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REACTOR COMPARTMENT
DISPOSAL PACKAGE
HAZARDOUS MATERIAL INVESTIGATION

PUGET SOUND NAVAL SHIPYARD
BREMERTON WASHINGTON

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TABLE OF CONTENTS

	PAGE
EXECUTIVE SUMMARY	1
PURPOSE AND SCOPE	2
BACKGROUND	2
MATERIAL REVIEW AND SAMPLING PROGRAM	3
LABORATORY ANALYSIS	4
DOCUMENTATION	5
APPLICATION OF WAC 173-303 TO IDENTIFY AND DESIGNATE WASTE	6
APPLICATION OF THE TOXIC SUBSTANCES CONTROL ACT, 40 CFR 761	9
QUALITY ASSURANCE	10
CONCLUSIONS	11
APPLICABILITY TO OTHER REACTOR COMPARTMENT PACKAGES	11

LIST OF TABLES

TABLE
NUMBER

1. Tabulation of the Weight of all Hazardous/Toxic Materials Identified in the SSBN600 and the SSN607 Disposal Packages
2. List of Materials for Toxic Waste Mixture Evaluation
3. List of Heavy Metals for Extraction Procedure Toxicity Evaluation
4. List of Materials for Carcinogenic Dangerous Waste Evaluation
5. Tabulation of all PCB's Identified in Components in the SSBN 600 and SSN 607 Packages

LIST OF FIGURES

FIGURE
NUMBER

1. Typical Submarine with Reactor Compartment Identified
2. Typical Disposal Package PCB Areas
3. Typical RC Disposal Package Hazardous Material Report Form
4. Typical Laboratory Chemical Analysis Report
5. Toxic Dangerous Waste Mixtures Graph

Executive Summary

The Puget Sound Naval Shipyard, located in Bremerton, Washington, unexpectedly discovered high concentrations of PCB's in the sound damping felt found in older submarines. Investigation revealed the PCB bearing felt was also in the submarine nuclear reactor compartment disposal packages which had previously been shipped to the Department of Energy Site at Hanford, Washington for disposal. In addition to committing to remove the PCB felt from the packages at Hanford and from future packages prior to shipment, Puget Sound Naval Shipyard conducted an extensive detailed engineering review of the two reactor compartment disposal packages which were undergoing preparations for shipment, to determine if there were any other quantities of hazardous materials requiring regulation. The review's major conclusions were:

- With the exception of the over 100 tons per package of already identified lead shielding, the Reactor Compartment Disposal Packages do not contain any material which would require them to be regulated as Dangerous Waste or Extremely Hazardous Waste under the Washington Administrative Code. However, even though not regulated under the federal Resource Conservation and Recovery Act, the presence of the lead shielding does require the Reactor Compartment Disposal Packages to be regulated under the Washington Administrative Code's Hazardous Waste Management Act.

- Asbestos, which is present as insulation on pipes and components, is fully contained in compliance with the Clean Air Act.

- PCBs in concentrations above 50 ppm were found in solid components such as thermal insulation, electrical cable, and rubber items. These are common industrial components and similar results would likely be obtained from sampling many similar industrial components manufactured in the same era. These PCB's cause the packages to be regulated under the federal Toxic Substances Control Act.

PURPOSE AND SCOPE: This report documents the results of an extensive Puget Sound Naval Shipyard investigation of the materials contained within the ex-USS THEODORE ROOSEVELT (SSBN 600) and the ex-USS DACE (SSN 607) reactor compartment disposal packages. This investigation was undertaken as the result of the unexpected discovery of PCB bearing felt in the SSBN 600 package, and was intended to determine if there were any other hazardous or toxic materials that could cause the packages to be regulated as waste under the pertinent state and federal regulations, including the State of Washington Administrative Code and The federal Toxic Substances Control Act.

BACKGROUND: The Puget Sound Naval Shipyard discovered in April, 1989 that wool felt sound damping material used on some of the Navy's older submarines contained high concentrations (up to 35%) of polychlorinated biphenyls (PCB's). These PCB's were initially found during the dismantling of the missile compartment on the submarine USS JOHN ADAMS (SSBN 620). The discovery was a surprise to the Shipyard and the Navy. The Shipyard took the proper actions to inform the State and Federal regulating agencies, and to control the material.

The defueled reactor compartment from the submarine USS THEODORE ROOSEVELT (SSBN 600) was being prepared as a disposal package for shipment to Hanford during this period. PCB bearing felt was discovered in the package on areas of the hull forward and aft of the reactor compartment, but not in the compartment itself. Figure 1 shows the location of the reactor compartment before it is removed from the submarine.

Further investigation showed that the six reactor compartment packages already shipped to the DOE disposal site at Hanford also contained the felt material. Most of the PCB material in the reactor compartment disposal packages at Hanford was sealed within welded steel bulkheads, although a small amount, estimated at no more than five pounds per package, was in areas outside the bulkheads. Figure 2 shows the areas of a typical disposal package where PCB bearing felt was found. The material was in solid form, relatively insoluble in water, and covered with paint, thus even the exposed material posed little immediate risk to the environment. The Shipyard removed all PCB bearing felt and cleaned the affected surfaces on the disposal packages being prepared for shipment and prepared to quickly remove the exposed material from the packages at Hanford. This work was completed on December 5, 1989.

