This document is part of Appendix A, Controllable Pitch Propeller Hydraulic Oil: Nature of Discharge for the "Phase I Final Rule and Technical Development Document of Uniform National Discharge Standards (UNDS)," published in April 1999. The reference number is EPA-842-R-99-001.

Phase I Final Rule and Technical Development Document of Uniform National Discharge Standards (UNDS)

Appendix A

Controllable Pitch Propeller Hydraulic Oil: Nature of Discharge

April 1999

NATURE OF DISCHARGE REPORT

Controllable Pitch Propeller Hydraulic Oil

1.0 INTRODUCTION

The National Defense Authorization Act of 1996 amended Section 312 of the Federal Water Pollution Control Act (also known as the Clean Water Act (CWA)) to require that the Secretary of Defense and the Administrator of the Environmental Protection Agency (EPA) develop uniform national discharge standards (UNDS) for vessels of the Armed Forces for "...discharges, other than sewage, incidental to normal operation of a vessel of the Armed Forces, ..." [Section 312(n)(1)]. UNDS is being developed in three phases. The first phase (which this report supports), will determine which discharges will be required to be controlled by marine pollution control devices (MPCDs)—either equipment or management practices. The second phase will develop MPCD performance standards. The final phase will determine the design, construction, installation, and use of MPCDs.

A nature of discharge (NOD) report has been prepared for each of the discharges that has been identified as candidates for regulation under UNDS. The NOD reports were developed based on information obtained from the technical community within the Navy and other branches of the Armed Forces with vessels potentially subject to UNDS, from information available in existing technical reports and documentation, and, when required, from data obtained from discharge samples that were collected under the UNDS program.

The purpose of the NOD report is to describe the discharge in detail, including the system that produces the discharge, the equipment involved, the constituents released to the environment, and the current practice, if any, to prevent or minimize environmental effects. Where existing process information is insufficient to characterize the discharge, the NOD report provides the results of additional sampling or other data gathered on the discharge. Based on above information, the NOD report describes how the estimated constituent concentrations and mass loading to the environment were determined. Finally, the NOD report assesses the potential for environmental effect. The NOD report contains sections on: Discharge Description, Discharge Characteristics, Nature of Discharge Analysis, Conclusions, and Data Sources and References.

2.0 DISCHARGE DESCRIPTION

This section describes the controllable pitch propeller (CPP) hydraulic oil discharge and includes information on: the equipment that is used and its operation (Section 2.1), general description of the constituents of the discharge (Section 2.2), and the vessels that produce this discharge (Section 2.3).

2.1 Equipment Description and Operation

CPPs are used to control vessel speed and direction without changing the speed or direction of the vessel's main propulsion plant shafting. With CPPs, the angle of the propeller blades (pitch) is variable, which affects the "bite" that the blade has on the water. This allows the amount of water displaced in the forward or reverse directions to be varied, which changes the forward and reverse speed of the vessel.

The pitch of the CPP blades is controlled hydraulically through a system consisting of a pump, piston, crosshead, and blade crank rings. The piston, crosshead, and crank rings are located in the propeller hub. High pressure hydraulic oil, acting on either side of the piston, moves the piston axially within the propeller hub. The piston is attached to a piston rod that connects to the crosshead that moves axially with the piston. Sliding blocks fit in machined slots on the crosshead and these sliding blocks fit over eccentrically-located pins mounted on the crank pin rings. As the crosshead moves forward and backwards within the hub, the sliding blocks move in an arc that also moves the eccentric pin and rotates the crank pin rings to which the CPP blades are bolted.[1]

High-pressure hydraulic control oil is provided to each propeller by a hydraulic oil pressure module (HOPM). While operating, the HOPM supplies oil pressure at 400 pounds per square inch (psi) to control the CPP. While a vessel is pierside, the HOPM is idle and the pressure to the CPP consists of approximately 6 to 8 psi provided by 16 to 21 feet of hydraulic head, depending on the vessel class, from a 40- to 65-gallon reservoir that supplies head to a larger sump tank (600 to 800 gallons) for the CPP system. Several rubber O-ring seals, along with the finely machined surfaces of the blade port cover, the bearing ring, and the crank pin ring, keep the hydraulic oil inside the CPP hub and away from the water.

Figures 1 through 3 show cross sections and a top view of a CPP. Figure 4 is a block diagram of a CPP system.

2.2 Releases to the Environment

The hydraulic oil can be released under three conditions from a CPP and CPP maintenance tools: leaks past CPP seals; releases during underwater CPP repair and maintenance activities; and release of power head tool hydraulic oil during CPP blade replacement. Small quantities of oil can leak past the CPP seals if they are old, worn, or defective.

