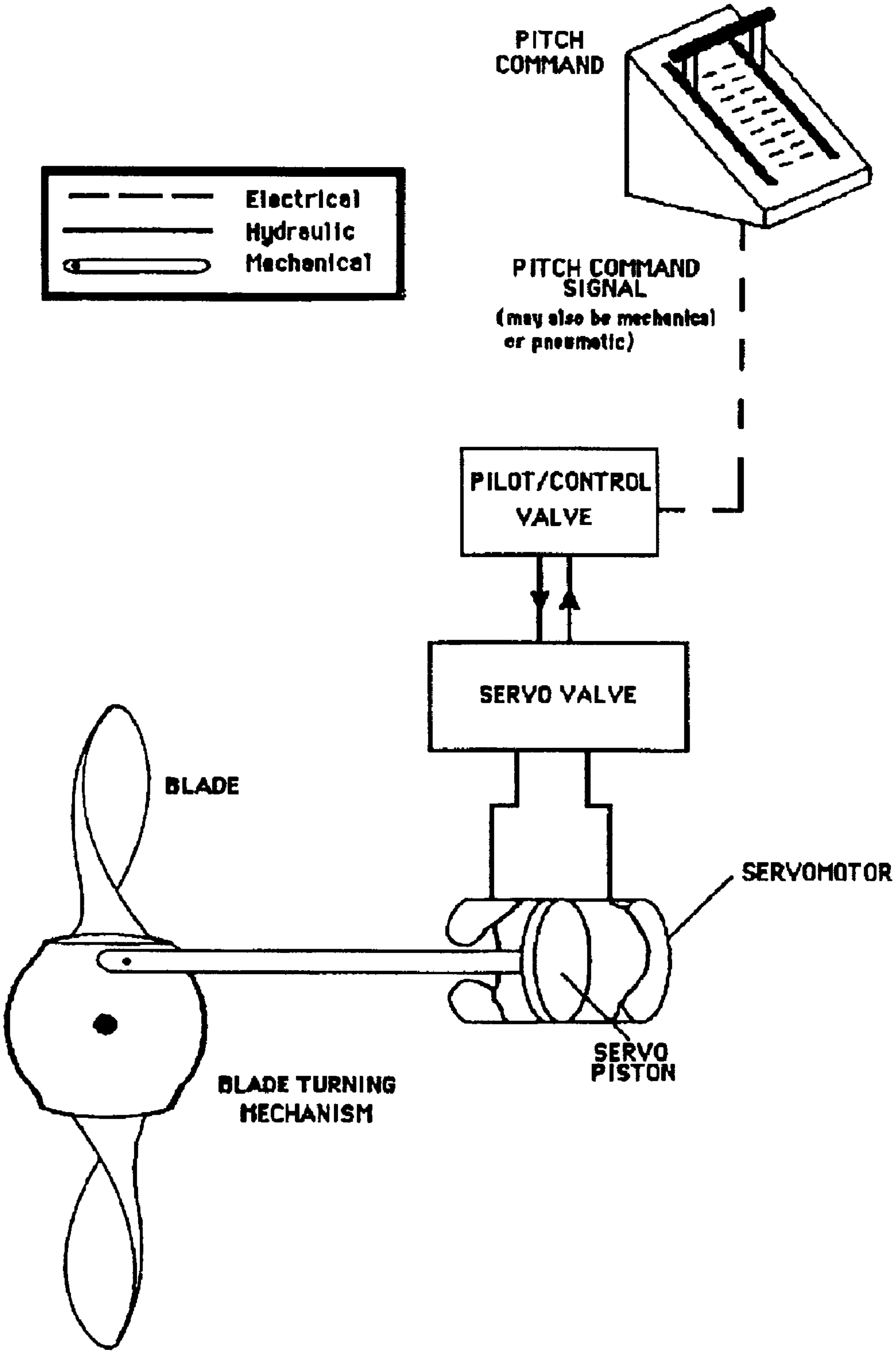

Figure 245-5-1. Controllable-Pitch Propeller - Functional Diagram

245-5-2.2.2 The major components of the hub servomotor-type CPP system are:

a. Electrohydraulic servo control assembly
b. Oil distribution (OD) box
c. Hydraulic system (including hydraulic oil power module [HOPM])
d. Valve rod assembly
e. Hub assembly and propeller blades

245-5-2.2.2.1 Electrohydraulic Servo Control Assembly. This unit electronically controls, monitors, actuates, and displays propeller pitch settings and changes. It receives pitch commands from the ship control console in the pilot house through the propulsion auxiliary control console in the central control station or from the propulsion local control console and provides electrical pitch commands to the OD box (specifically, the electrohydraulic servo valve on the manifold block assembly). It also receives pitch position input from the feedback potentiometer on the local pitch indicator at the OD box, displays pitch position, and provides pitch position input to the control consoles.

245-5-2.2.2.2 Oil Distribution Box. The OD box is usually mounted on the forward side of the reduction gear and is connected by hydraulic piping to the head tank, sump tank, and HOPM. Attached to the OD box are the local pitch indicator and the manifold block assembly (which consists of the remote operation servo valve, the manual control valve, and the manual changeover valves). The OD box receives electrical pitch control commands from the electrohydraulic servo control assembly. The command signal activates the electrohydraulic servo valve on the manifold block assembly. This valve directs the flow of auxiliary servo oil (control) pressure to and from the auxiliary servo pistons (forward and aft pistons), which change the position of the valve rod; this arrangement is sometimes referred to as the valve rod actuating mechanism. Pitch position feedback is provided to the electrohydraulic servo control assembly from the feedback potentiometer located on the local pitch indicator. Additionally, the OD box directs high pressure (HP) (hub servo) oil to, and low-pressure (LP) (return) oil from, the hub assembly through the propeller shaft and provides a passage for PRAIRIE system tubing. Major components of the OD box are:

a. Manifold block assembly
b. Forward and aft pistons
c. Single-row bearing assembly
d. Emergency pitch lock
e. Housing
f. Thrust bearing
g. LP oil seals
h. HP oil seals
i. Local pitch indicator and follow-up rod assembly