Based on the unexpected discovery of PCB's, the Navy decided to conduct a much more detailed review of disposal package materials and to compare the results with current hazardous material regulations to determine if there were any other sources of PCB's or any other unidentified potentially hazardous materials in the disposal packages.

The following sections of this report discuss how this material review was conducted and reports the results of the investigation.

MATERIAL REVIEW AND SAMPLING PROGRAM: A team of Shipyard managers and supervisors was dedicated to develop and implement the program to review all materials contained within the reactor compartment disposal packages. The Shipyard Commander placed priority on this review to assure a prompt and thorough investigation. A major portion of the Shipyard's engineering staff was diverted to this task from other work in progress. Unlimited overtime was authorized and the staff worked evenings and weekends to complete the review.

In deciding how to approach the problem, the team questioned how PCB bearing felt could have gone undetected in these ships, considering that PCB's have been banned from commerce since the early 1970's. A review of the specification for the material showed that while it did not require the use of PCB's, it also did not prevent their use. The manufacturer apparently used PCB impregnation to obtain the required fire retardant properties. Although the Navy has had a program for many years for identifying and eliminating PCB's from places where they were known or suspected of being used, most of the known applications have been liquid PCB's in electrical and hydraulic equipment. Solid sound damping material was not suspected.

The felt sound damping and some other components in the submarines were procured with a type of specification commonly referred to as a "performance specification". These specifications often do not tightly control material formulation, rather they identify the required characteristics of the product, and leave the formulation to the manufacturer. This recognition led to the conclusion that a review of drawings and material specifications alone would not positively identify all the materials in the reactor compartment packages. From the beginning then, it was apparent that where specifications did not positively identify material constituents, laboratory testing of actual samples would have to be employed.

The reactor compartment packages from the ex-USS THEODORE ROOSEVELT (SSBN 600) and the ex-USS DACE (SSN 607), being prepared for shipment in October, were reviewed in detail to identify materials of concern. Instructions on the methods and the documentation to be used in the review were issued to the cognizant engineering organizations. The review began on 25 August 1989. By the time it was completed one month later, over 39,000 man-hours had been expended.

The starting point for identifying the materials was the Ships Drawing Index which is the master listing of all the drawings for the specific submarine. The Ships Drawing Index lists were broken down and marked to show which individual technical organization within the Shipyard was responsible for each drawing listed.

Each drawing listed on the Ships Drawing Index was reviewed by an engineer to determine if it applied to components within the disposal package boundary. All the applicable drawings were then reviewed to find the constituent materials involved. Drawings of complex systems were reviewed to list their sub-systems and assembly drawings. The sub-system and assembly drawings were further broken down to obtain the detail drawings of the components. The detail drawings of the components, including the material lists on each drawing, were reviewed to determine the component materials and their procurement specifications. The drawing and specification trail was followed until the constituent materials could be conclusively identified. The determination of material composition also typically involved the review of material safety data sheets, vendor's catalogs, and calls to the original component designers and manufacturers.

To provide positive assurance that nothing was overlooked, the technical organizations reviewing the drawings also went into the reactor compartment disposal packages and checked the readily accessible portions of the actual systems and components against the drawings. Support service items installed in the ship by the Shipyard during the decommissioning also were subject to the same kind of drawing review and on site checks.

As soon as the individual components and their constituent materials were identified, the pertinent information was entered onto an individually serialized Hazardous Material Report Form specifically developed for this project. Figure 3 shows a typical example. At the time that the engineer entered the data onto the form, an initial determination was made on whether the material was hazardous, non-hazardous, or required further determination. This determination was based on hazardous material information sheets prepared by the Shipyard's environmental engineering staff and distributed to the technical engineering staff performing the reviews. These information sheets were derived from the Washington State Dangerous Waste Regulations (WAC 173-303), along with the federal Toxic Substances Control Act (40CFR761) and the Clean Air Act for National Emissions Standards (NESHAPS-Asbestos 40 CFR 61). Where there were questions about whether or not the material was hazardous, the reviewing engineers discussed the question with the environmental engineering staff to see if a clear determination was possible.

LABORATORY ANALYSIS: In those cases where the material could not be positively identified from drawings and specifications (i.e. such as for performance specifications) or from other sources, and a sample could be obtained, the reviewing engineer obtained a laboratory analysis. Over 500 individual laboratory determinations were made. The majority of this laboratory work was done at the Shipyard's own laboratory, which is American Industrial Hygiene Association certified. Because the volume of this testing taxed the capacity of even this large facility, it was necessary to hire contract chemists to supplement the laboratory staff, and to contract out some of the work.