Oil can also be released to the environment during the underwater maintenance of CPP propeller blades or seals.[2] Underwater maintenance is performed to: 1) replace seals or center blade post sleeves; or 2) replace one or more propeller blades. The procedures for performing underwater replacements are detailed in reference (2). The detailed information in the following subsections applies to Navy vessels. Data on Military Sealift Command (MSC) underwater replacements are unavailable, and the U.S. Coast Guard (USCG) performs replacements only in dry dock.[3,4]

Blade Port Cover Removal. Approximately five to seven of the estimated thirty underwater replacements per year fleetwide are to remove blade port covers for maintenance and can cause some hydraulic oil to be released from the CPP hub.[5] The CPP hub seals or center post sleeve are replaced when observations or inspections indicate failure or cracking.[6] To change hub seals or the center post sleeve, the CPP blade is removed to access the blade port cover, which, in turn, must be removed to access the seals and center post sleeve. The underwater husbandry manual for the underwater change outs also references "NAVSEA Best Management Practices (BMPs) to Prevent/Mitigate Oil Spills Related to Waterborne Removal(s) of Blades on Variable Pitch Propellers for Naval Vessels." This BMP is described in Section 3.2.2.

CPP Blade Replacement. CPP blade replacement normally occurs after a casualty that causes blade damage (e.g., running aground, hitting a submerged object). During blade replacements, a CPP blade is unbolted from the blade port cover and replaced (see Figure 1). Removing a CPP blade does not, in itself, cause hydraulic oil to be released from the CPP hub assembly (other than that released by the bleeding procedure described above). Seals, bearings, and sleeves are still in place to prevent any oil from being released.

During CPP blade replacement, the blade is rotated to the 12 o'clock position to remove the Morgrip bolts that secure the blade to the CPP hub.[6] The Morgrip bolts are removed with a hydraulic power head tool. Before the power head tool is used, it is bled of air underwater while attached to the Morgrip bolt by allowing oil to flow from a port until a "steady stream of hydraulic fluid (no air) bleeds from the loosened port opposite the HP tube in the power head."[6]

2.3 Vessels Producing the Discharge

The Navy, MSC and USCG operate vessels equipped with CPPs. The Army and Air Force do not operate any vessels equipped with CPPs. Table 1 lists the vessels that have CPPs and the number of shafts (i.e., number of CPPs, per vessel).

3.0 DISCHARGE CHARACTERISTICS

This section contains qualitative and quantitative information that characterizes the discharge. Section 3.1 describes where the discharge occurs with respect to harbors and near-shore areas, Section 3.2 describes the rate of the discharge, Section 3.3 lists the constituents in the discharge, and Section 3.4 provides concentrations of the constituents in the discharge.

3.1 Locality

Leaks of hydraulic oil past seals can occur at sea or within 12 n.m. of shore. Discharge underway is more likely than while pierside or at anchor because the CPP system is operating under a higher pressure.

Hydraulic oil can be discharged within 12 n.m. of shore during CPP repairs. The replacements are performed in port and are conducted on an as-needed basis when dry-docking is not scheduled for a vessel or is impractical.

3.2 Rate

The rate of oil release from CPPs will vary with the activity performed on the CPP. The leakage rate from CPP seals is expected to be negligible while the release of oil from CPP blade replacement will be larger. The release of oil from the underwater replacement of CPP seals will generate more oil than the underwater replacement of CPP blades only. The following paragraphs provide further information related to the anticipated release rates from CPPs.

3.2.1 Leaks From CPP Seals

The systems that monitor hydraulic oil loss can detect catastrophic failures on the order of 5 to 250 gallons over 12 hours, but not small leaks. The internal pressure in the CPP hub is approximately 6 to 8 psi, depending on the vessel class, when the HOPM is not operating (e.g., while a vessel is pierside). The external pressure from the seawater is approximately 5.8 to 8 psi provided by 13 to 18 feet of seawater, depending on the vessel class. Therefore, the pressure differential between the hydraulic oil in the CPP and the seawater is low (e.g., 1 psi or less) and provides little driving force to force oil from the CPP hub. Leakage rates under these conditions constitute seal failures requiring repairs/replacement considering that CPP hubs are designed to operate at 400 psi without leakage. CPPs are pressure tested at 400 psi prior to ship delivery and during dry dock maintenance. The CPPs are inspected quarterly for damage and signs of failure or excessive wear.[7] CPP seals are designed to last five to seven years and are reported to last their projected life.[7,8] Most Navy vessels equipped with CPPs have dry-dock cycles of approximately five years and MSC vessels have dry-dock cycles of two to three years.[3,9,10] During the dry dock cycle, the CPP is removed and shipped back to the manufacturer for inspection and maintenance, which includes replacement of the CPP seals. Based on the above information, the release rate of hydraulic oil from CPPs under normal operating conditions is expected to be negligible.