245-5-2.2.2.3 Hydraulic System. The hydraulic system provides control (auxiliary servo) fluid pressure and flow to the OD box to operate the valve rod actuating mechanism. It also provides HP fluid to the hub servomotor through the OD box and valve rod to operate the blade-turning mechanism. The system includes a HOPM connected by hydraulic piping to the sump tank, head tank, OD box, and manifold block assembly. Gear- and motor-driven pumps provide a flow of hydraulic fluid, which is regulated at the pressure control assembly, to achieve operating (high) and control (auxiliary) fluid pressure and flow to the OD box. Major components of the hydraulic system and HOPM are:

a. Motor - AC
b. Motor-driven pump
c. Suction (inlet) strainers
d. Oil cooler (if installed)

e. Gauge panel assembly

f. Gear-driven pump

g. Oil filters

h. Bypass valve

i. Pressure control assembly:
   1. In-line check valves
   2. Unloading valve
   3. Pressure-reducing valve
   4. Auxiliary servo relief valve
   5. Sequencing valve
   6. Main relief valve

245-5-2.2.2.4 Valve Rod Assembly. The valve rod assembly provides passage for HP hydraulic fluid from the OD box to the hub assembly and mechanically translates hydraulic pitch control commands in the OD box into valve rod movement. The regulating-valve pin, attached to the aft end of the valve rod, moves with the valve rod and carries HP oil through the hub regulating-valve liner to the servomotor (in the hub assembly). Guides support the valve rod in the center of the propeller shaft bore. The forward end attaches to the OD box distance tube. PRAIRIE system tubing is mounted in the bore of the valve rod. Low-pressure hydraulic fluid returns to the OD box from the hub assembly through the cavity between the valve rod assembly and the inside surface of the main propulsion shaft.

245-5-2.2.2.5 Hub Assembly and Propeller Blades. The hub assembly is attached to the aft end of the propulsion shaft. Propeller blades are bolted symmetrically around the circumference of the hub. A blade port cover and blade seal base ring prevent seawater from entering the hub and pressurized hydraulic fluid from leaking out around each blade. The position of the blades is set and maintained by the hub servomotor assembly through the blade-turning mechanism. Pitch commands from valve rod and regulating-valve pin movement port HP hydraulic fluid to the servomotor through the regulating-valve liner. When the desired pitch is reached, the regulating-valve liner acts as a follow-up mechanism, closing servo piston HP hydraulic fluid supply ports to restrict the flow through metering relieves in the valve liner. This balances the forces on the servo piston, holding the pitch in the desired position. The PRAIRIE system tube ends at the hub, where air is carried internally to the blade edges. Major components are:

a. Hub cone and cover

b. Blade-turning mechanism:
   1. Crosshead
   2. Sliding block
   3. Crank pin ring
   4. Eccentric pin

c. PRAIRIE system check valve (where applicable)

d. Purge valve assembly

e. Safety relief valves

f. Propeller blades

g. Regulating valve liner

h. Servomotor (piston or cylinder assembly)

i. Blade seals and bearing rings

245-5-2.2.2.6 Other Components and System Interfaces.

245-5-2.2.2.6.1 Sump Tank. The sump tank is the hydraulic fluid reservoir for the CPP system. It supplies hydraulic fluid for the main and standby pumps and is connected to the head tank and OD box through piping. The major components of the sump tank are:

a. Thermostat
b. Low oil level sensor
c. Immersion heater
d. Temperature gauge
e. Sounding tube or tank level indicator

245-5-2.2.2.6.2 Head Tank. The head tank stores system hydraulic fluid and is installed above all other CPP components and above the ship's waterline. The head tank maintains a static hydraulic fluid pressure in the hub greater than the ambient water pressure on the blade seals to prevent seawater from entering when the system is secured or when there is damage to a blade seal.

245-5-2.2.2.6.3 Circulating Pump. Some ships have a separate pump that provides hydraulic fluid to replenish the head tank when the fluid level falls below a specified level. Other ships use the motor-driven pump to replenish the head tank. Refer to the system technical manuals for specific instructions on replenishing the head tank hydraulic fluid level.

245-5-2.2.2.6.4 PRAIRIE System Interface. A PRAIRIE system is installed on some ships to mask propeller noise. PRAIRIE system tubing enters the CPP system through the forward end of the OD box and travels through the bore of the valve rod to the propeller hub, where the air is carried to the blades. The PRAIRIE system should be operated in accordance with the engineering operational sequencing system (EOSS) and type commander's instructions.

245-5-2.2.2.6.5 Lube Oil Purifier Interface. The lube oil purifier is hard-piped to the CPP system sump tank and is shared with other propulsion and auxiliary systems. It is used to remove water and particulate contamination from lube oil and hydraulic fluid. Piping is interconnected with storage and settling tanks for sump tank replenishment or fluid replacement, as well as for recirculating through the purifier. Some systems may use the purifier as a heater for the hydraulic fluid during startup.

245-5-2.2.2.6.6 Propulsion Control System Interface. The normal operating mode for most ships is automatic remote operation from the pilot house (bridge) or central control station. Throttle and pitch control are integrated in a single handle on the control consoles for normal combinations of shaft rpm and pitch. Additionally, control on most ship classes can be split at certain stations to allow an infinite combination of rpm and pitch (within engine overload and overspeed limits). Pitch system alarms and indicators are also found together on propulsion system control consoles.

245-5.3. SPECIAL COMPONENT FEATURES.

The following are special component features that may be found on some CPP systems:

245-5.3.1 PITCH-LOCKING DEVICE. This device provides a means to mechanically lock the OD box, piston, valve rod, and propeller blades in the emergency-ahead pitch position. This position allows the propeller to operate in the event of loss of pitch control through hydraulic or electrical failure.

245-5.3.2 EMERGENCY PITCH-POSITIONING EQUIPMENT. In the event of hydraulic or electrical system failure, this equipment provides a means to mechanically position the propeller blades using a hand-operated hydraulic pump to provide hydraulic fluid under pressure to the OD box piston.

245-5.3.3 PUMP DRIVE ASSEMBLY. The pump drive assembly is mounted on the reduction gear and contains gears and shafting for driving the CPP system gear-driven pump. This assembly includes a sliding tooth clutch that permits engaging the gear-driven pump at rest and disengaging the gear-driven pump during operation.

245-5.4. CPP SYSTEM OPERATION.

245-5.4.1 OPERATIONAL REQUIREMENTS. The EOSS provides ship-specific written procedures, charts, and diagrams that allow watch-standers to operate the CPP system and handle casualties in a safe, orderly, and controlled manner. The EOSS consists of two parts: engineering operating procedures (EOP) and engineering operational casualty control (EOCC). The EOP consists of sequential actions required for CPP alignment and operation; it includes system diagrams to support these procedures. EOCC consists of casualty response procedures for watch standers to implement in order to control casualties. Casualty responses include loss of CPP control, loss of oil pressure, and major oil leakage. NSWCPD 426 is responsible for developing and maintaining the applicable Ship's Information system EOSS. Refer to the applicable Ship's Information Books (SIB) for specific descriptions of operating stations and capabilities.