The types of laboratory analysis included:

- Soxhlet extraction and gas chromatography for PCB's
- Induction coupled plasma (ICP) spectrometry of dissolved materials for total heavy metals
- Extraction procedure toxicity using ICP spectrometry for leachable heavy metals.
- Ion chromatography for persistent halogenated hydrocarbons.
- Gravametric analysis for polycyclic aromatic hydrocarbons
- EPA 625 semivolatile analysis using GC mass spectrometry.

Figure 4 shows a typical laboratory chemical analysis report.

In a few cases material samples could not be obtained because the materials were too small to analyze (e.g. small rubber grommets in electrical components) or were inside components that could not be disassembled without great effort (e.g. non-metallics inside radioactive components). In all cases the characteristics of these materials were sufficiently well known and/or their size was small enough to conclude their effects on the final hazardous material determination for the total package was negligible. Where there was any question about toxicity of these materials, they were assumed to be in the most dangerous category for purposes of evaluating the material under the dangerous waste regulations of WAC 173-303

DOCUMENTATION: After each hazardous material report form was filled out and the initial material determination made, the form was given to a staff member whose job was to review the forms for completeness and enter the data into a computer data base. After validation of the data, this data base would allow all like- material to be tabulated, totaled for weight, and compared to the governing regulatory requirements.

To validate the data, each hazardous material report form was submitted to the Shipyard's environmental engineering staff for a final review and material hazard determination. Where necessary, additional data was requested, either from further engineering research, or by laboratory analysis. When the material described on the report form was determined to be properly defined, the environmental engineers then determined whether the material was potentially regulated under the State of Washington Dangerous Waste Act, the Clean Air Act, or the Toxic Substances Control Act, and entered this determination onto the form.

After signature validation by the Shipyard's environmental engineering group, the data from the updated forms was input to update the computer data base. The

forms were then retained in a file. At the end of the project, over 13,000 report forms, representing approximately 6,000 types of components, had been generated, evaluated and filed.

Using the computer data base, the total weight of each of the identified hazardous materials was totaled to allow comparison with the controlling regulations. The result of this effort is shown on Table 1 of this report, which lists the weight of all Hazardous/Toxic Materials identified in the SSBN 600 and the SSN 607 disposal packages. With the exception of the discovery of PCB's above 50 ppm in a number of common industrial products in the disposal packages, the investigation did not produce any unexpected findings. The results typically represent small amounts of hazardous materials in residual liquids in drained down components, and in protective coating systems and adhesives; heavy metals, typically as plating applied to fasteners and electrical contacts; and hazardous materials found in the composition of plastics, rubber and other common non-metallic components.

APPLICATION OF WAC 173-303 TO IDENTIFY AND DESIGNATE WASTE. Washington State's Dangerous Waste Regulations, WAC 173-303, implement Subtitle C of federal Public Law 94-589, the Resource Conservation and Recovery Act. This state code is the controlling RCRA regulation, and among other things, provides a method for identifying and designating those solid wastes considered dangerous or extremely hazardous to the public health and environment. WAC 173-303 also provides the rules for regulating and disposing of such waste. These regulations are enforced by the State of Washington's Department of Ecology.

WAC 173-303 does not cover the regulation of polychlorinated biphenyls (PCB's) except for liquid PCB's in concentrations less than 50 ppm. PCB's, instead, are regulated by the federal Toxic Substances Control Act (TSCA) in 40 CFR 761, which is the regulation applicable to the PCB's found in the disposal packages. The TSCA regulations are enforced by the United States Environmental Protection Agency.

Other Washington State laws apply to solid waste. They are found in the Revised Code of Washington (RCW), Title 70 - Public Health and Safety, and include: Chapter 70.93 - Model Litter Control and Recycling Act; Chapter 70.95 - Solid Waste Management, Recovery and Recycling; and Chapter 70.105 - Hazardous Waste Management. The latter chapter contains a caveat on disposing of extremely hazardous wastes that contain radioactive components. Disposal is allowed in a radioactive waste disposal site owned by the United States Department of Energy or a licensee of the Nuclear Regulatory Commission.

When applying WAC 173-303 to identify and designate dangerous wastes (DW) or extremely hazardous wastes (EHW) regulated by the code, the starting point is WAC 173-303-070. Briefly the waste generator (in this case the Shipyard) shall evaluate his waste using the Lists and Characteristics method of the regulation, which prescribes five procedures which are accomplished in sequence. In addition, the generator may also choose (or be required) to evaluate his waste

using the additional criteria contained in the regulation. These methods are:

Lists and Characteristics	Additional Criteria
~~1. Discarded Chemical Products~~	~~1. Toxic Dangerous~~ Waste
2. Dangerous Waste Sources	2. Persistent Dangerous Waste
3. Infectious Waste Mixtures	3. Carcinogenic Dangerous Waste
4. Dangerous Waste Mixtures	
5. Dangerous Waste Characteristics	

The Shipyard study actually evaluated the disposal package materials against all applicable criteria. the following description of the sequence actually employed covers sections 1 through 5 of Lists and Characteristics, then discusses the Additional Criteria.

