This document is part of Appendix A, and includes Sonar Dome Discharge: 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)

Sonar Dome Discharge: Nature of Discharge

April 1999

NATURE OF DISCHARGE REPORT

Sonar Dome Discharge

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 a candidate 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 the 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 sonar dome 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

Sonar domes are located on the hulls of submarines and surface ships. Their purpose is to house electronic equipment used for detection, navigation, and ranging. Figures 1 through 4 show typical hull-mounted submarine and surface ship sonar domes.

Sonar domes on Navy surface ships are made of rubber. On submarines, they are made of steel or glass-reinforced plastic (GRP) with a 1/2-inch rubber boot covering the exterior. Military Sealift Command (MSC) T-AGS Class ships have sonar domes made of GRP. Zinc anodes are fastened to the exterior of steel sonar domes, and are contained within all the sonar domes, for cathodic protection. Figure 5 shows a Navy surface ship rubber dome, prior to installation.

Sonar domes can be filled with fresh and/or seawater to maintain their shape and design pressure. Most surface ship sonar domes are initially filled with freshwater, and any water that is lost underway is replenished with seawater from the firemain system. Sonar domes on FFG 7 Class frigates and some MSC ships are filled with seawater. Submarine sonar domes are connected to the sea through a small tube to equalize pressure, but water inside the dome has limited exchange with seawater.[1]

Table 1 summarizes sonar dome types, applications, and characteristics. The larger AN/SQS-53 and AN/SQS-26 sonar domes on cruisers and destroyers are located at the bow, and the smaller AN/SQS-56 domes on frigates are mounted on the keel. Submarine sonar domes are located at the bow. MSC T-AGS Class ships have several small sonar domes at various locations on the hull. The T-AGS Class sonar domes listed as free flood in Table 1, have ports which are open to the sea.

Table 2 shows materials that compose sonar domes, and components and materials inside sonar domes. Components and materials interior to sonar domes can include piping, sacrificial anodes, paint and the interior material surface of the sonar dome itself. Materials on the exterior surface of the sonar dome consist of the exterior material surface of the dome itself, any paints or coatings applied to the dome, and in some cases, sacrificial anodes.

There have been changes in the composition of the rubber material in Navy surface ship sonar domes. Prior to 1985, all sonar domes contained tributyltin (TBT) antifoulant on the interior and exterior, to prevent or minimize marine growth. The TBT was impregnated into the outermost 1/4-inch layers (both exterior and interior) of the rubber. Figure 6 shows the plys or layers of a surface ship rubber sonar dome. Since 1985 rubber sonar domes have been manufactured with TBT only on the exterior surface. This type of sonar dome has been backfitted on older ships when they require sonar dome replacement, and has been installed on all new ships since 1990. Submarine sonar domes do not contain TBT. Instead, the exterior rubber boots are coated with a copper-based antifouling paint.[2] Table 3 lists the surface ships that have no TBT in the interior of their sonar domes.

Sonar domes are emptied for sonar dome maintenance or replacement, and are always emptied when a vessel is in drydock. Some maintenance can be performed pierside. Sonar domes are emptied by first pressurizing them with air, to force as much water as possible through the installed eductor piping. Once this step is complete, eductors are used to remove all remaining water in the dome. The total volume of water discharged exceeds the sonar dome volume because the seawater used to operate the eductors is discharged along with water from the sonar dome.

The water emptied from the sonar dome interior is: 1) discharged overboard, if the vessel is waterborne, or 2) collected for proper management ashore, if the vessel is in drydock.

2.2 Releases to the Environment

There are two sonar dome discharges, discharges of the water from the interior of sonar domes and external discharges. Discharges of water from the interior of the sonar dome result from maintenance evolutions that require the sonar dome to be emptied. External discharges result from continuous leaching of TBT or other anti-fouling compounds from the sonar dome exterior.

2.3 Vessels Producing the Discharge

Only Navy and MSC vessels are equipped with sonar domes; the other Armed Forces ships are not. Sonar domes are equipped on the following types and classes of Navy and MSC ships:

- cruisers (CG and CGN Classes);
- destroyers (DD and DDG Classes);
- frigates (FFG Class);
- submarines (all SSN and SSBN Classes); and
- MSC T-AGS Class ships.

Tables 1 and 4 list the classes and populations of sonar dome-equipped vessels. Eighty-three of the Navy surface ships have the larger AN/SQS-26 or SQS-53 sonar domes, and 43 have the smaller SQS-56 domes. Seventy-two active submarines have the smaller BQQ-5, BQR-7 or BSY-1 sonar domes, and the 17 others have much larger BQQ-6 sonar domes.

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 gives the concentrations of the constituents in the discharge.

3.1 Locality

Discharges from the interior of sonar domes only occur while vessels are pierside. Discharges from the external surface of sonar domes occur both within and beyond 12 nautical miles (n.m.) of shore, as materials leach continuously from the exterior of the dome. Discharges from the external surface of sonar domes were studied by the Naval Command, Control and Ocean Surveillance Center to characterize the environmental effects in San Diego harbor.[3]

3.2 Discharge Rate

Discharge from the interior of sonar domes is intermittent, depending on when the dome is emptied for maintenance. The average volume of water discharged for maintenance or repair activities is estimated based on input from naval shipyards. Sonar dome discharge volume varies with the dome type (size) and the method used to empty the dome. Norfolk and Pearl Harbor Naval Shipyards report that between 23,000 and 38,000 gallons is typically emptied from AN/SQS-53 sonar domes.[4,5] Table 4 contains the estimated annual discharge for sonar done-equipped vessels, based on the vessel class populations, sonar dome water capacity, and number of sonar domes expected to be emptied per year. On average, sonar domes on surface ships are emptied two times per year. Submarine sonar domes are normally emptied once per year.[2] Table 4 indicates a total annual discharge estimate of about 9.3 million gallons of interior sonar dome effluent, with just under 4.0 million of that being from sonar domes with internal TBT coatings.