3.2.2 Underwater Replacements

Approximately thirty underwater CPP blade replacements occur per year, and five to seven of these include blade port cover removal to access the seal or center post sleeve for replacement.[5]

CPP Blade Port Cover Removal. According to Reference No. 2, as much as five gallons of oil could be present in CPP hub cavities.[2] It is unlikely that all of this oil is released during a seal replacement because the hub cavity opening is required to be oriented to the 6 o'clock position; the hydraulic oil is buoyant and floats within the hub cavity, effectively trapping the oil.[6]

Oil (0 to 5 gallons) could be released when oil is supplied to the assembly to displace water before replacing the blade port cover.[6] After the seals or the center post sleeve are replaced, head pressure is applied from the head tank to force out any water that entered the hub. The husbandry manual does not specify if oil is discharged when displacing water in the hub, but it appears to be a reasonable probability. The blade port cover is then replaced, and the hub is pressure tested at 20 psi. Leaks can appear if the seals are not properly seated, the mylar shims (i.e., spacers) are not the proper thickness, or the bearing ring is worn.[6] If the bearing ring requires replacement the vessel must be put in a dry dock.

Small amounts of oil can be discharged when removing and replacing the seal, bearing ring, blade seal base ring, and center post sleeve. Assuming the worst-case condition, five gallons of oil are discharged from the CPP hub during each replacement. At most a total of 35 gallons of hydraulic oil could be discharged annually fleetwide based on an average of seven replacements per year.

The BMP also requires the following precautionary measures:

a. Establish/install a floating oil boom in the vicinity of the work. Position this boom to enclose the aft one-third of the vessel, with approximately 20 feet beyond the stern to ensure that escaping oil is contained.[11]

b. Ensure that the oil recovery kit and personnel, who are trained in oil spill recovery, are at the work site at all times during the propeller blade removal/ installation to respond to any oil spill. The spill kit shall include a boom, absorbent pads, and other materials that remove oil from water.[11]

c. Any released oil will be captured within the oil boom and subsequently removed by the oil recovery team on the surface. A vacuum truck, equipped with a noncollapsible hose, will be at the site to remove any visible oil on the surface.[11]

CPP Blade Replacement. For the replacement of a CPP blade, the only source of oil release is from bleeding the Morgrip bolt power head tool. Each blade replacement results in approximately twenty ounces of hydraulic oil bled from the power tool (e.g., 10 ounces for the blade removal and 10 ounces for the blade replacement).[12] For the estimated 30 replacements that occur each year, this translates to approximately 600 ounces (4.7 gallons) of hydraulic oil bled from power head tools.

3.3 Constituents

The expected constituents of the discharge are 2190 TEP hydraulic oil from the CPP and the hydraulic oil (e.g., Tellus #10) that is bled from the power head tool. Constituents of the oil vary by manufacturer and are noted in Table 2. Hydraulic oils contain C_{17} (heptadecane, heptadecene) and large paraffins and olefins.[13] The 2190 TEP oil can also contain up to 1% tricresylphosphate (TCP) as an antiwear additive.[14] Shell Oil Tellus Oil #10 (Code 65203) hydraulic oil contains solvent-refined, hydrotreated middle distillates and light hydrotreated naphthenic distillates.[15] CPP hydraulic oil can contain copper, tin, aluminum, nickel, and lead that are leached from the piping, hub, and propeller.

Copper, nickel, and lead are priority pollutants that could be present in the hydraulic oil. There are no known bioaccumulators in this discharge.

3.4 Concentrations

The released material is expected to be hydraulic oil with metals such as copper, tin, aluminum, nickel, and lead from the piping, hub, and propeller. These metal constituents are expected to be in low concentrations because metals have low corrosion rates when in contact with oil. In addition, the hydraulic oil is continually processed through a filtration system to prevent particulate matter and water from entering the CPP system and potentially causing system failures.

4.0 NATURE OF DISCHARGE ANALYSIS

Based on the discharge characteristics presented in Section 3.0, the nature of the discharge and its potential impact on the environment can be evaluated. The estimated mass loadings are presented in Section 4.1. In Section 4.2, the concentrations of discharge constituents after release to the environment are estimated and compared with water quality criteria. In Section 4.3, the potential for the transfer of non-indigenous species is discussed.

4.1 Mass Loadings

4.1.1 Leaks From CPP Seals

As discussed in Section 3.2.1, the release rate of oil from CPP seals due to normal operations is expected to be negligible. CPPs are designed not to leak and are tested prior to delivery at 400 psi. In addition, the CPPs are inspected quarterly.[7] The majority of those vessels equipped with CPPs have dry-dock cycles of five years or less and CPPs are returned to the manufacturer for inspection and overhaul during the dry dock period.[3,7,9,10] Therefore, the mass loading for oil leakage from CPPs is expected to be negligible.

4.1.2 Underwater Replacements

As estimated in Section 3.2.2, Armed Forces vessels could release up to 4.7 gallons of hydraulic oil from the Morgrip tool and 35 gallons of hydraulic oil from blade port cover removals each year. This quantity of oil has a mass of approximately 290 pounds based on a specific gravity of 0.88 for the hydraulic oil.