Lists and Characteristics Method:

First, using WAC 173-303-081, evaluate whether the material is a discarded chemical product. For the disposal package materials this involves determining whether the material is listed on the discarded chemical products list in WAC 173-303-9903. Typical chemicals on this list are ammonium picrate, ammonium vanadate, anilene, arsenic (III) oxide, etc. No discarded chemical products were identified in the disposal package materials.

Second, using WAC 173-303-082, evaluate whether the material constitutes a specific or non-specific dangerous waste source. This involves determining whether the material is listed on the Dangerous Waste Sources List of WAC173-303-9904. This listing includes the wastes from numerous processes such as degreasing, wood preservation, electroplating, smelting, chemical manufacturing, etc. None of the materials in the disposal packages were on the dangerous waste source list.

Third, assure there are no infectious dangerous wastes per WAC 173-303-083. Although this section of the WAC is reserved (i.e. no criteria yet provided), there are no materials in the disposal packages that would fall into an infectious category.

Fourth, evaluate, using WAC 173-303-084, combinations of materials not already identified as dangerous wastes in the above three evaluations, to determine whether they constitute either toxic dangerous waste mixtures or persistent dangerous waste mixtures, and determine from the waste mixtures graphs of WAC 173-303-9906 and 173-303-9907 whether the quantity and equivalent concentration of the mixture should be either undesignated, or designated Dangerous Waste (DW) or Extremely Hazardous Waste (EHW).

This evaluation involves comparing the materials to listings of toxic materials in standard reference documents such as the National Institute for Occupational Safety and Health's (NIOSH) *Registry of Toxic Effects of Chemical Substances*, the Spill Table in USEPA's regulations in 40 CFR Table 302.4, and Sax, Irving

Standard Properties of Industrial Materials, Van Nostrand Reinhold. Toxic categories are assigned for each constituent material listed, ranging from Category X (most toxic) through A, B, C, and D (in order of decreasing toxicity). each category has a corresponding toxicity divisor of 1, 10, 100, 1,000 and 10,000 respectively which allows the calculation of an equivalent concentration of toxicity for the mixture. The toxic waste mixture graph, WAC 173-303-9906 (Figure 5) is then used to plot the equivalent concentration against the waste quantity to determine whether the mixture is designated as a Dangerous Waste, an Extremely Hazardous Waste, or is undesignated. The regulations state that "if toxicity data for a constituent cannot be found in EPA's Spill Table, NIOSH Registry, or other source reasonably available to a person, then he need not determine the toxic category for that constituent; however, where the Shipyard could not determine the specific material composition or toxicity, in every case where there was a potential toxicity, a worst case toxicity category of X was assigned.

Table 2 of this report provides the list of materials and calculations for WAC 173-303-084 Waste Mixture categories. It should be noted that the reactor compartment is not packaged within a fabricated container, but instead serves as its own container. Thus, the entire reactor compartment disposal package can be considered to be the waste under evaluation. The percentage of each toxic constituent and its waste category was determined. The toxics equivalent concentration was then determined by applying the numerical factors for each individual waste category (X%÷1, A%÷10, B%÷100, C%÷1000, D%÷10,000), then summing these to determine the toxics equivalent concentration. As shown on Table 2, the toxics equivalent concentration is 0.000602 % for the SSBN 600 package, and 0.000339 % for the SSN 607 package. These concentrations are less than 0.001 %, which is the smallest equivalent concentration for designating waste on the Toxic Dangerous Waste Mixtures Graph (reproduced as Figure 5). The waste is therefore undesignated, which means it is not a toxic dangerous waste mixture.

Special procedures and calculation methods are provided in WAC 173-303-083 for determining concentrations of persistent waste mixtures (halogenated hydrocarbons or polycyclic aromatic hydrocarbons with more than three rings and less than seven rings). The concentrations are used to designate the waste for persistence using the persistent waste mixture graph, WAC 173-303-9907. No persistent waste constituents were identified in the disposal packages.

The generator must also evaluate whether the waste is a carcinogenic dangerous waste. This involves comparing the waste materials against listings of IARC (International Agency for Research on Cancer) human or animal, positive or suspected carcinogens. If the waste quantity exceeds 220 pounds and the total concentration of the IARC carcinogens exceeds 1.0% of the waste, the waste is classified Dangerous Waste. The evaluation of the disposal packages identified an estimated 76.5 lbs of one such material, Coal Tar Epoxy, which is used in some paint systems. This epoxy material is fully cured and in a solid form which can not be readily ingested. In any case, the quantity when considered against the

total weight of waste is 0.0036 percent, which is less than the 1.0 % required to designate the waste Dangerous Waste. Thus, the waste is not designated. The result of this section's investigation are provided for easy reference as Table 4 of this report.