245-5.4.2 OPERATING MODES. There are two types of operating conditions for CPP systems, normal operation, and emergency operation. Several facets of normal operation correspond to operation from the various control consoles; control alignment varies with ship type. Refer to the Ship Information Book (SIB) and control technical manuals for information on specific ship controls. Additionally, refer to the system manuals and the EOSS for further information and procedures for normal and emergency operation. If the automatic or manual controls fail, most ships are able to set and lock blade pitch in an emergency-ahead position to permit limited operation. Refer to the system manuals (Table 245-5-1) for specific information on this capability.

245-5.5. MATERIAL CONDITION AND MAINTENANCE.

245-5.5.1 OVERVIEW. This section provides requirements, instructions, and information to aid in the performance of preventive and corrective maintenance.

245-5.5.2 PLANNED MAINTENANCE. The planned maintenance system (PMS) requirements shall be performed according to the instructions provided on the applicable maintenance requirement card (MRC). NSWCPD 426 is responsible for developing and maintaining the PMS for CPP systems. If the applicable ship class MRC is incorrect or do not exist for a particular piece of equipment or component, institute interim maintenance according to the manufacturer's recommendations and notify NSWCPD 426. The following standard maintenance items shall be included in each CPP system PMS package:

a. Hydraulic Fluid Inspection and Maintenance
b. Lubrication
c. Operational Test
d. Heat Exchanger Cleaning and Inspection
e. CPP Blade Mounting Bolt Inspection
f. System Adjustment and Alignment

245-5.5.2.1 A report, reference (t), shall be submitted in accordance with reference (u) requesting coverage for the equipment.

245-5.5.3 HYDRAULIC FLUID INSPECTION AND MAINTENANCE. Typical maintenance actions for CPP systems will include the following:

a. Obtaining and providing samples for analysis

b. Cleaning or replacement of contaminated fluid

c. Inspection of filters and strainers

d. Cleaning or replacing filters and strainers

e. Removal of bottom sediment and water from the head tank

245-5.5.3.1 System Fluid Condition. Controllable-pitch propeller systems are considered hydraulic systems, even though most systems use lubricating oil, reference (v), The most common cause of problems with the hydraulic system is fluid contamination. Hydraulic system particulate contamination may be the result of component catastrophic failure, component wear, or entry from some external source. To prevent system damage, the system hydraulic fluid (and filters) shall be maintained in accordance with the ship class PMS. Reference (w) provides additional criteria for inspection and testing of hydraulic system oil. Some servo valves have tiny screen filters in the pilot stage of the valve body that are often overlooked and can become clogged and adversely affect (slow) blade slew rates. Specific inspection and maintenance actions are discussed in the following paragraphs.

245-5.5.3.1.1 Wear Metal Contamination. Compare the current wear metal analysis results to the system's historical trend. Significant variations from the system norm for a given wear metal(s) is indicative of accelerated deterioration. NSWCPD 426 and NSWCPD 337 shall be notified of instances of wear metal contamination. NSWCPD 426 will use wear metal analysis results to identify likely sources of subject material and direct targeted troubleshooting efforts.

245-5.5.3.1.2 Water Intrusion Contamination. CPP systems are subject to seawater and freshwater contamination. The "clear and bright" criteria and the bottom sediment and water (BS&W) tests have been adapted from lubricating oil testing to provide a shipboard capability for evaluating the contamination of CPP system hydraulic fluid. CPP hydraulic fluid, however, is evaluated under different criteria than lubricating oils. The following is a discussion of the various contamination ranges for CPP hydraulic fluid and the required maintenance actions.

245-5.5.3.1.2.1 The operating goal for the hydraulic fluid is "clear and bright" (free of visible contaminants). If the hydraulic fluid sample appears "clear and bright", the fluid is satisfactory for continued use. As part of standard preventive maintenance, the CPP system fluid should be purified for 4 hours per day while at sea to maintain a "clear and bright" condition.

245-5.5.3.1.2.2 If the hydraulic fluid sample appears hazy or cloudy or if sediment is present on the bottom of the sample bottle, perform a BS&W test. In instances where the oil has darkened to the point where it is difficult to see through the oil (dark red or burgundy color), the sample shall be illuminated by holding a standard 2 D-cell flashlight or equivalent against the side or bottom of the 8 ounce glass oil sample bottle and inspecting for visible cloudiness or sediment. If dark oil is observed, perform an inspection of the electric heater if equipped as described below.

245-5.5.3.1.2.3 If results indicate less than or equal to 0.1 percent BS&W, the hydraulic fluid is satisfactory for system operation. Purify the system fluid for 12 hours per day. Obtain and analyze samples daily until "clear and bright" fluid is achieved.

245-5.5.3.1.2.4 If the BS&W results indicate contamination is greater than 0.1 percent, but less than or equal to 0.4 percent, purify the system for 48 hours. Inspect system for leaks and source of contamination. Every 12 hours of the 48-hour purification period, obtain fluid samples and perform a BS & W test. Record the results obtained. At the end of the 48-hour purification period, review the BS&W results.

245-5.5.3.1.2.5 If there is no reduction of contamination, or if there is an increase in the BS&W contamination level greater than 0.4 percent as shown by the BS&W test results, performed a detailed inspection of the CPP system to determine the source of the contamination or leak. Continue to purify system for the maximum hours per day possible and monitor the hydraulic fluid condition until the problem is resolved. Prolonged operation of

CPP systems with high levels of water contamination can result in system corrosion and damage. A report of this condition shall be forwarded to NSWCCD-SSES 932. Technical assistance may also be requested from NSWCCD-SSES 932.

245-5.5.3.1.2.6 If the results indicate that the contamination level is decreasing, control of the contamination problem has probably been established. Continue purifying the system for the maximum number of hours that the purifier is available until BS&W test results indicates water contamination of 0.1 percent or less. Continued unrestricted operation is acceptable with water content greater than 0.1 percent and less than or equal to 0.4 percent, provided control of water content can be maintained within this range. Inability to purify to 0.1 percent or less may be due to fluid additive oxidation and/or a system leak and should be corrected as soon as possible.