4.2 Environmental Concentrations

The quantities of hydraulic oil released can cause a sheen on receiving waters that violate federal and state “no sheen” standards. The metal constituents (e.g., copper, tin, nickel, and lead) in the oil can also be toxic, but it is anticipated that the concentrations, when dissolved in water, will be below toxicity thresholds. Florida has a water quality criterion for oil and grease of 5 milligrams per liter (mg/L) that the estimated environmental concentration for underwater replacement exceeds.

4.2.1 Leaks From CPP Seals

Because the release of oil from a CPP under routine operations is negligible, the resulting environmental concentration is negligible.

4.2.2 Underwater Replacements

The underwater replacements are expected to result in periodic, batch releases of hydraulic oil. Based upon the estimated release rates given in Section 3.2.2, the estimated discharge volume during each replacement is five gallons. During a typical underwater replacement requiring the removal of the port blade cover, the aft third of a vessel plus an additional 20 feet are enclosed with an oil boom. The Navy vessels having CPPs are between 445 and 567 feet in length and between 45 and 67 feet in beam (i.e., width). The average boomed length is approximately 190 feet and width of approximately 65 feet (e.g., average beam of 55 feet plus an estimated 10 feet for proper deployment). The quantity of oil released from CPPs during underwater replacements will result in free-phase oil that will result in localized visible oil sheens on the surface of the water. The resulting visible oil sheens are prohibited releases of oil under the Discharge of Oil (40CFR110) regulations of the Federal Water Pollution Control Act.

4.3 Potential for Introducing Non-Indigenous Species

CPPs do not transport seawater; there is no potential for transporting non-indigenous species.

5.0 CONCLUSIONS

5.1 Leaks From CPP Seals

The release of oil from CPPs during normal operation due to seal leakage is expected to be negligible. This is due to the following:

1) CPPs are designed not to leak at 400 pounds per square inch (psi) when new or

overhauled and are tested at 400 psi for leaks prior to delivery. There is a zero-leakage tolerance under the 400 psi test.

2) CPP seals are designed with service lives of 5 to 7 years and leakage that can occur due to wear or age occurs late within this operational life. The majority of vessels equipped with CPPs have dry-docking cycles for overhauls of approximately 5 years such that the releases occurring toward the end of the operational life of a CPP seal are avoided.

3) CPPs are inspected quarterly for damage and evidence of system failure (e.g., leaking seals).

The amount of oil leakage of CPPs under routine operating conditions has a low potential to cause an adverse environmental effect.

5.2 Underwater Replacements

CPP hydraulic oil discharge has the potential for causing adverse environmental effects during underwater replacements because:

1) oil is released to receiving waters by the equipment used to perform the underwater replacements, and

2) oil is released from the CPP hub assembly during underwater removals of the CPP blade port covers.

Releases due to underwater replacements are periodic and occur approximately thirty times per year. Those replacements that require the removal of the blade port cover release sufficient oil to cause a visible oil sheen on receiving waters and also exceed state WQC. These releases from waterborne CPP repairs are controlled using NAVSEA BMPs that reduce the adverse effects of the oil releases to receiving waters.

6.0 DATA SOURCES AND REFERENCES

To characterize this discharge, information from various sources was obtained. Process information and assumptions were used to estimate the rate of discharge. The resulting

environmental oil and grease concentrations were then estimated. Table 3 shows the sources of data used to develop this NOD report.

Specific References

1. Blank, David A.; Arthur E. Block; and David J. Richardson. Introduction to Naval Engineering, 2nd Edition. Naval Institute Press, 1985.

2. John Rosner, NAVSEA 00C. Frequency of Underwater CPP Blade Replacements. December 1996, Gordon Smith (NAVSEA 03L1).

3. Penny Weersing, Military Sealift Command. Controllable Pitch Propeller (CPP) Hydraulic Seals for MSC Ships. April 1997.

4. LT Joyce Aivalotis, USCG. Response to Action Item RT11, May 28, 1997, David Ciscon, M. Rosenblatt & Son, Inc.

5. John Rosner, NAVSEA 00C. Meeting on Underwater CPP Blade Replacements. April 14, 1997, Clarkson Meredith, Versar, Inc., and David Eaton, M. Rosenblatt & Son, Inc.

6. Naval Sea Systems Command. Underwater Hull Husbandry Manual, Chapter 12, Controllable Pitch Propellers. S0600-PRO-1200. February 1997.

7. Harvey Kuhn, NAVSSES. Personal Communication, March 13, 1997, Jim O'Keefe, M. Rosenblatt & Son, Inc.

8. UNDS Equipment Expert Meeting Minutes. CPP Hydraulic Oil. September 26, 1996.

9. William Berberich, NAVSEA 03Z51. Prepared Responses to UNDS Questionnaire, UNDS Equipment Expert Meeting. September 26, 1996.

10. William Berberich, NAVSEA 03Z51. Response to CPP Hydraulic Oil Questions, March 28, 1997, Clarkson Meredith, Versar, Inc.