Fifth. The materials must be checked for dangerous waste characteristics using WAC 173-303-090. This involves checking for ignitability, corrosivity, (chemical) reactivity, and for toxicity (using a standard leachability extraction procedure (EP)). None of the disposal package materials were found to be ignitable, corrosive or chemically reactive. A number of the individual materials however are EP toxic heavy metals (contain leachable concentrations of either arsenic, barium, cadmium, chromium, lead, mercury, selenium or silver), either as determined from the literature, or when subject to actual EP extraction procedure testing. This testing samples the leachate extracted from a "representative waste sample" (e.g. we tested a representative sample of cadmium plated bolts). (Note that the requirement to test "a representative sample of the waste" is interpreted as testing individual components which are suspect, rather than putting together and testing a composite sample of all the components constituting a disposal package). These materials and their leachable concentrations are listed on Table 3 of this report. None of the EP toxicity concentrations (mg/L in extract) for the listed materials would exceeded the threshold values in the table in WAC 173-303-090, and the package would be undesignated.

Additional Criteria

If used, the three sections of this method must be accomplished in the order set forth until the waste is designated. The three sections of this method are contained in WAC sections 173-303-101, 173-303-102, and 173-303-103.

The only significant additional criteria for toxic dangerous waste (WAC 173-303-10) and for persistent dangerous waste (WAC 173-303-102), is that salmonid (fish) bioassays may be required where applicable. No such bioassays were necessary for the disposal package analysis.

The additional WAC 173-303-103 criteria for designating carcinogenic waste is that if the concentration of any one IARC positive (human or animal) carcinogen exceeds 0.01 % of the waste quantity the waste is designated Dangerous Waste, and if the concentration of any one of these IARC positive carcinogens exceeds 1.0 % the waste is designated Extremely Hazardous Waste. Since the coal tar epoxy listed on Table 4 constitutes only 0.0036 % of the waste weight, the waste is not designated under this criteria.

APPLICATION OF THE TOXIC SUBSTANCES CONTROL ACT, 40 CFR 761

The Toxic Substances Control Act (TSCA) regulates polychlorinated biphenyls (PCB's) that are found in concentrations above 50 ppm. These regulations, which address both liquid and solid PCB materials, provide cleanup standards for spills and establish requirements for PCB control and disposal.

An unexpected result of the laboratory testing of materials was the identification of small amounts of PCB's in material other than the sound damping felt. A significant percentage of all of the nonmetallic items sampled contained PCB concentrations greater than 50 ppm. These PCB's were found in asbestos insulation, electrical cables, rubber components, and a few other items. Table 5 of this report is a tabulation of all PCB's identified in components in the SSBN 600 and SSN 607 Packages. Since there are components with PCB levels above the 50 parts per million limit, these PCB's cause the disposal packages to be regulated under the Toxic Substances Control Act. Similar results would likely be obtained if similar samples were taken from many items manufactured prior to the mid 1970's since the types of materials found to contain greater than 50 ppm were ordinary industrial materials.

All of the PCB's remaining in the disposal packages are contained in the formulation of solid compounds and none of the PCB's can be removed by wipe survey cloths. The total weight of these solid PCB's is less than three pounds per Reactor Compartment Package. For comparison, EPA regulations allow anyone to dispose of PCB small capacitors weighing up to three pounds, as municipal waste. As in the case of the sound damping felt, the presence of PCB's in these materials is due to the widespread use of PCB's in a variety of industrial applications in the early 1960's when these submarines were constructed. The PCB containing insulation and electrical cabling are distributed widely throughout the reactor compartment, and their removal would be very difficult and result in significant personnel radiation exposure. Therefore, since these components are isolated from the environment by the high integrity steel RC disposal package, the Shipyard considered the best course of action was to pursue disposal of the packages under the provisions of TSCA.

QUALITY ASSURANCE: Reviews by independent organizations were conducted at the onset of the project to assure the integrity of the methods being used. These independent reviews were then continued throughout the project to monitor performance of the work and to provide a check of the finished product. Independent auditors not only reviewed the pertinent documents, but they also interviewed key personnel, inspected work in progress, and evaluated the effectiveness of personnel training and supervision. As problems were identified during these reviews, corrective actions were initiated. In some instances this required modifying the review process to assure all areas were properly evaluated. For a quality assurance check of Shipyard laboratory testing, representative samples of materials being tested at the Shipyard were also sent to the EPA Northwest Water Quality Laboratory at Manchester, Washington to validate the Shipyard's results.

CONCLUSIONS:

- It was concluded that all materials constituting the disposal packages meet the definition of "solid waste" under the State of Washington Code.

- Although the disposal packages contain roughly 13,000 pounds of asbestos insulation on pipe and other components, all this material is completely contained within the welded steel disposal package, and this material is fully in compliance with the Clean Air Act, 40CFR61.

- With the exception of lead, no other materials were found which would cause the disposal packages to be classified as a dangerous waste under the State regulations. Thus, with the exception of lead, the packages would not be regulated under Washington State regulations, WAC 173-303.

- An unexpected result of the investigation was that a significant percentage of all of the nonmetallic items sampled contained PCB concentrations greater than 50 ppm. These PCB's were found in asbestos insulation, electrical cables, rubber components, and a few other items. Similar results would likely be obtained if similar samples were taken from many items manufactured prior to the mid 1970's since the types of materials found to contain greater than 50 ppm were ordinary industrial materials. These PCB's, however, cause the disposal packages to be regulated under the Toxic Substances Control Act.
Since the components containing these PCB's are isolated from the environment by the high integrity steel RC disposal package, and their removal would be very difficult and result in significant personnel radiation exposure. the Shipyard considered the best course of action was to pursue disposal of the packages under the provisions of TSCA.