245-5.5.3.1.3 System Fluid Smell and Color. Operators shall note the odor of oil samples taken for analysis and compare the smell to that of new oil. Any odor of volatile substances similar to gasoline shall be cause for replacement of the oil and a report made to the appropriate command authority. Oil which has darkened to the point where a BS&W test cannot be performed shall also be replaced.

245-5.5.3.1.4 Fluid Inspection Requirements for Ships Equipped with Electric Heaters on CPP Systems. Oil samples shall be submitted to NOAP on a semi-annual basis. Testing will include flash point and viscosity tests in addition to existing tests.

245-5.5.3.1.4.1 Operators shall perform flash point testing on system sump oil on a quarterly basis using NAVIFLASH testing equipment. Samples for testing shall be taken at normal system operation temperatures and shaken just prior to analysis to ensure a homogeneous sample. If the flash point is lower than 370° F, discontinue use of the equipment until the cause of the reduced flash point can be determined, the oil replaced, and the system flushed.

245-5.5.3.1.4.2 If testing of viscosity in the CPP system is below 70 CST, discontinue use of the equipment and replace hydraulic system fluid. If the viscosity is less than 74 CST but above 70 CST, the system may continue to be operated and efforts taken to improve the viscosity.

245-5.5.3.1.4.3 Inspect electric heaters which service the CPP system on an annual basis with a borescope. The inspection shall ensure that no coking, tar formation or other problems are present. If coking or tar formation is found, the heater shall be taken out of service until the heater can be cleaned or the heating elements replaced.

245-5.5.4 OTHER MAINTENANCE ACTIONS.

245-5.5.4.1 Lubrication. Lubricate moving parts such as the linkages, bearings, and couplings in accordance with the applicable ship class MRCs.

245-5.5.4.2 Operational Testing. Operate the pitch control system (cycle times), test the emergency pitch positioner, test the alarms, and test the hydraulic pump output in accordance with the applicable ship class MRCs.

245-5.5.4.3 Heat Exchanger Cleaning and Inspection. Clean and inspect the heat exchanger (if installed) in accordance with the applicable ship class MRCs.

245-5.5.4.4 CPP Blade Mounting Bolt Inspection. Inspect blade mounting bolts in accordance with Sections 3 and 4 to determine if there are any missing or loose blade bolts. Missing bolts shall be replaced. Loose blade bolts shall be removed, inspected for damage, and if found acceptable, reinstalled. When missing or loose blade bolts are found, all remaining blade bolts for the ship shall be re-torqued in accordance with the ship class maintenance standards. A report of this condition shall be provided to NSWCCD-SSES 932. A Rolls Royce Naval

Marine representative shall be present during the drydock installation of CPP blade bolts (Section 3). A copy of the Rolls Royce Naval Marine blade bolt installation sheet shall be provided to NSWCCD-SSES 932 via the final docking report.

245-5.5.4.5 Hose Inspection. Inspect the hoses for cracking, wear, and age in accordance with the applicable ship class MRCs. For further guidance on hose inspection, replacement, and testing, refer to reference (x).

245-5.5.4.6 Adjustment and Alignment. Certain electrical, hydraulic, pneumatic, and mechanical components require periodic adjustment and alignment. The periodicity of these actions is specified on the applicable MRCs. Procedures for making the adjustments and alignments are found in the appropriate component technical manuals. These adjustments and alignments include calibrating pitch indication, testing the relief valves, testing the sequencing valves, testing the control valves, checking the electrical enclosures and motors, checking pitch cycle times, and aligning the control circuits.

245-5.5.4.7 Mechanical Pitch Indicator Calibration and Alignment. The mechanical pitch indicator shall be calibrated following repair or replacement of major components in the hub, valve rod, shafting, or OD box. Refer to the applicable system technical documentation for specific instructions. This alignment ensures that the local pitch-indicating assembly accurately reflects the actual pitch position of the blades at the hub. Calibration should be done with the hydraulic fluid at normal operating temperature to avoid inaccuracies due to thermal growth or contraction of the valve rod. Significant changes in ambient seawater temperature will result in variations in the normal operating temperature of the hydraulic fluid. Since this will cause thermal growth or contraction of the valve rod, ships should re-calibrate after changing operating areas where differences in seawater temperature are significant.

245-5.5.4.8 Inspection of Gear-Driven Pumps. Couplings and mounting bolts on gear driven pumps may loosen, causing vibration and eventual pump failure. Routine inspection and maintenance, in accordance with PMS requirements, should eliminate this problem.

245-5.5.4.9 Inspection of Head Tank Drain Down. With the CPP system secured, the head tank should maintain a static fluid pressure for approximately 12 hours without the need for replenishment.

245-5.5.4.9.1 Head tank drain down within approximately 20 minutes after system shutdown indicates that a valve is open that bypasses the return line check valve. The correct valve alignment should be identified in the EOSS procedures.

245-5.5.4.9.2 Significant decreases in the head tank fluid level may be experienced during the initial stages of system shut-down due to fluid cooling. This is a direct result of the cooling contraction of the warm hydraulic fluid in the hub and propulsion shafting. It is more apparent on systems with large quantities of fluid. In a CPP system with 2,300 gallons of fluid, for example, a change from an operating temperature of 110° F to an ambient temperature of 60° F may cause an volume loss of approximately 45 gallons. This condition is normal but could be misconstrued as a leaking hub oil seal or return line check valve. Volume loss due to cooling is dependent upon temperature change and the quantity of fluid in the system. Figure 245-5-2 is provided for estimating the amount of volume loss that will occur for a specific temperature change and a specified volume of system fluid. The capacity is the volume of hydraulic fluid pressurized by the head tank; the fluid in the sump tank and associated piping must be discounted.