11. Naval Sea Systems Command. NAVSEA Best Management Practices (BMP) to Prevent/Mitigate Oil Spills Related to Waterborne Removal(s) of Blades on Variable Pitch Propellers for Naval Vessels. Undated.

12. John Rosner, NAVSEA 00C. Morgrip Power Head Purge During CPP Replacements, June 6, 1997, David Eaton, M. Rosenblatt & Son, Inc.

13. Patty's Industrial Hygiene and Toxicology, 3rd Edition. George D. and Florence E. Clayton, Ed. John Wiley & Sons: New York, 1981.

14. Military Specification MIL-L-17331H, Lubricating Oil, Steam Turbine and Gear, Moderate Service. November 19, 1985.

15. Shell Oil Company. MSDS for Tellus Oil #10, Code 65203. August 1988.

General References

USEPA. Toxics Criteria for Those States Not Complying with Clean Water Act Section 303(c)(2)(B). 40 CFR Part 131.36.

USEPA. Interim Final Rule. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance – Revision of Metals Criteria. 60 FR 22230. May 4, 1995.

USEPA. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants. 57 FR 60848. December 22, 1992.

USEPA. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California, Proposed Rule under 40 CFR Part 131, Federal Register, Vol. 62, Number 150. August 5, 1997.

Connecticut. Department of Environmental Protection. Water Quality Standards. Surface Water Quality Standards Effective April 8, 1997.

Florida. Department of Environmental Protection. Surface Water Quality Standards, Chapter 62-302. Effective December 26, 1996.

Georgia Final Regulations. Chapter 391-3-6, Water Quality Control, as provided by The Bureau of National Affairs, Inc., 1996.

Hawaii. Hawaiian Water Quality Standards. Section 11, Chapter 54 of the State Code.

Mississippi. Water Quality Criteria for Intrastate, Interstate and Coastal Waters. Mississippi Department of Environmental Quality, Office of Pollution Control. Adopted November 16, 1995.

New Jersey Final Regulations. Surface Water Quality Standards, Section 7:9B-1, as provided by The Bureau of National Affairs, Inc., 1996.

Texas. Texas Surface Water Quality Standards, Sections 307.2 - 307.10. Texas Natural Resource Conservation Commission. Effective July 13, 1995.

Virginia. Water Quality Standards. Chapter 260, Virginia Administrative Code (VAC) , 9 VAC 25-260.

Washington. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A, Washington Administrative Code (WAC).

Committee Print Number 95-30 of the Committee on Public Works and Transportation of the House of Representatives, Table 1.

The Water Quality Guidance for the Great Lakes System, Table 6A. Volume 60 Federal Register, p. 15366. March 23, 1995.