Discharge from the external surface of a sonar dome is not a liquid discharge; rather, it is the leaching of anti-fouling agents into the surrounding water, and cannot be characterized by a volumetric flow rate. A Navy study was conducted in San Diego Bay in 1996 to determine TBT release rates from rubber sonar domes. Release rates from the external surfaces were determined by attaching a closed capture system to the sonar domes exteriors of three ships. The sampled sonar domes ranged in age, at 3, 10 and 20 years since installation. Table 5 shows that the average release rate for TBT from the external surfaces of the sonar domes was 0.36 $\mu g/cm^2/day$ (micrograms per square centimeter per day), which results in an average release of 0.27 grams of TBT per day per ship.[3]

3.3 Constituents

Table 2 shows the components and materials in sonar domes that can contribute constituents to the sonar dome discharge. The specific constituents depend on vessel class, the age of the dome, and the source of water that fills the dome. Discharges from the interior of sonar domes can include copper, nickel, tin and zinc which corrodes, erodes, or leaches from piping, sacrificial anodes, paint, or other material inside the dome. If the interior of the dome is impregnated with TBT, discharges will also include that constituent. The potable water and/or seawater that fills the sonar dome is also a source of constituents in discharges from the interior.

In addition to these constituents, the interior effluent can contain compounds that are produced by degradation of the materials or reaction of material with the water. For instance, TBT, which might be found on both the interior and exterior of surface ship rubber sonar domes, degrades to dibutyltin (DBT) and monobutyltin (MBT).

External discharge constituents will include the TBT impregnated into the exterior of rubber sonar domes, or copper from copper based antifoulant coating on GRP and steel domes. Discharge from copper based and other antifoulant coatings are addressed separately, by the Hull Coating Leachate NOD Report.

Sampling of the water within the interior of sonar domes was conducted to identify and measure constituents, and was done according to procedures specified by the Navy. Samples from the interior of sonar domes were manually collected from the sonar dome piping systems of Navy surface ships and submarines, prior to discharge. The three sampling activities, Norfolk and Pearl Harbor Naval Shipyards and the Naval Command, Control and Ocean Surveillance Center did not all sample for the same constituents, as shown in Table 6. The tests that were performed on the samples included gas chromatography, hydride derivization and atomic absorption for TBT, and Toxicity Characteristic Leaching Procedure (TCLP) for metals. Tests done on sonar domes have indicated that the constituents of discharges from the interior of sonar domes are copper, nickel, tin, zinc, TBT (also known as tetra-normal-tributyltin), DBT and MBT. External sonar dome discharge constituents are TBT, DBT, MBT, copper, and zinc.[3,4,5,6]

Of the discharge constituents listed above, copper, nickel, and zinc are priority pollutants. None of the discharge constituents are bioaccumulators.

3.4 Concentrations

A summary of results of sampling discharges from the interior of sonar domes is contained in Table 6. Altogether, previous Navy studies have analyzed the water from the interior of sonar domes on 31 surface ships and submarines, with some vessels sampled multiple times. In addition to the metals and compounds listed in Section 3.3, four samples from the USS South Carolina were analyzed for Chemical Oxygen Demand (COD) and four samples from the USS Conolly were analyzed for both Total Suspended Solids (TSS) and Total Organic Carbon (TOC). The results of the sampling are summarized below:[3,4,5]

The average concentrations of the metal constituents are listed in Table 6.

Among the classical pollutants, COD levels ranged from 20 to 180 milligrams per liter (mg/L), with an average of 123 mg/L. Total organic carbon levels ranged between 4 and 6 mg/L. Total suspended solids were all below 4 mg/L.

TBT concentrations ranged from 1 to 470 micrograms per liter (μg /L), with an average of 74 μg/L. Only one sample has been taken for concentrations of MBT and DBT. The results were 5 and 33 μg/L, respectively.

The firemain system is normally used to replenish sonar dome water lost on surface ships while underway and to educt the final water remaining when a sonar dome is emptied. However, the seawater from the firemain has a negligible effect on the constituent concentrations in this report. The salinity of the samples was low, indicating that little make-up seawater was added to the sonar domes during operations. The sonar dome sampling procedure requires samples to be taken from the dome, not from the emptied water, so firemain water that powers the eductors will not dilute or contribute constituents to the samples.

The above analytical results only address discharges from the interior of the sonar domes, and do not account for the discharge from the external surfaces. The external surface TBT release rates and estimated mass loadings are included in Sections 3.2 and 4.1, respectively.

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 the water quality standards. In Section 4.3, the potential for the transfer of non-indigenous species is discussed.

4.1 Mass Loadings

The amount of water discharged fleet-wide from the interior of sonar domes was estimated using:

1) the amount of water generated from each type of sonar dome when that sonar dome is emptied;
2) the frequency of maintenance requiring sonar domes to be emptied;
3) the number of vessels with each type of sonar dome; and
4) the average concentrations of each of the constituents.

The estimated fleet-wide mass loadings for copper, nickel, tin, and zinc were calculated by the following formula:

Mass Loading (lbs/yr) =
(avg. concentrations in µg/L) (discharge in gal/yr) (3.7854 L/gal) (2.2 lb/kg) (10^{-9} kg/µg)

For example, copper:

Mass Loading =
(303 µg/L) (9,278,800 gal/yr) (3.7854 L/gal) (2.2 lb/kg)(10^{-9} kg/µg) = 23.4 lbs/yr

This calculation of mass loadings from sonar domes overestimates the actual mass loadings because:

1) All discharges are assumed to occur pierside, but some of the discharges actually occur in drydock, where they are managed under shipyard discharge permits.
2) All discharges are assumed to occur within U.S. territorial waters, but some of the discharges actually occur outside U.S. territorial waters.
3) Results of discharge sample measurements which were below detection levels were assumed to be at the detection level.

The average constituent concentrations from Table 6, and a total estimated annual discharge volume of 9.3 million gallons per year for all vessels, taken from Table 4, were used to calculate the mass loadings. Based upon this information and the above formula, the annual mass loadings for metals were calculated to be 23 pounds for copper, 11 pounds for nickel, 15 pounds for tin, and 122 pounds for zinc.