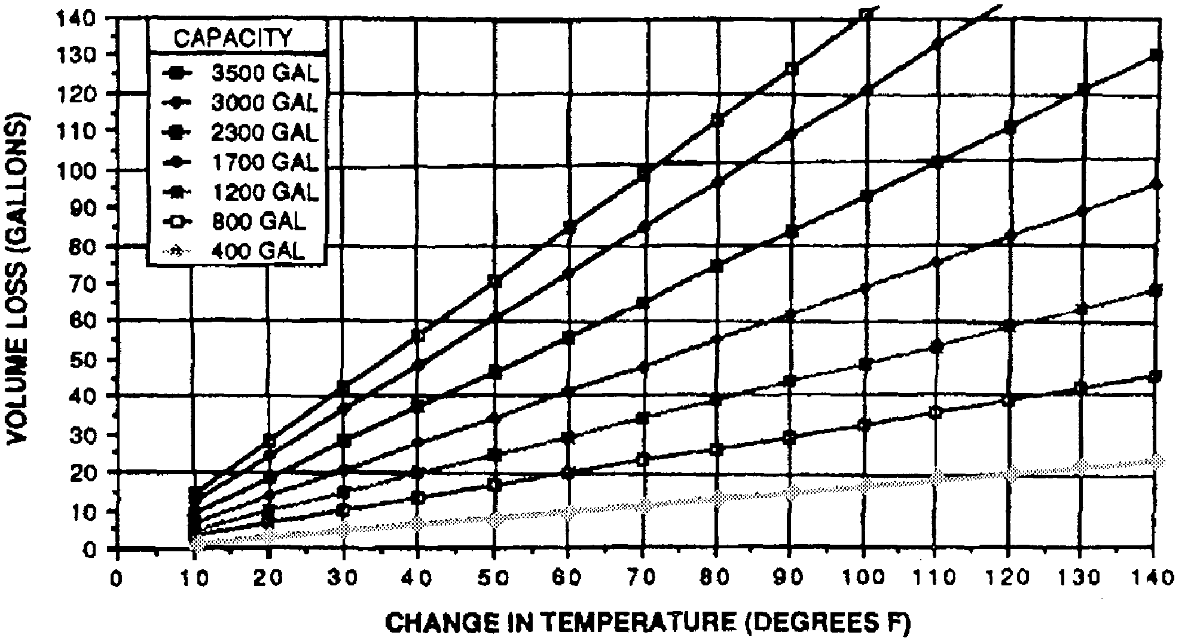

Figure 245-5-2. Controllable-Pitch Propeller Hydraulic Fluid (MIL-L-17331) Volume Loss Due to Thermal Contraction

245-5.5.4.9.3 A slow head tank drain down after system cool down, with a corresponding rise in sump tank level, commonly indicates a leaking return line check valve; the leak may also be through another component, however, such as the isolation valves, foot valve, or manifold block assembly.

245-5.5.4.9.4 Hydraulic oil leaks through the blade seals (as evidenced by an oil slick astern) or into the engine room bilges are less common occurrences but may contribute to head tank drain down. From an equipment perspective, blade seal leakage does not impose a risk of significant equipment degradation as long as pressure is supplied to the hub via pumps or the head tank. If positive pressure is maintained, fluid will be discharged to the surrounding water from the leak. If pressure is not maintained, water ingress to the hub and CPP system can degrade the hub or other CPP system components as well as result in system contamination. A maximum leakage rate of eight (8) drops per minute has been applied to blade seals in order to ensure system safety.

NOTE

Local environmental standards may restrict or prohibit leakage of oil. These requirements may dictate the need for seal replacement even though operationally there is no need to replace the seal.

245-5.5.4.10 Emergency Ahead Pitch Lock Inspections. The pressure required to move the OD box piston to the emergency ahead pitch lock position is much higher than normal auxiliary servo pressure and may stretch the valve rod and OD box. This may deform (overstress) the attached assemblies if operated improperly. While operating in emergency ahead pitch lock, closely monitor the shaft rpm and oil temperature, as this mode of operation generates considerable heat. Refer to the operating instructions for restrictions and operating parameters.

245-5.5.4.11 Obsolete Parts. One of the recurring problems for CPP systems is the need to replace components that are no longer available in the supply system. Obtaining obsolete replacement parts becomes increasingly difficult, especially for older CPP systems. Manufacturers are constantly modifying their equipment to improve component efficiency and keep pace with industry standards. Modifications are occasionally needed to accommodate new components. When a ship receives a replacement part that has been modified in some way or modifies the system, the ship shall document the configuration change as required by reference (y) (to update the Weapon System File and Coordinated Shipboard Allowance List), and to submit technical manual, PMS, and EOSS changes (feedback reports) as applicable.

245-5.5.4.12 Mechanical Seal Inspection and Replacement. Mechanical seals are installed in CPP systems to prevent the loss of hydraulic fluid and to prevent the ingress of seawater or other contaminants. Periodic inspection in accordance with the applicable ship MRCs is required. In-service seals shall be replaced when the seal is removed for any reason, or the seal leakage rate exceeds eight (8) drops per minute.

NOTE

> Local environmental standards may restrict or prohibit leakage of oil. These requirements may dictate the need for seal replacement even though operationally there is no need to replace the seal.

245-5.6. CONDITION BASED DOCKING DETERMINATION CRITERIA.

245-5.6.1 BACKGROUND. Under the Condition Based Assessment (CBA) approach, the following periodic inspections and tests of the CPP system are provided to assess the material condition of the system and permit a determination to be made concerning the need for depot level maintenance. Applicable technical manuals and technical repair standards are identified in Table 245-5-1.

245-5.6.1.1 Periodicities. After the first six years of CPP hub operation, CBA procedures/inspections are required. Evaluation of the periodic inspection results will be compared to inspection records from the last inspection and CPP system installation or the last major system overhaul to identify deteriorating trends and/or departures from allowable operating conditions. If the six year inspection does not identify material deficiencies requiring drydocking to correct, the CPP system is acceptable for continued operation for an additional two years. At the end of two years, repeat the CBA inspection process and every two years thereafter until the next drydocking, at which time, the CPP blades and blade port covers (as applicable) shall be removed and blade ports shall be inspected, critical dimensions taken, and the hubs repaired or replaced as required during the availability.

245-5.6.1.2 Condition Based Assessments. The following condition based assessment procedures and inspections shall be conducted in accordance with the periodicities discussed above.

245-5.6.1.3 Visual Inspection For Oil Leaks.

245-5.6.1.3.1 Shipboard.

245-5.6.1.3.1.1 Action. Inspect shipboard system piping, hoses and equipment for leakage.

245-5.6.1.3.1.2 Criteria. No Leakage Permitted.

245-5.6.1.3.1.3 Corrective Actions. Troubleshoot and correct leakage in accordance with applicable system technical manual.

245-5.6.1.3.2 Waterborne.

245-5.6.1.3.2.1 Action. Qualified divers shall inspect the CPP system waterborne. The diver shall inspect the hub for oil leaks from the following locations while the system is pressurized and placed on purge via applicable MRC card.

a. Blade Ports (including blade bolts)

b. Hub Body (including plugs, joints, etc)

c. PRAIRIE Emitter Holes

245-5.6.1.3.2.2 Criteria. Eight (8) drops per minute maximum from blade ports; no leakage permitted from hub body or PRAIRIE emitter holes.