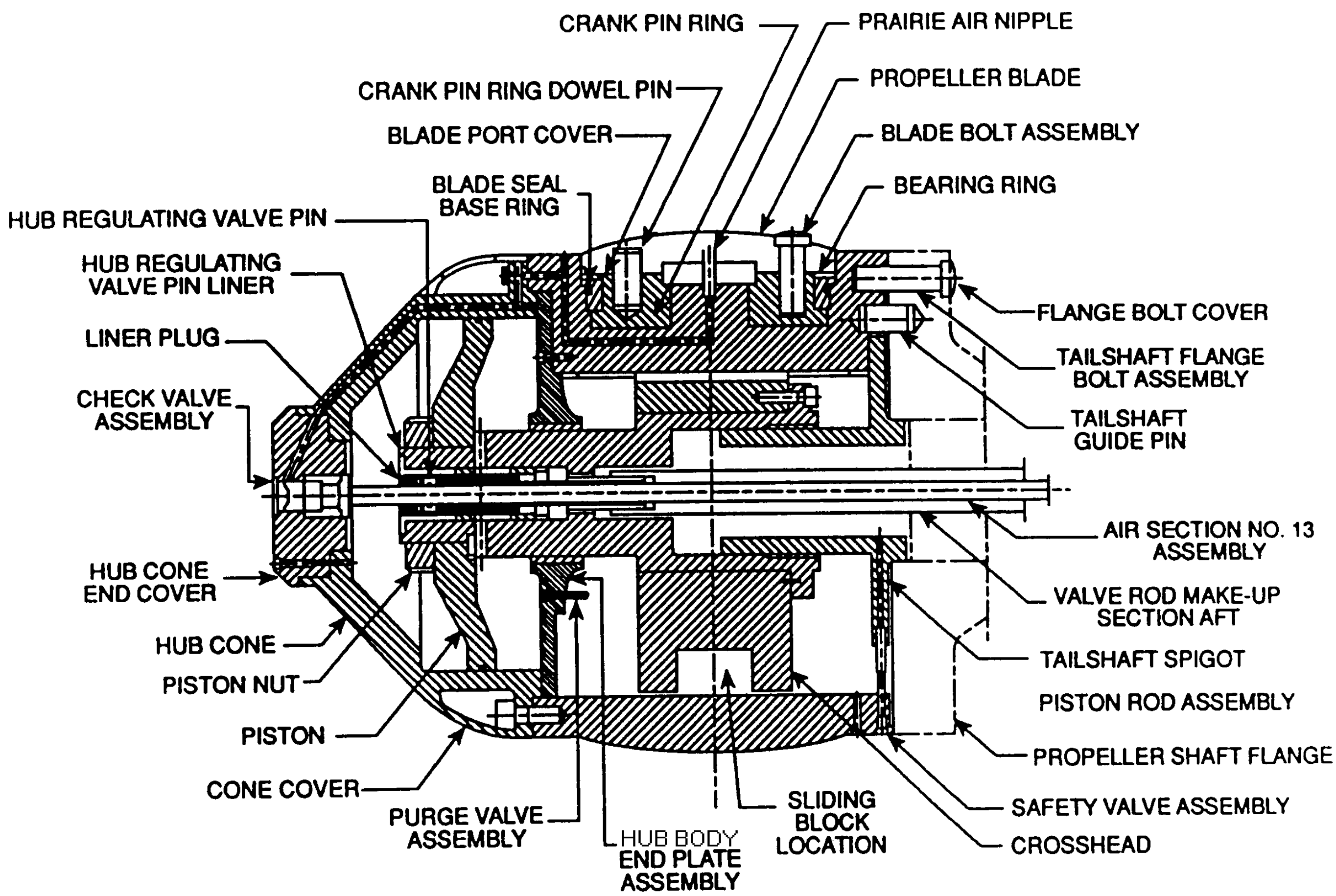


Figure 1. Cross Section of a CPP