The estimated fleet-wide mass loading for TBT, DBT and MBT generated from sonar dome interiors was calculated by the same formula (above), using a 3.96 million gallon discharge volume per year for those vessels in Table 4 that could have TBT inside the sonar dome. Using the average TBT concentration of 74 μg/L, the annual mass loading estimate for TBT is 2.4 pounds per year due to discharges of water from the interior of the sonar dome. Although not representative of all vessels, the one sample in which DBT and MBT were measured is used to calculate fleet-wide mass loading for those constituents, using the same 3.96 million gallon discharge volume , since DBT and MBT are degradation products of TBT. Based on the single sample concentrations of 33 and 5 μg/L for DBT and MBT, respectively, the estimated mass loadings are 1.1 and 0.2 pounds per year, respectively.

The calculation for TBT mass loading from the exteriors of surface ship rubber sonar domes was performed using the following formula:

Sonar Dome External Discharge TBT Mass Loading (lbs/yr) =
(avg. release rate in g/day) (0.00205 lbs/g) (no. of ships with rubber domes) [avg. days/yr in port + ((no. transits/yr) (4 hrs/transit)÷ 24 hrs/day)]

(0.27 g/day) (0.00205 lbs/g) (126 ships) (158 days/yr in port + ((12 transits/yr)(4 hrs/transit)÷ 24 hrs/day)) = 12.6 lbs/yr

This formula uses the release rate from Table 5, which is based on sampling the discharge from the external surface of rubber sonar domes on three Navy surface ships, two of which had older sonar domes, and the newer DDG 51 Class USS John Paul Jones.[3] The formula also uses 158 days/yr as the estimated annual in-port time for each ship. The result is a TBT annual mass loading of 12.6 pounds due to discharges from the external surface of the sonar dome.

Therefore, the estimated maximum TBT mass loading within 12 n.m. for surface ships equipped with rubber sonar domes is 15.0 lbs/yr. This is the sum of 2.4 lbs/yr from discharges from the interior of the sonar domes and 12.6 lbs/yr from discharges from the external surface.

The estimated mass loadings generated from sonar dome interior and exterior discharges are presented in Table 7.

4.2 Environmental Concentrations

Table 8 compares the concentrations of constituents in sonar dome discharge with the most stringent water quality criteria (WQC) for that constituent. For sonar dome discharge, the constituents known to be present are TBT, DBT, MBT, copper, nickel, tin, and zinc. As a result of the comparison, the mean concentrations of TBT, copper, nickel, and zinc each exceed their respective Federal and most stringent state acute WQC. The interior concentrations can be compared to acute values and the exterior concentrations compared to chronic values. Neither DBT, MBT, nor tin has a relevant WQC.

4.3 Potential for Introduction of Non-Indigenous Species

Most sonar domes do not have the potential for the transfer of non-indigenous species in discharge of water from the interior of the sonar dome, or for transfer from the external surface. Non-indigenous species transfer would occur primarily during the emptying and replenishment of water in the interior of the sonar dome, and that is normally performed at a vessel's homeport or a shipyard. TBT on the interior surface of older rubber sonar domes and the exterior of all rubber sonar domes prevents attachment of marine organisms and could inhibit their growth.

Sonar domes filled with freshwater have little potential to be a mechanism for transfer of non-indigenous species in the water that fills the dome. There is minimal exchange with seawater. Only a small volume of water from the ship's potable water or surrounding seawater is added to the existing potable water in the dome between emptying and replenishment events to make up for any loss of sonar dome water during operations. Therefore, the opportunity to introduce non-native organisms into the surrounding water is limited.

Non-free-flood sonar domes filled with seawater have the potential for transfer of non-indigenous species. These types of sonar domes are found on FFG 7 Class Navy frigates. However, the non-indigenous species transfer potential is considered very low for the following reasons: 1) the maintenance requiring sonar dome emptying and replenishment is normally performed at the ship’s home port, so water taken on will be discharged in the same locality; 2) most of the sonar domes have TBT on the interior surface because the ships were built prior to 1990; and 3) the residence time inside these sonar domes is long (on the order of 6 months), making the probability of survival of non-indigenous species more remote.[1]

5.0 CONCLUSIONS

Discharges from sonar domes has a low potential for causing adverse environmental effect. Although concentrations of organotins (MBT, DBT, and TBT), copper, nickel, and zinc discharged from sonar dome interiors exceed water quality criteria mass loadings of these substances are small (3.7, 23, 11, and 122 pounds per year, respectively). Exterior releases of TBT are also expected to be small (12.6 pounds annually).

6.0 DATA SOURCES AND REFERENCES

To characterize this discharge, information from various sources was obtained. Table 9 lists data sources for this report.

Specific References

1. UNDS Equipment Expert Meeting Minutes. Sonar Dome. September 10, 1996.

2. UNDS MPCD Practicability Meeting. Sonar Dome. June 26, 1997.

3. U.S. Navy. Marine Environmental Support Office, Naval Command, Control and Ocean Surveillance Center RDT&E Division (NRaD). Sonar Dome Discharge Evaluation. San Diego, California, February, 1997.

4. U.S. Navy. Pearl Harbor Naval Shipyard. Uniform National Discharge Standards Information. Pearl Harbor, Hawaii. Memorandum, September 1996.

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7. Sharpe, Richard. Jane's Fighting Ships. Jane's Information Group, Ltd., 1996-97

General References

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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.