245-5.6.1.3.2.3 Corrective Actions.

245-5.6.1.3.2.3.1 Blade Port Leaking. When waterborne inspections reveal oil leaks greater that eight (8) drops per minute, this is indicative of blade port seal deterioration. The blade and blade port seals shall be replaced waterborne in accordance with system technical manuals and procedures contained in reference (r). After seal replacement, the system shall be re-inspected as specified above. If the system continues to exceed allowable leakage rates after seal replacement, the ship must be drydocked, the CPP hub opened and inspected, and associated components repaired or replaced in place during the availability.

245-5.6.1.3.2.3.2 Hub Body Leaking.

245-5.6.1.3.2.3.2.1 Plugs. Leakage from hub body plugs can be corrected by tightening and re-staking of the leaking plug in accordance with procedures contained in reference (r).

245-5.6.1.3.2.3.2.2 Joints. Leakage located at hub body to hub cone, or hub body to propeller shafting joints requires drydocking to correct.

245-5.6.1.3.2.3.3 PRAIRIE Emitters. Oil leakage from PRAIRIE emitter holes is indicative of damage to PRAIRIE tubing. Temporary repairs are possible (eliminating PRAIRIE function), but full correction requires drydocking.

245-5.6.1.3.2.3.3.1 Temporary Repair of Leaking PRAIRIE Emitters.

245-5.6.1.3.2.3.3.2 Onsite technical assistance conduct system inspection and Qualified Navy divers conduct a waterborne inspection of the subject hub in an effort to determine if the PRAIRIE tube is parted, or is simply leaking.

245-5.6.1.3.2.3.3.3 If the PRAIRIE tube is leaking but not parted, the hub PRAIRIE check valve is replaced with a plug in order to block flow of oil to the blade emitter holes in accordance with procedures contained in reference (r). This eliminates PRAIRIE function.

245-5.6.1.3.2.3.3.4 If the PRAIRIE tube is parted in the vicinity of the hub section of PRAIRIE tube flange weld (usual case), the PRAIRIE flange, and attached section of the tube is removed and a blank is installed on the end of the valve pin liner in accordance with procedures contained in reference (r). The PRAIRIE check valve is also removed and replaced with a plug. This restores operation of the CPP system, but eliminates PRAIRIE function until permanently repaired.

245-5.6.1.4 Blade Bolt & Blade Bolt Cap Inspection.

245-5.6.1.4.1 Qualified divers shall inspect the CPP blade bolts and blade bolt caps (as applicable) for tightness.

245-5.6.1.4.2 Acceptance Criteria. No loss of preload, as measured by a qualified Navy diver using ultrasonic blade bolt stretch measurement device in accordance with Navy Underwater Ship Husbandry Manual (Chapter 12) Procedures, reference (q).

245-5.6.1.4.3 Corrective Action. If a loose bolt is found, the subject bolt must be removed, inspected, and reinstalled or replaced in accordance with the Navy Underwater Ship Husbandry Manual (Chapter 12) Procedures, reference (q). Additionally, in order to ensure that the joint integrity is not compromised as a result of the change in load distribution due to the loose bolt, measure stretch (preload) of all blade bolts on affected blade port after the loose bolt has been satisfactorily re-installed.

245-5.6.1.5 System Fluid Inspection.

245-5.6.1.5.1 Action. Take system fluid samples in accordance with applicable Sample for Chemical Analysis MRC Card, and have samples tested for wear metals, particulate count, and water. Evaluate current sample against established criteria and historical trend for subject ship and system, observing for variations that would be indicative of component/subcomponent deterioration.

245-5.6.1.5.2 Criteria. Refer to paragraph 245-5.5.3 for system fluid characteristic criteria.

245-5.6.1.5.3 Corrective Action.

245-5.6.1.5.4 Water. Identify the source of water contamination and correct.

245-5.6.1.5.5 Wear Metals & Particulate Count. High particulate count and wear metals are indicative of component/subcomponent deterioration. Using wear metal analysis in accordance with the Sample for Chemical Analysis MRC Card, identify likely sources of subject material and determine if waterborne or drydock repair is required based on applicable system technical manual and class maintenance plan.

245-5.6.1.5.6 Evidence of Oil Consumption.

245-5.6.1.5.7 Action. Verify no loss of system fluid is observed during operation.

245-5.6.1.5.8 Criteria. No oil consumption permitted.

245-5.6.1.5.9 Corrective Action. Perform detailed system inspection in accordance with applicable system technical manual.

245-5.6.1.6 System Pressures and Temperatures.

245-5.6.1.6.1 Action. Observe system pressures and temperatures at system Hydraulic Oil Power Module (HOPM), pier side and underway.

245-5.6.1.6.2 Criteria. System pressures and temperatures at HOPM are within allowable values in accordance with applicable system technical manual.

245-5.6.1.6.3 Corrective Action. Troubleshoot in accordance with applicable system technical manual.

245-5.6.1.7 Slew Rate.

245-5.6.1.7.1 Action. Cycle propeller blade pitch, Full Ahead to Full Astern in manual mode (from oil distribution box). Observe and record time required. Cycle pitch, Full Astern to Full Ahead in manual mode (from oil distribution box). Observe and record time required.

245-5.6.1.7.2 Criteria. 30 Seconds (Maximum).

245-5.6.1.7.3 Corrective Action. Troubleshoot in accordance with applicable system technical manual.

245-5.6.1.8 Hub Servo Stall Check.

245-5.6.1.8.1 Action. Slew propeller blade pitch, pier side in manual mode (from oil distribution box), while manipulating the pressure control manifold valves on the Hydraulic Oil Power Module (HOPM) to affect a reduction in hub servo pressure until the hub servo piston in the propeller hub stalls. Record the pressure at which hub servo stall occurs. Evaluate current pressure against historical trend for subject ship and system, observing for variations in the trend that would be indicative of component/subcomponent deterioration.

245-5.6.1.8.2 Criteria. Variance of + 50 psi from original installation pressure.

245-5.6.1.8.3 Corrective Action. Correlate results of hub stall check with fluid chemical analysis and other system inspection results. Conduct further troubleshooting in accordance with applicable system technical manual to isolate root cause and determine course of repair.

245-5.6.1.9 Valve Rod Stall Check.