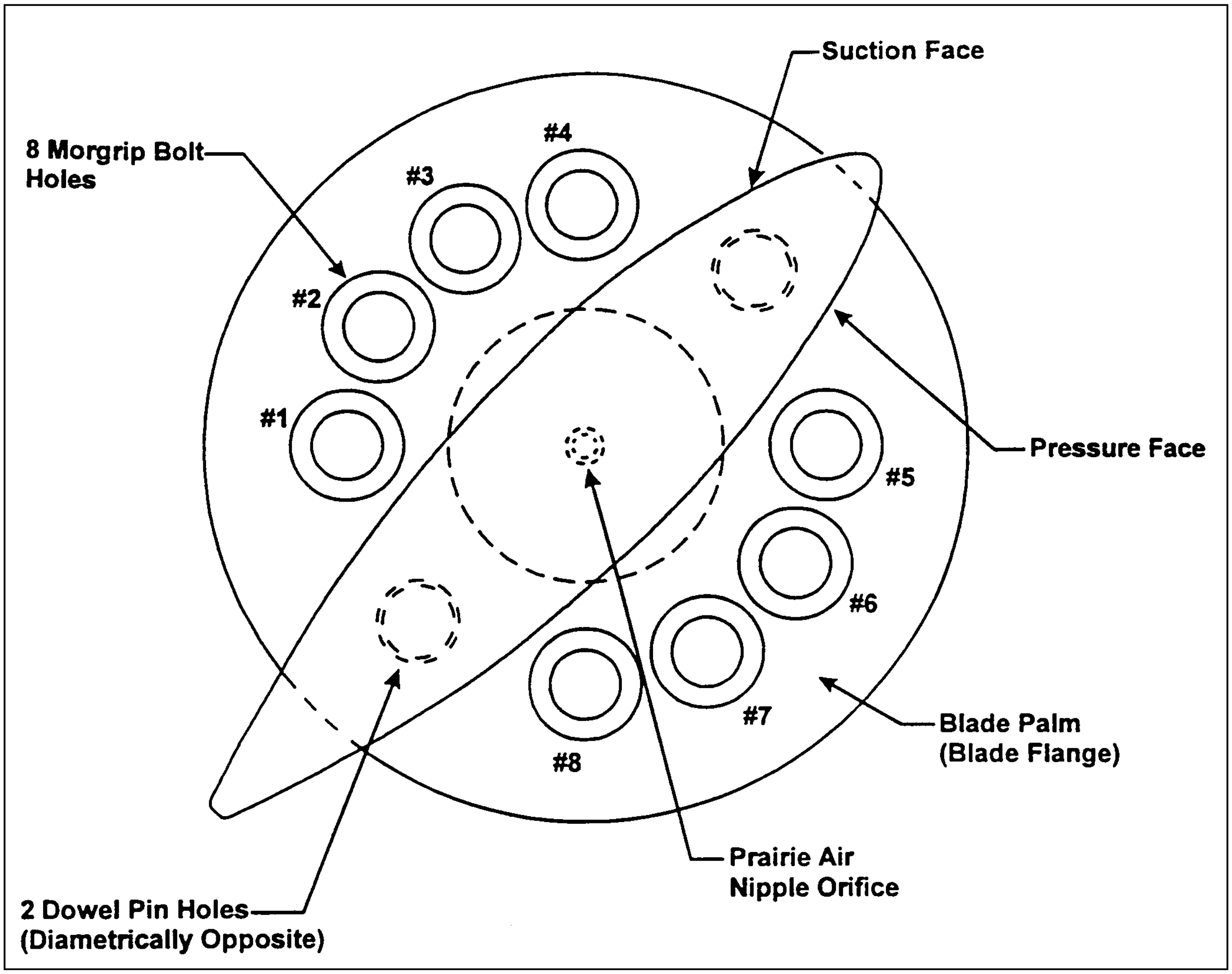
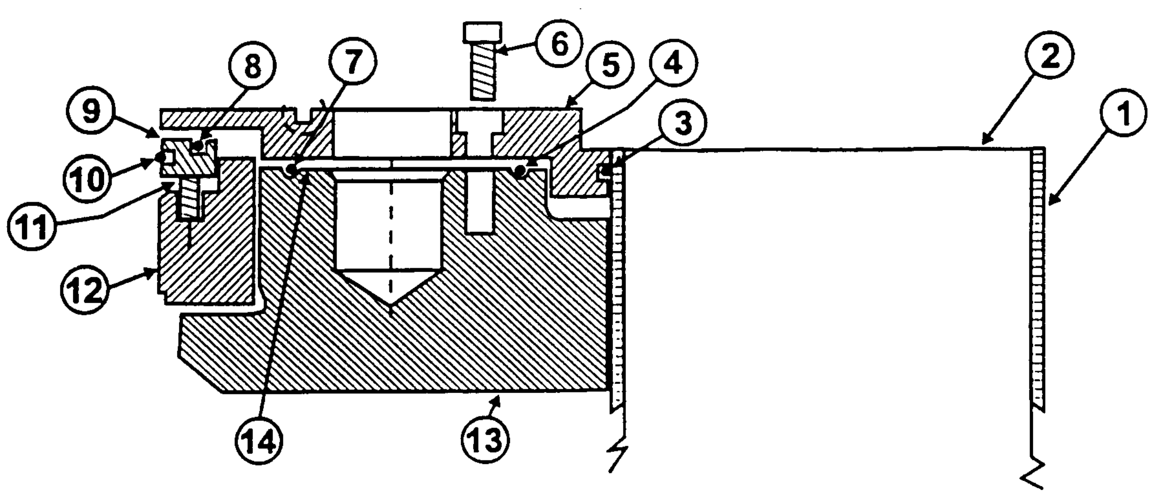