The Navy is working with The Department of Energy Richland Operations Office, Region X of the EPA, and The State of Washington Department of Ecology, to assure the proper permits are obtained for disposal of the reactor compartment disposal packages and to assure the burial trench is in compliance with the applicable regulations. Interim agreements were reached with these agencies to allow shipment of two reactor compartment disposal packages in October 1989 and the appropriate permit applications and other agreed upon actions are underway to assure continuation of these shipments.

APPLICABILITY TO OTHER REACTOR COMPARTMENT PACKAGES

This study was directed specifically towards the two RC packages which were being prepared at the Shipyard in September 1989 for shipment for disposal. Additional sampling and analysis will be conducted to confirm that the results are applicable to other RC packages, including the packages previously sent to Hanford and any packages prepared for shipment in the future.

Due to the ubiquitous presence of low concentrations of PCBs in nonmetallic materials, it is likely that similar concentrations will exist in other RC packages. Since more than two thirds of the PCBs were contained within thermal insulation and electrical cables, PCB content in other packages will be estimated by taking a composite sample of insulation and cabling. This will provide an estimate of the amount of PCBs contained in each package. In addition, to establish a reliable baseline for components containing PCB's, the Shipyard will continue a limited random sampling program of non-metallic components common to submarine reactor compartment disposal packages. It is anticipated that this baseline will be fixed with the sampling of an additional eight packages, at which time it should no longer be necessary to conduct random PCB sampling.

With the exception of the unexpected findings of PCBs, and the already identified lead shielding,there were no other findings of hazardous materials requiring regulation as hazardous waste, in the RC packages. Since similar materials were used in the construction of other reactor compartments, it is unlikely that there would be any materials other than PCB's and lead in other reactor compartments which would require regulation. In order to ensure this is the case, the Navy will conduct a material review of major components for classes of reactor compartments other than the two studied by this report. This review will consist of an examination of the major components which provide a significant fraction of the weight of the package and will focus on the heavy metals listed in table 3. Since none of these toxic heavy metals (with the known exception of lead) even approached the regulatory limits in the SSBN 600 and 607 packages , only a significant change in the composition of plating or coating materials used for major components could result in am amount requiring regulation. Thus, a review of the major components for different RC classes will be sufficient to ensure there is no change in the regulatory status of the RC packages.

TABLES

TABLE 1

TABULATION OF THE WEIGHT OF ALL HAZARDOUS/TOXIC MATERIALS IDENTIFIED IN THE SSN 600 AND THE SSN 607 DISPOSAL PACKAGES

MATERIAL	PRIMARY FORM/LOCATION	600 WEIGHT	607 WEIGHT
AMINE	RESIDUAL FLUID	0.3	0.3
ASBESTOS	PIPE AND COMPONENT INSULATION, ADHESIVES, GASKETS, LINERS, PACKING	13982.19	14266.98
CAD PLATING	PLATED FASTENERS, ELEC. AND STRUCTURAL PARTS	8.1757	11.2194
CHROMATES	SOLIDIFIED RESIDUAL RUST INHIBITOR LIQUID, SLUDGE	1.14	1.14
LEAD NAPTHENATE	PAINT	2.03	2.02
RED LEAD	PAINT	120.8	791.8
CYANIDE	PAINT	9.45	9.45
LEAD	REACTOR COMPARTMENT	>100 TONS	>100 TONS
LEAD (RUBBER CEMENT)	ADHESIVE FOR DECK GRATING PADS	0.5	0.5
LEAD (OTHER)	SOFT SOLDER, SOLIDIFIED SLUDGE, MISC. SMALL PARTS	13.364	11.25
PCB'S	VARIOUS ADHESIVES, RUBBERS, PLASTICS, PAINTS	1.71357	0.533995
ETHYLENE GLYCOL	GAGE FLUID	0.55	0.55
SILVER	PLATED ELEC CONTACTS & CONNECTORS, SOLIDIFIED SLUDGE	1.191	0.747
ARSENIC TRIOXIDE	VIEWING WINDOW GLASS ADDITIVE	1.07	4.16
CYNOACRYLATE ADHESIVE	ADHESIVE	3	3
CADMIUM	PAINT	0.055	0.055
CHROMIUM TRIOXIDE	RUST INHIBITING PAINT	34.25	36.05
COAL TAR EPOXY	PAINT	76.5	76.5

TABLE 1

TABLE 1 (Continued)