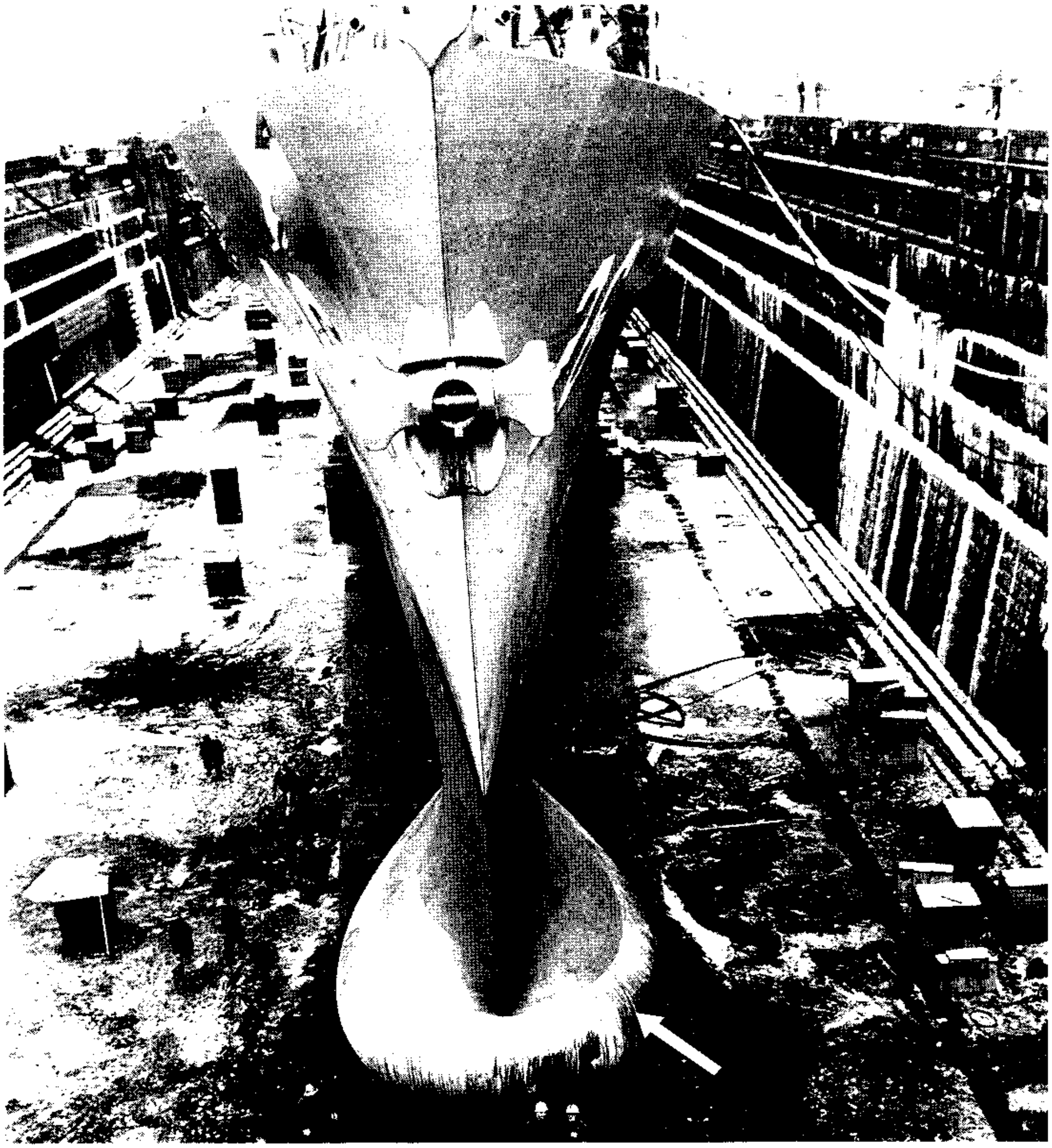

Figure 1. SQS-26 Sonar Dome in the Cruiser Belknap (CG 26)

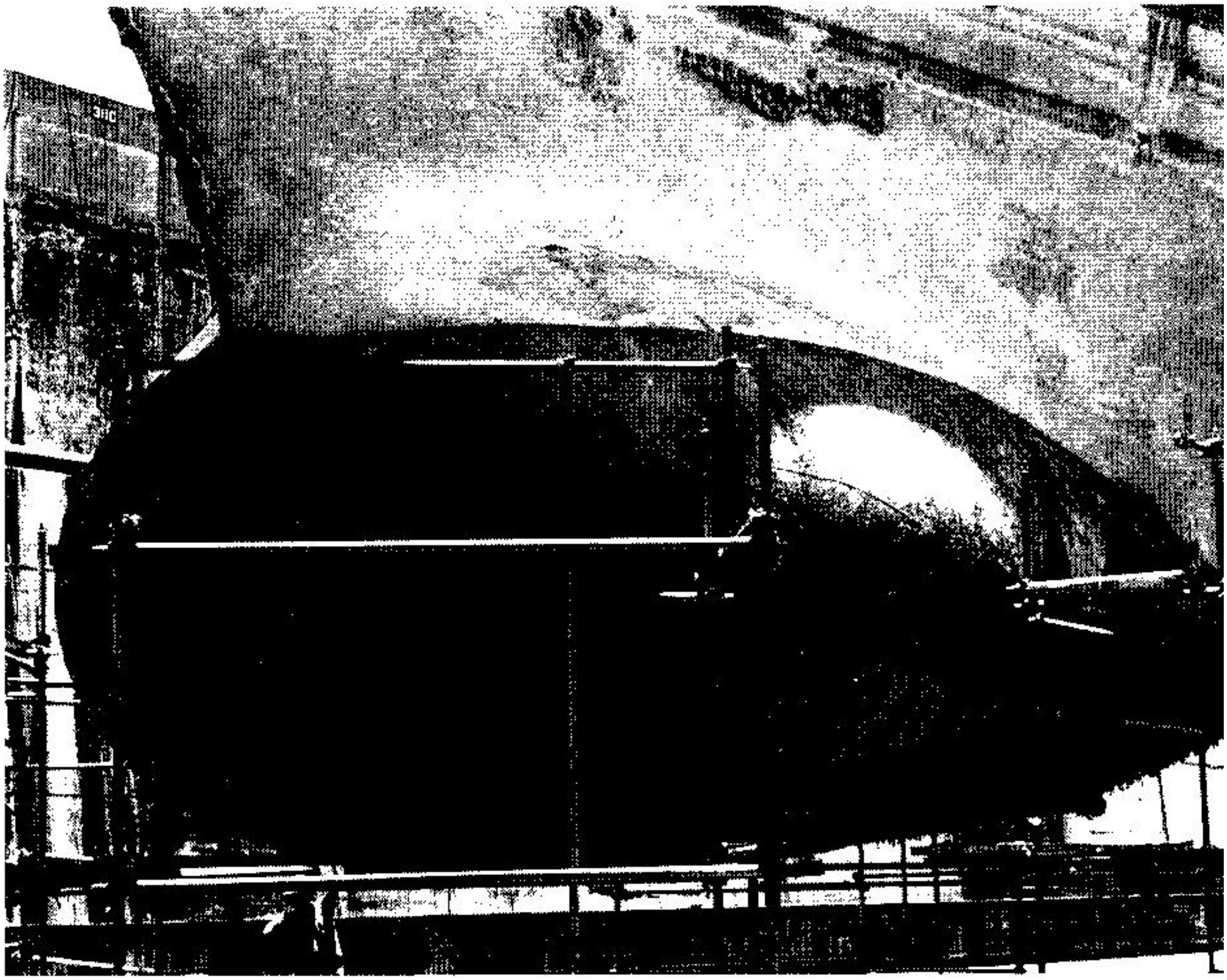

Figure 2. SQS-26 Sonar Dome on the Frigate Knox.