Figure 2. Top View of a CPP Blade



Item	Name
1	Center Post Sleeve
2	Center Post
3	O-ring (dynamic)
4	O-ring (static)
5	Blade Port Cover
6	Capscrew
7	O-ring (static)
8	O-ring (dynamic)
9	Blade Seal Base Ring
10	O-ring (static)
11	Spring
12	Bearing Ring
13	Crank Pin Ring
14	Mylar Shim

Figure 3. Cross Section of a CPP Blade Port Assembly

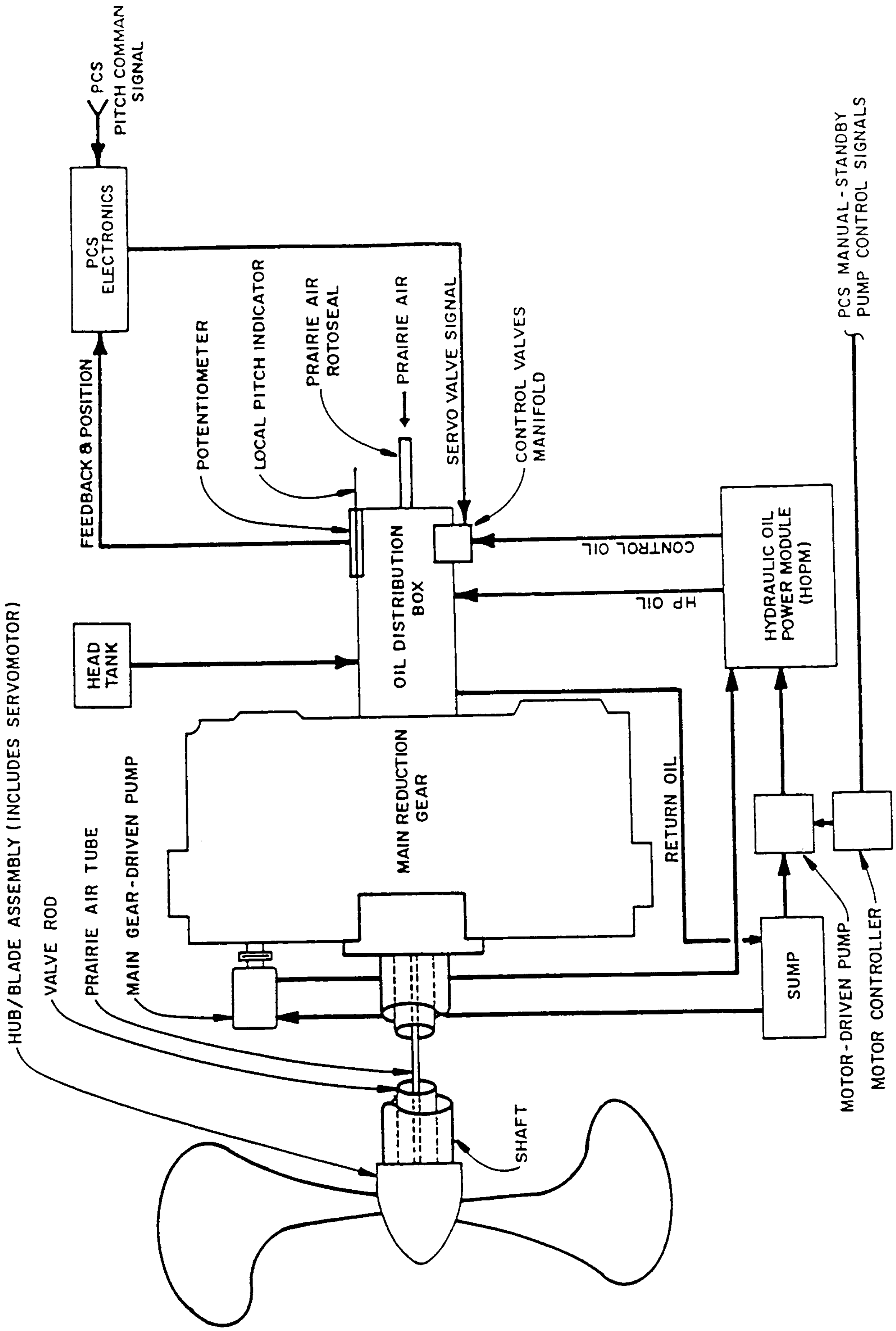


Figure 4. Block Diagram of a CPP System

Table 1. Armed Forces Vessels with CPP Systems

Vessel Class	Description	Vessel	Shafts
Navy:			
CG 47	Ticonderoga Class Guided Missile Cruiser	27	2
DD 963	Spruance Class Destroyers	31	2
DDG 51	Arleigh Burke Class Guided Missile Destroyers	19	2
DDG 993	Kidd Class Guided Missile Destroyers	4	2
FFG 7	Oliver Hazard Perry Guided Missile Destroyers	43	1
LSD 41	Whidbey Island Class Dock Landing Ships	8	2
LSD 49	Harpers Ferry Class Dock Landing Ships	3	2
MCM 1	Avenger Class Mine Counter Measures Ship	14	2
	Total:	149	
MSC:			
T-AO 187	Henry J. Kaiser Class Oilers	13	2
T-ATF 166	Powhatan Class Fleet Ocean Tugs	7	2
	Total:	20	
USCG:			
WHEC 715	Hamilton and Hero Class High Endurance Cutters	12	2
WMEC 901	Famous Class Medium Endurance Cutters	13	2
WMEC 615	Reliance Class Medium Endurance Cutters	16	2
WAGB 10	Polar Class Icebreakers	2	3
	Total:	43	
	Total Armed Forces Vessels with CPP:	212	

Table 2. Percentages of Constituents, TEP 2190 Oil and Tellus Hydraulic Oil

Constituent	MIL-L-17331H Turbine Oil 2190	Chevron Oil MSDS Turbine Oil 2190	Mobil Oil MSDS Turbine Oil 2190	Shell Oil MSDS Tellus Oil #10
Virgin Petroleum Lubricating Oil (a)	Balance			
Tricresyl Phosphate (TCP)	≤ 1%			
Additives	≤ 0.5%		Unknown Formaldehyde	< 1%
Hydrotreated Heavy Paraffinic Distillates		> 99%	> 95%	
Solvent-Dewaxed Heavy Petroleum Distillates		< 1%		
Hydrotreated Middle Distillate				0 - 100%
Hydrotreated Light Naphthenic Distillate				0 - 100%

(a) Virgin Petroleum Lubricating Oil is all classes of lubricating oil including heavy and middle Paraffinic distillates, solvent-dewaxed heavy distillates, light naphthenic distillates, etc.

Table 3. Data Sources

	Data Sources			
NOD Section	**Reported**	**Sampling**	**Estimated**	**Equipment Expert**
2.1 Equipment Description and Operation				X
2.2 Releases to the Environment				X
2.3 Vessels Producing the Discharge	UNDS Database, Jane's, Navy Home Page, USCG Cutters List			X
3.1 Locality				X
3.2 Rate			X	
3.3 Constituents	MSDSs, Mil Specs			X
4.1 Mass Loadings			X	
4.2 Environmental Concentrations	Federal and State Regs		X	
4.3 Potential for Introducing Non-Indigenous Species				X