245-5.6.1.9.1 Action. Slew propeller blade pitch pier side in manual mode (from oil distribution box) while manipulating the pressure control manifold valves on the Hydraulic Oil Power Module (HOPM) to affect a reduction in auxiliary servo pressure until the OD Box piston stalls. Record the pressure at which the auxiliary servo stall occurs. Evaluate current pressure against historical trend for subject ship and system, observing for variations in the trend that would be indicative of component/subcomponent deterioration.

245-5.6.1.9.2 Criteria. Variance of +50 psi from original installation pressure.

245-5.6.1.9.3 Corrective Action. Correlate results of valve rod stall check with fluid chemical analysis and other system inspection results. Conduct further troubleshooting in accordance with applicable system technical manual to isolate root cause and determine course of repair.

245-5.6.2 EMERGENT CASUALTIES. At any time if there is a loss of pitch, unusual noise or vibration (not due to valve rod guide wear), or a significant variation in operating oil pressure during ship operations, the propeller system shall be inspected immediately by qualified technicians. If the CPP system components within the hull are determined not to be the source of the problem, the ship must be drydocked, the CPP hub shall be opened, and associated equipment shall be inspected and repaired or replaced. Noise associated with valve rod guide wear is not considered a cause for an emergent drydocking, unless the ship's mission is considered noise critical, because it does not pose an immediate threat to continued CPP system operation. The valve rod guides shall be repaired at the ship's next availability. If the CPP hub is repaired, the ship will return to the two-year pressurized inspection cycle until the next drydocking, at which time, the CPP hub shall be opened and inspected, and repaired or replaced if required during the availability. If the CPP hub is replaced, pressurized inspection of the CPP system shall be performed after six years of operation and at two year intervals thereafter until the next drydocking, at which time, the CPP blades and blade port covers (as applicable) shall be removed and blade ports shall be inspected, critical dimensions taken, and the hubs repaired or replaced as required during the availability.

245-5.6.3 EMERGENT DRYDOCKINGS. In the event that the ship is drydocked for non CPP system related reasons after six years of CPP operation, the CPP blades and blade port covers (as applicable) shall be removed and blade ports shall be inspected, critical dimensions taken, and the hubs repaired or replaced as required during the availability. The ship will return to the two-year pressurized inspection cycle after the CPP hub is repaired in drydock. If the CPP hub is replaced, pressurized inspection of the CPP system shall be performed after six years of operation and at two year intervals thereafter until the next drydocking, at which time, the CPP hub the CPP blades and blade port covers (as applicable) shall be removed and blade ports shall be inspected, critical dimensions taken, and the hubs repaired or replaced as required during the availability.

245-5.6.4 REPORTING. The results of all inspections, tests, and repairs shall be forwarded to NSWCPD 426.

245-5.6.5 CPP HUB INSPECTION AND MAINTENANCE WHEN SHIP IS DRYDOCKED. Drydocking presents the only opportunity to inspect the internals of the CPP hub. CPP hub inspections during drydock availabilities should be conducted in accordance with the periodicities defined in paragraphs 245-5.4.4.2 and 245-5.4.4.5. Standard (baseline) inspections should be done in accordance with applicable technical manuals, technical repair standards, and drawings; and the results reported to the ship's commanding officer, TYCOM and NSWCCD-SSES 932. In addition to the requirements of Section 3, the following minimum standard work item inspections should be in the applicable CMP's and scheduled during drydocking inspections:

a. Inspect the propeller blade bolts for residual stretch and take action as described in previous paragraphs.

b. Inspect the internal condition of the hub at one blade port and measure the critical clearances and dimensions.

c. Inspect the blade ports.

d. Test and verify pitch alignment. Verify alignment using hub bench marks.

e. Remove, test, and reinstall the hub body safety valves.

f. Tighten the hub and tailshaft bolts to the specified torque.

g. Inspect the propeller bearing rings and skim-cut the ring to the maximum depth tolerance before reassembling it (if disassembled).

h. Clean the PRAIRIE system emitter holes.

i. Clean and inspect the after PRAIRIE system check valve.

j. Inspect and check the tightness of the retaining setscrews on the PRAIRIE system adapter plug and retaining plate.

245-5.6.6 HUB ASSEMBLY AND BLADE REPAIR AND REPLACEMENT WHEN SHIP IS DRYDOCKED. Results of the blade and hub assembly inspections, discussed in paragraphs 245-3.3 and 245-5.4.5, are used to determine if the assembly will operate satisfactorily until the next scheduled drydocking. If the inspection results are unsatisfactory, hub and blade removal, disassembly, repair or replacement, and reinstallation are required. Guidance for repair and maintenance actions is provided in paragraph 245-1.4 and the CPP technical repair standards. CPP blade replacement information is provided in paragraph 245-3.7.

245-5.6.7 PROPELLER CLEANING, INSPECTION, REPAIR, AND BLADE REPLACEMENT WHEN SHIP IS WATERBORNE. Refer to Section 4.

245-5.6.8 BLADE BALANCE REQUIREMENTS. Blades are repaired and balanced as a hub set, to the requirements of reference (b). The blade position, as installed on the hub, is identified by the blade serial number stamped on each blade. Sometimes blade sets are separated as a result of individual blade replacements. In these cases, contact NSWCCD-SSES 932 to identify replacement blades that can be properly matched to the remaining blades to achieve an acceptable set. NSWCCD 932 maintains a record of all CPP blade weights. At the ship's next drydocking, the complete blade set shall have the balance inspected and corrected, as necessary, by a certified facility in accordance with reference (b). Upon completion of a successful balance inspection, the existing serial number and weight, as necessary, shall be ground off and the corrected serial number and weight are to be stamped on the blade palm.

245-5.6.9 POST REPAIR INSPECTIONS AND TESTS.

245-5.6.9.1 When the overhaul (or other industrial availability) has been completed, all CPP system repairs and maintenance shall be verified by performing a complete series of inspections and tests. Component inspections and tests provide assurance that the CPP system is operating properly, obvious deficiencies were corrected, and adjustments critical to safety and reliability were made. The shipyard or industrial activity should provide documentation for retention on the ship, including the equipment replacements, equipment settings, and test results obtained in support of all the overhaul maintenance performed on the CPP system. The appropriate technical manuals, TYCOM instructions, the total ship test program (TSTP) procedures, and PMS and EOSS for each specific piece of equipment should be reviewed for detailed information on appropriate inspections and testing procedures. Test procedures for some ships are formalized in the TSTP documentation maintained by Planning, Engineering, Repairs, and Alterations, planning yards and building yards (new construction).