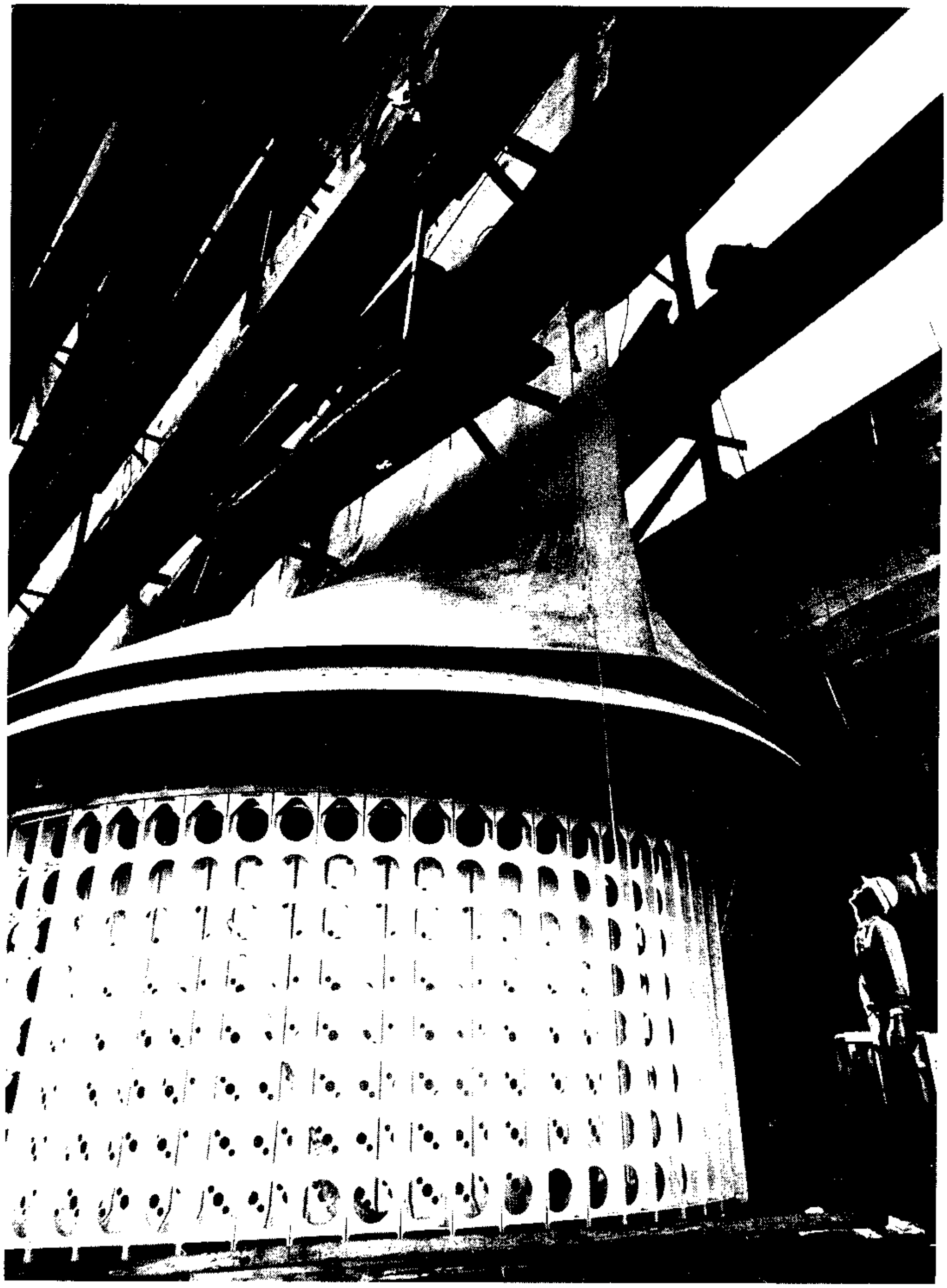

Figure 3. SQS-53 Transducer Housing on a Spruance-Class Destroyer.