TABULATION OF THE WEIGHT OF ALL HAZARDOUS/TOXIC MATERIALS IDENTIFIED IN THE SSN 600 AND THE SSN 607 DISPOSAL PACKAGES

MATERIAL	PRIMARY FORM/LOCATION	600 WEIGHT	607 WEIGHT
PAINT COMPOUNDS	ELEC COMPONENT PAINT	0.4	0
RUBBER COMPOUNDS	HANGERS, RESILIENT MOUNTS, LINERS	6.01	6
PLASTIC COMPOUNDS	ELEC COMPONENTS	0.1	0.2
ADHESIVE COMPOUNDS	INSULATION AND MISC SMALL PARTS	0.16	0.16
MISC. SOFT ITEM COMPOUNS	MISC. ELEC. COMPONENT GASKETS, PACKING, INSULATION, VARNISH, ETC.	7.56	2.01
MISC ELEC. COMPONENT COMPOUNDS	CAN NOT BE REMOVED OR DISASSEMBLED (SWITCHES, THERMOCOUPLES, ETC)	3.6	4.8

TABLE 1 (Continued)

TABLE 2
SSN 600

LIST OF MATERIALS AND CALCULATIONS FOR WASTE MIXTURE CATEGORIES

KNOWN HAZARDOUS MATERIAL (KHM)	WEIGHT (LBS.)	TOXIC CRITERIA (A)	LD50 OR LC50	TOXIC CATEGORY (B)	PERCENT OF WEIGHT PACKAGE (C)	INDIVIDUAL EQUIVALENT CONCENTRATION % (D)
AMINE	0.30	0	3130	D	.0000147	1.470E-09
CYANINE	9.45	0	161	C	.0004637	4.637E-07
ETHYLENE GLYCOL	0.55	0	8540	D	.0000270	2.788E-09
CYANOACRYLATE	3.0	NA	NA	D	.0001472	1.472E-08
SUM IEC'S (KHM)						4.826E-07
MATERIALS WHICH COULD NOT BE SAMPLED (MNS)	WEIGHT (LBS.)	TOXIC CRITERIA	LD50 OR LC50	TOXIC CATEGORY (B)	PERCENT OF WEIGHT PACKAGE (C)	INDIVIDUAL EQUIVALENT CONCENTRATION % (D)
PAINT (E)	.4	NA	NA	X	.000020	1.963E-05
SYNTHETIC RUBBER	.2	NA	NA	X	.000010	9.81E-06
INSULATION (MISC)	0	NA	NA	X	0	0
PLASTIC	0.1	NA	NA	X	.000005	4.907E-06
ADHESIVE (MISC)	0.16	NA	NA	X	.000008	7.851E-06
SOFT ITEMS (MISC)	7.56	NA	NA	X	.000371	3.710E-04
ELEC COMP (MISC)	3.8	NA	NA	X	.000186	1.865E-04
SUM IEC'S (MNS)						5.997E-04
EQUIVALENT CONCENTRATION = SUM IEC'S (KHM) + SUM IEC'S (MNS)						*6.002E-04

COMMENTS

A) TOXICITY CRITERIA (A-AQUATIC, O-ORAL, I-INHALATION, AND D-DERMAL) WERE DETERMINED FOR WASTE MIXTURE MATERIALS FROM SAX IF CHEMICAL INFORMATION WAS PROVIDED

B) TOXIC CATEGORIES DETERMINED AS DEFINED IN WAC 173-303-101 CATEGORY D IS ASSUMED WORST CASE FOR CYANOACRYLATE, FOR MATERIALS NOT SAMPLED (MNS) CATEGORY X IS ASSUMED

C) PERCENT OF WEIGHT PACKAGE IS BASED ON A SRC WEIGHT OF 1019 TONS

D) INDIVIDUAL EQUIVALENT CONCENTRATION (IEC) IS EQUAL TO THE PERCENT WEIGHT OF THE MATERIAL DIVIDED BY A TOXIC CATEGORY FACTOR. THE TOXIC CATEGORY FACTORS ARE . X=1, A=10. B=100, C=1000, D=10000
ONLY TOXIC CATEGORIES X, C, AND D ARE APPLICABLE FOR THESE MATERIALS

E) EPOXY BASED PAINTS (MISC)

TABLE 2 (Continued)
SSN 607

LIST OF MATERIALS AND CALCULATIONS FOR WASTE MIXTURE CATEGORIES

KNOWN HAZARDOUS MATERIAL (KHM)	WEIGHT (LBS.)	TOXIC CRITERIA (A)	LD50 OR LC50	TOXIC CATEGORY (B)	PERCENT OF WEIGHT PACKAGE (C)	INDIVIDUAL EQUIVALENT CONCENTRATION % (D)
AMINE	0.30	O	3130	D	.0000142	1.415E-09
CYANINE	9.45	O	161	C	.0004457	4.458E-07
ETHYLENE GLYCOL	0.55	O	8540	D	.0000260	2.594E-09
CYANOACRYLATE	3.0	NA	NA	D	.0001415	1.415E-08
SUM IEC'S (KHM)						4.640E-07
MATERIALS WHICH COULD NOT BE SAMPLED (MNS)	WEIGHT (LBS.)	TOXIC CRITERIA	LD50 OR LC50	TOXIC CATEGORY (B)	PERCENT OF WEIGHT PACKAGE (C)	INDIVIDUAL EQUIVALENT CONCENTRATION, % (D)
PAINT (E)	0	NA	NA	X	0	0
SYNTHETIC RUBBER	0	NA	NA	X	0	0
INSULATION (MISC)	0	NA	NA	X	0	0
PLASTIC	0.2	NA	NA	X	.000009	9.434E-06
ADHESIVE (MISC)	0.16	NA	NA	X	.000008	7.547E-06
SOFT ITEMS (MISC)	2.01	NA	NA	X	.000094	9.481E-04
ELEC COMP. (MISC)	4.8	NA	NA	X	.000226	2.264E-04
SUM IEC'S (MNS)						3.382E-04
EQUIVALENT CONCENTRATION = SUM IEC'S (KHM) + SUM IEC'S (MNS)						*3.387E-04