APPENDIX A

GLOSSARY

Actuating rod	A linkage that connects the servomotor piston to the blade-turning mechanism in push-rod systems.
Actuating unit	A type of rotary hydraulic valve manifold in push-rod systems that directs high-pressure oil to and return oil from the servomotor through the double oil tube assembly.
Attached pump	Same as gear-driven pump.
Blades	Part of the propeller hub assembly that cuts through the water, creating thrust. On controllable-pitch propeller (CPP) systems, changes in the angle or pitch of the blades create changes in thrust. The blades are attached to the hub individually.
Blade trunnion	The rotating bearing connected to the blade that translates linear motion of the crosshead through the connecting pin to blade rotation in the hub of push-rod systems.
BS&W -	Bottom Sediment & Water test performed on hydraulic fluid in a CPP system.
CCS	Central control station
CP	Controllable pitch, same as CPP.
Conning station	Location where the ship's course and speed are controlled.
CPP	Controllable-pitch propeller. A type of propulsor system in which the propeller blade pitch can be continuously changed to provide thrust in the ahead or astern direction or any intermediate position, including zero thrust, without changing the direction of shaft rotation.
CRP	Controllable reversible pitch, same as CPP.
Double oil tube assembly	A tube inside a tube for carrying high-pressure oil to and return oil from the servomotor in push-rod systems.
Electric pump	Same as motor-driven pump.
Emergency ahead pitch	This is a device to mechanically lock the oil distribution (OD) box piston, valve rod, and propeller blades in the emergency ahead position. The emergency pitch positioner assembly is a portable, hand-operated hydraulic pump that provides hydraulic oil pressure to the OD box when auxiliary servo pressure is unavailable from main or standby pumps.
EOCC	Engineering Operational Casualty Control. Written procedures for recognizing, controlling, isolating, and recovering from certain propulsion plant casualties.
EOP	Engineering Operating Procedures. Written, step-by-step procedures, charts, and diagrams used for normal lighting off, operating, and securing the propulsion plant.
EOSS	Engineering Operational Sequencing System. Provides written procedures, charts, and diagrams that fit the individual ship's configuration. It allows watch standers to carry out major plant evaluations and correct casualties in a safe, orderly, and controlled manner.
EPI	Electronic Pitch Indicator.
Gear-driven pump	Hydraulic pump driven by the reduction gear or propulsion shaft through a flexible coupling or splined shaft connection. Depending upon the type of system, a gear-driven pump may be either the main or the standby pump.
GSO	General Specification for Overhaul of Surface Ships, NAVSEA S9AAO-AB-GOS-010/GSO. The document that contains the requirements for overhaul and repair of propellers, including CPPs.
Head tank	Tank used to maintain a constant static pressure greater than the ambient water pressure on the hub assembly when the CPP hydraulic system is secured. The head tank is installed above the ship's waterline at a higher level than other hydraulic components of the CPP system.
HOPM	Hydraulic Oil Power Module. A self-contained unit consisting of various hydraulic components that provides low-pressure (LP) oil to the OD box and high-pressure (HP) oil, through the OD box, to operate the hub assembly.
HP	High Pressure.

Hub assembly	Attached to the aft end of each propulsion shaft. Provides a mounting base for attaching the propeller blades. Houses the blade-turning mechanism for changing the pitch of the propeller blades.
IMA	Intermediate Maintenance Activity; such as Shore Intermediate Maintenance Activity (SIMA), or a tender.
LP	Low pressure.
Main pump	The hydraulic pump that provides primary hydraulic fluid power for maintaining or changing pitch. Depending on the type of system, the main pump may be either gear or motor driven.
MIP	Maintenance index page.
Motor-driven pump	A hydraulic pump driven by an electric motor. Depending on the type of system, the motor-driven pump may be either the main or a standby pump.
MRC	Maintenance requirement card.
NAVSEA	Naval Sea Systems Command, Washington, D.C.
NAVSUP WSS	Naval Supply Weapons Systems Support, Mechanicsburg, PA.
NOAP	Navy Oil Analysis Program.
NSWCPD 426	Naval Surface Warfare Center, Philadelphia Division, Pa. Code 426
OD Box	The oil distribution box is a type of rotary hydraulic manifold that directs HP (control) oil to and LP (return) oil from the hub assembly through the propeller shaft, and positions the valve rod assembly.
PACC	The propulsion and auxiliary control console located in the CCS.
PERA	NAVSEA Detachment, Planning, Engineering, Repairs, and Alterations, Surface.
PLCC	Propulsion local control console.
PMS	Planned maintenance system.
PRAIRIE system	The propeller air internally emitted (PRAIRIE) system is used to lessen the underwater sound level of the propeller. Air flows through tubing in the center of the valve rod assembly to drilled passages in the hub and is emitted from each blade through small holes near the leading edge of the blades.
Purifier	A device for removing water and other contaminants from lube oil and hydraulic fluid. It is connected with piping to the CPP system sump tank. In some systems, it is also used as a heater for the hydraulic fluid.
Return line check valve	Located in the hydraulic oil return line between the OD box and the sump tank, it provides a back pressure to prevent drain down of the head tank to the sump.
SCC	The ship control console located in the pilot house.
Servomotor	The assembly that drives the blade-turning mechanism. It may include the servo piston and valve, or the actuating rod and servo piston, depending on the type of CPP system.
SIMA	Shore Intermediate Maintenance Activity.
Standby pump	The hydraulic pump that provides secondary hydraulic fluid power for the CPP system. Depending on the type of system, the standby pump may be either gear- or motor-driven.
Sump tank	The main tank used for holding the hydraulic fluid used throughout the CPP system.
TCPI	Temperature-compensated pitch indicator.
TLI	Tank level indicator.
TRS	Technical repair standard.
TSTP	Total ship test program.
TYCOM	Ship type commander (i.e., COMNAVSURFLANT).
Valve rod assembly	The fabricated sections of seamless steel tubing joined by couplings and supported in the center of the propeller shaft by guides. It provides passage for HP hydraulic fluid from the OD box to the hub assembly and mechanically translates hydraulic pitch control commands in the OD box into servo valve movement in the hub. High-pressure hydraulic fluid is thus carried to the hub servomotor, resulting in corresponding pitch changes at the blade-turning mechanism in the hub assembly.