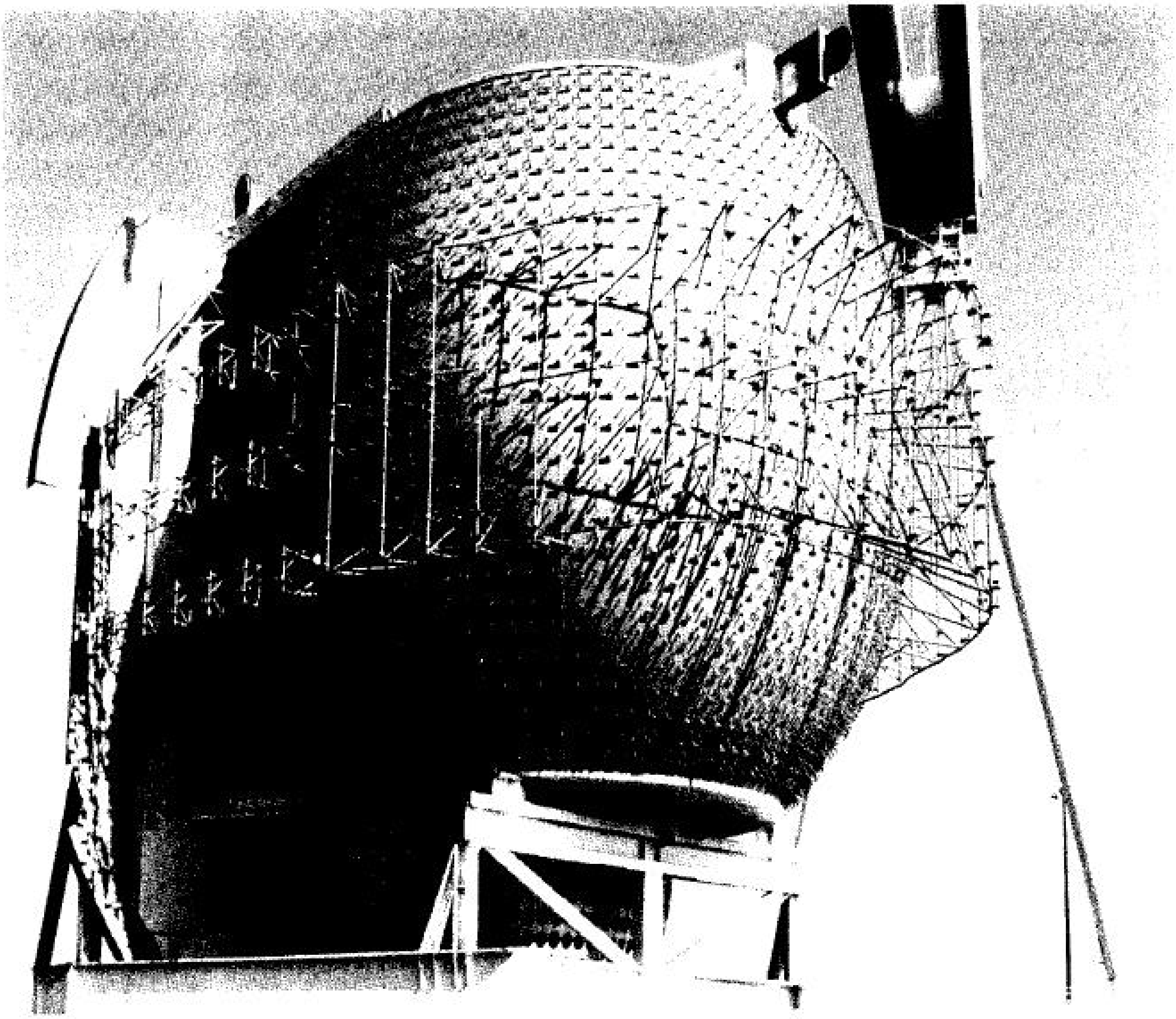

Figure 4. Spherical, Bow-Mounted Array Housing for the BSY-2 Combat System.

Figure 5. Surface Ship Rubber Sonar Dome Prior to Installation.

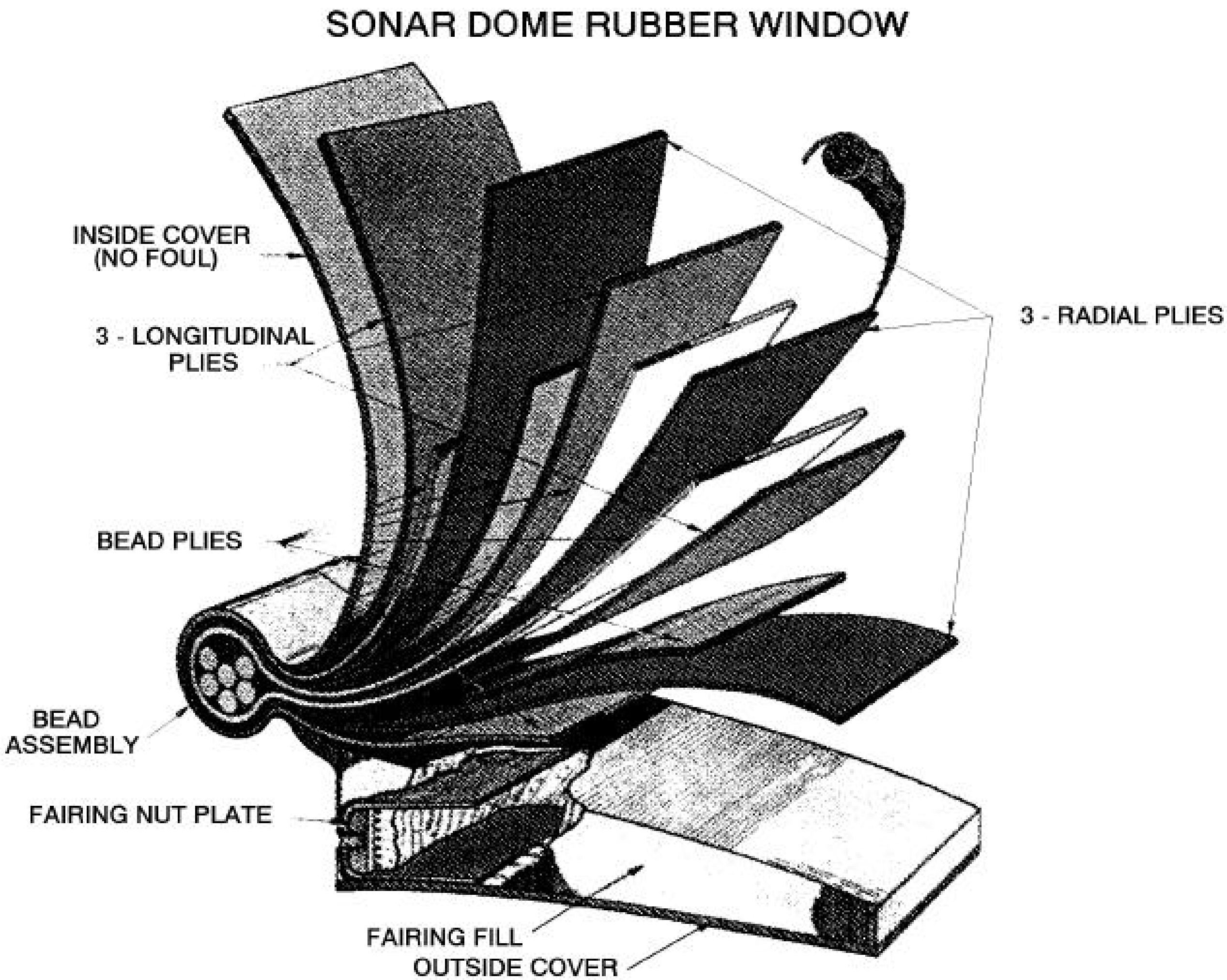

Figure 6. Surface Ship Rubber Sonar Dome Layers.

Table 1. Types and Characteristics of Sonar Domes[1,2,7]

Sonar Type	Ship Class	No. of Vessels	Dome Material	Dome Water Volume (gal, approx.)	Discharge Volume per Event (est.)
AN/SQS-53	CG 47, DDG 51, DD 963, DDG 993	80	Rubber/TBT	24,000	30,000
AN/SQS-26	CGN 36, 38	3	Rubber/TBT	24,000	30,000
AN/SQS-56	FFG 7	43	Rubber/TBT	5,000 *	6,000
AN/BQQ-5	SSN 688 (through 750), SSN 637, SSN 671	47	GRP or steel	35,000	35,000
AN/BQQ-6	SSBN 726	17	GRP or steel	74,000	74,000
AN/BQR-7	SSN 640	2	GRP or steel	35,000	35,000
AN/BSY-1	SSN 688 (from 751)	23	GRP or steel	35,000	35,000
EM100	MSC T-AGS 51	2	GRP	N/A *	N/A (free flood)
EM1000	MSC T-AGS 60 (62 & 63)	2	GRP	N/A *	N/A (free flood)
EM121A	MSC T-AGS 60	4	GRP	300	300**
SEABEAM	MSC T-AGS 26	2	GRP	511	300**
TC-12NB	MSC T-AGS 60	4	GRP	25	300**
TR-109	MSC T-AGS 60	4	GRP	75	300**

* Filled with seawater

** 300 gallons is representative of the two larger sonar dome types on MSC ships

Table 2. Sonar Dome Materials[1,2]

Component/Compound	External to dome		Internal to dome	
	Surface Ships	Submarines	Surface Ships	Submarines
Tributyltin	X		X	
Copper-nickel piping			X	X
Tin (other than TBT, DBT, MBT)			X	X
Zinc anodes			X	X
Glass-reinforced plastic	X	X	X	X
Steel components	X	X	X	X
Epoxy-based paints		X	X	X
Rubber	X	X	X	X
Antifouling paint (Cu & other based)	X	X		

Note: Not all surface ships have TBT internal or external to the sonar dome(s).

Table 3. Ships With TBT-Free Sonar Dome Interiors[1,2]

Class	Vessels in Class	Number in Class
CG 47 Class	CG 51, CG 73	2 of 27 ships
DD 963 Class	DD 972, 979, 987	3 of 31 ships
DDG 51 Class	DDG 54, 56-67, 69, 71, 74	16 of 18 ships
DDG 993 Class	DDG 993	1 of 4 ships
T-AGS 26, 51, 60 Classes	All	8 of 8 ships
SSNs & SSBNs	All	89 of 89 vessels

Based on equipment experts and sampling analysis results.

Table 4. Annual Sonar Dome Interior Discharge by Ship Class[1,2,4,5,6]

Ship Class	Total Ships	Ships with Internal TBT	Gallons per Drainage Event (est.)	Drainage Events per Year	Gallons per Year (ships with internal TBT*)	Gallons per Year (all vessels)
CG 47	27	25	30,000	2	1,500,000	1,620,000
CGN 36	2	2	30,000	2	120,000	120,000
CGN 38	1	1	30,000	2	60,000	60,000
DDG 51	18	3	30,000	2	180,000	1,080,000
DD 963	31	28	30,000	2	1,680,000	1,860,000
DDG 993	4	3	30,000	2	180,000	240,000
FFG 7	43	20	6,000	2	240,000	516,000
T AGS	8	0	300	2	0	4,800
SSN 637	13	0	35,000	1	0	455,000
SSN 640	2	0	35,000	1	0	70,000
SSN 671	1	0	35,000	1	0	35,000
SSN 688	56	0	35,000	1	0	1,960,000
SSBN 726	17	0	74,000	1	0	1,258,000
TOTAL:	**223**	**82**	**N/A**	**N/A**	**3,960,000**	**9,278,800**

* Could have TBT inside sonar dome, based on Table 6.
N/A = not applicable

Table 5. Tributyltin Release Rates from Exterior of Sonar Domes[3]

Sampled Vessel	Sample Date	Tributyl tin (TBT) Release Rate	
		$\mu g/cm^2/day$	grams/day
DDG 53 USS John Paul Jones	12-96	0.89	0.62
CG 59 USS Princeton	12-96	0.06	0.09
DD 976 USS Merrill	12-96	0.14	0.10
Average:		**0.36**	**0.27**

Table 6. Constituent Concentrations in Sonar Dome Interior Discharge (parts per billion, or µg/L, except as noted)[3,4,5]

Vessel	Date of Sample	Tributyl-tin (TBT)	Dibutyl-tin (DBT)	Mono-butyltin (MBT)	Copper	Nickel	Tin	Zinc	Chemical Oxygen Demand	Total Suspended Solids	Total Organic Carbon
CGN 40 USS Mississippi	2-7-94	85	-	-	-	-	-	-	-	-	-
DDG 52 USS John Barry	3-28-94	470	-	-	-	-	-	-	-	-	-
FF 1079 USS Bowen	4-1-94	82	-	-	-	-	-	-	-	-	-
CGN 37 USS South Carolina	5-23-94	-	-	-	-	-	-	-	170***	-	-
CGN 37 USS South Carolina	5-23-94	-	-	-	-	-	-	-	120***	-	-
CGN 37 USS South Carolina	5-23-94	-	-	-	-	-	-	-	20***	-	-
CGN 37 USS South Carolina	5-23-94	-	-	-	-	-	-	-	180***	-	-
DD 968 USS Radford	6-30-94	58	-	-	-	-	-	-	-	-	-
DD 968 USS Radford	6-30-94	35	-	-	-	-	-	-	-	-	-
CG 48 USS Yorktown	7-7-94	58	-	-	-	-	-	-	-	-	-
CG 74 USS Ticonderoga	7-25-94	48	-	-	-	-	-	-	-	-	-
DD 988 USS Thorn	8-26-94	41	-	-	-	-	-	-	-	-	-
DD 963 USS Spruance	12-1-94	14	33	5	-	-	-	-	-	-	-
DD 984 USS Leftwich	10-94	-	-	-	920	660	<DL	110	-	-	-
SSN 648 USS Aspro	11-94	-	-	-	220	<DL	<DL	5390	-	-	-
SSN 717 USS Olympia	11-94	-	-	-	220	<DL	<DL	1040	-	-	-
CG 73 USS Port Royal	1-95	-	-	-	1350	300	<DL	1520	-	-	-
SSN 672 USS Pintado	2-95	-	-	-	190	<DL	250	1870	-	-	-
SSN 697 USS Indianapolis	3-95	-	-	-	160	<DL	190	2370	-	-	-
FFG 37 USS Crommelin	4-95	-	-	-	<DL	<DL	210	<DL	-	-	-
DDG 53 USS John Paul Jones	4-95	-	-	-	660	140	<DL	2900	-	-	-
FFG 37 USS Crommelin	5-95	-	-	-	190	160	<DL	1010	-	-	-
SSN 724 USS Louisville	6-95	-	-	-	<DL	<DL	160	130	-	-	-
SSN 677 USS Drum	7-95	-	-	-	130	<DL	260	5310	-	-	-
SSN 715 USS Buffalo	8-95	-	-	-	<DL	<DL	240	<DL	-	-	-

Table 6. (Continued)

Vessel	Date of Sample	Tributyl-tin (TBT)	Dibutyl-tin (DBT)	Mono-butyltin (MBT)	Copper	Nickel	Tin	Zinc	Chemical Oxygen Demand	Total Suspended Solids	Total Organic Carbon
CG 65 USS Chosin	9-95	-	-	-	1630	590	<DL	2130	-	-	-
DDG 59 USS Russell	12-95	-	-	-	<DL	<DL	<DL	180	-	-	-
DD 979 USS Conolly	1-31-96	-	-	-	-	-	-	-	-	<4***	5***
DD 979 USS Conolly	1-31-96	-	-	-	-	-	-	-	-	<4***	6***
DD 979 USS Conolly	1-31-96	-	-	-	-	-	-	-	-	<4***	5***
DD 979 USS Conolly	1-31-96	-	-	-	-	-	-	-	-	<4***	4***
DDG 60 USS Hamilton	1-96	-	-	-	180	<DL	<DL	8300	-	-	-
SSN 675 USS Bluefish	1-96	-	-	-	<DL	500	1100	260	-	-	-
DDG 60 USS Hamilton	1-96	-	-	-	450	<DL	<DL	880	-	-	-
SSN 717 USS Olympia	3-96	-	-	-	100	<DL	290	570	-	-	-
SSN 715 USS Buffalo	3-96	-	-	-	<DL	<DL	280	830	-	-	-
FFG 57 USS Reuben James	5-96	-	-	-	<DL	<DL	100	300	-	-	-
SSN 752 USS Pasadena	6-96	-	-	-	<DL	130	280	<DL	-	-	-
SSN 680 USS Wm H. Bates	6-96	-	-	-	<DL	100	310	220	-	-	-
DDG 56 USS John McCain	9-96	-	-	-	120	<DL	<DL	630	-	-	-
DDG 53 USS John Paul Jones	12-96	36.67	-	-	-	-	-	1500	-	-	-
CG 59 USS Princeton	12-96	30.53	-	-	-	-	-	2600	-	-	-
DD 976 USS Merrill	12-96	0.62	-	-	-	-	-	800	-	-	-
DD 984 USS Leftwich	12-96	2.8	-	-	-	-	-	-	-	-	-
MINIMUM*		**1**	**N/A****	**N/A****	**50**	**50**	**50**	**50**	**20*****	**<4*****	**4*****
MAXIMUM		**470**	**N/A****	**N/A****	**1,630**	**660**	**1100**	**8,300**	**180*****	**<4*****	**6*****
AVERAGE*		**74**	**33****	**5****	**303**	**145**	**194**	**1577**	**123*****	**<4*****	**5*****

A hyphen (-) denotes the sample was not analyzed for that parameter
DL = detection limit (50 µg/L)
N/A = not applicable
* Measurements below Detection Limit (DL) were set equal to the DL
** DBT and MBT based on only one sample
*** Units are mg/L

Table 7. Estimated Sonar Dome Mass Loadings

Constituent	Loading (lbs/yr)	Discharge Origin	
		External	Internal
Copper	23.4		X
Nickel	11.2		X
Tin	15.0		X
Zinc	121.9		X
TBT	2.4		X
TBT	12.6	X	
DBT	1.1		X
MBT	0.2		X

Table 8. Comparison of Measured Values in Sonar Dome Interior Discharge with Water Quality Criteria (μg/L)

Constituent	Mean / Max Reported Concentration	Federal Acute WQC	Federal Chronic WQC	Most Stringent State Acute WQC	Most Stringent State Chronic WQC
TBT	74 / 470	0.37[a]	0.01[a]	0.001 (VA)	0.001 (VA)
Copper	303 / 1,630	2.4	2.4	2.4 (CT, MS)	2.4 (CT, MS)
Nickel	145 / 660	74	8.2	8.3 (FL, GA)	7.9 (WA)
Zinc	1,577 / 8,300	90	81	84.6 (WA)	76.6 (WA)

Notes:
Refer to federal criteria promulgated by EPA in its National Toxics Rule, 40 CFR 131.36 (57 FR 60848; Dec. 22, 1992 and 60 FR 22230; May 4, 1995)
Where historical data were not reported as dissolved or total, the metals concentrations were compared to the most stringent (dissolved or total) state water quality criteria.

CT = Connecticut
FL = Florida
GA = Georgia
MS = Mississippi
VA = Virginia
WA = Washington

[a] Proposed water quality criteria, August 7, 1997

Table 9. Data Sources

NOD Report Section	Data Source			
	Reported	Sampling	Estimated	Equipment Expert
2.1 Equipment Description and Operation	Navy 3M MRC*			X
2.2 Releases to the Environment	Navy 3M MRC*			X
2.3 Vessels Producing the Discharge	UNDS Database			X
3.1 Locality				X
3.2 Rate	Design Documentation		X	X
3.3 Constituents	Naval Shipyards			X
3.4 Concentrations	NRaD San Diego			
4.1 Mass Loadings	NRaD San Diego		X	
4.2 Environmental Concentrations	X		X	
4.3 Potential for Introducing Non-Indigenous Species				X

* MRC: Maintenance Requirement Card