COMMENTS

A) TOXICITY CRITERIA (A-AQUATIC, O-ORAL, I-INHALATION, AND D-DERMAL) WERE DETERMINED FOR WASTE MIXTURE MATERIALS FROM SAX IF CHEMICAL INFORMATION WAS PROVIDED

B) TOXIC CATEGORIES DETERMINED AS DEFINED IN WAC 173-303-101 CATEGORY D IS ASSUMED WORST CASE FOR CYANOACRYLATE, FOR MATERIALS NOT SAMPLED (MNS) CATEGORY X IS ASSUMED

C) PERCENT OF WEIGHT PACKAGE IS BASED ON A SRC WEIGHT OF 1060 TONS

D) INDIVIDUAL EQUIVALENT CONCENTRATION (IEC) IS EQUAL TO THE PERCENT WEIGHT OF THE MATERIAL DIVIDED BY A TOXIC CATEGORY FACTOR THE TOXIC CATEGORY FACTORS ARE . X=1, A=10, B=100, C=1000, D=10000
ONLY TOXIC CATEGORIES X, C, AND D ARE APPLICABLE FOR THESE MATERIALS

E) EPOXY BASED PAINTS (MISC)

TABLE 3
SSN 600

EXTRACTION PROCEDURE TOXICITY CALCULATIONS

SSN 600 - KNOWN HAZARDOUS MATERIALS

DW = STATE OF WASHINGTON DANGEROUS WASTE
NOT REG. = DOES NOT EXIBIT CHARACTERISTIC OF EP TOXICITY, THEREFORE, NOT A DANGEROUS WASTE

MATERIAL (METAL TYPE)	WEIGHT (LBS.)	WEIGHT PERCENT OF PACKAGE (A)	DILUTION FACTOR (B)	PROJECTED CONCENTRATION (PPM) (C)	MINIMUM REGULATED CONCENTRATION (PPM) (D)	REGULATORY STATUS
ARSENIC	0.81	.0000397	0.05	1.99E-02	5.00	NOT REG.
BARIUM	0	0	0.05	0	100.00	NOT REG.
CADMIUM	8.23	.0004038	0.05	2.02E-01	1.00	NOT REG.
CHROMIUM	23.94	.0011747	0.05	5.87E-01	5.00	NOT REG
LEAD	23.57	.0011565	0.05	5.78E-01	5.00	NOT REG.
MERCURY	0	0	0.05	0	.20	NOT REG.
SELENIUM	0	0	0.05	0	1.00	NOT REG.
SILVER	1.19	.0000584	0.05	2.92E-02	5.00	NOT REG.

ASSUMPTIONS

A) WEIGHT PERCENT BASED ON A TOTAL PACKAGE WEIGHT OF 1019 TONS

B) DILUTION FACTOR BASED ON EP TOXICITY TEST OF EPA SW 846

C) PROJECTED CONCENTRATION IS EQUAL TO (WEIGHT PERCENT) x (DILUTION FACTOR)

D) MINIMUM REGULATED CONCENTRATION IS FROM WAC 173-303-070 (3).(b)

TABLE 3 (Continued)
SSN 607

EXTRACTION PROCEDURE TOXICITY CALCULATIONS

SSN 607 - KNOWN HAZARDOUS MATERIALS

DW = STATE OF WASHINGTON DANGEROUS WASTE
NOT REG. = DOES NOT EXIBIT CHARACTERISTIC OF EP TOXICITY, THEREFORE, NOT A DANGEROUS WASTE

MATERIAL (METAL TYPE)	WEIGHT (LBS.)	WEIGHT PERCENT OF PACKAGE (A)	DILUTION FACTOR (B)	PROJECTED CONCENTRATION (PPM) (C)	MINIMUM REGULATED CONCENTRATION (PPM) (D)	REGULATORY STATUS
ARSENIC	3.15	.0001486	0.05	7.43E-02	5.00	NOT REG.
BARIUM	0	0	0.05	0	100.00	NOT REG.
CADMIUM	11.28	0005320	0.05	2.66E-01	1.00	NOT REG.
CHROMIUM	25.17	.0011873	0.05	5.94E-01	5.00	NOT REG
LEAD	51.38	0024236	0.05	1.21E-00	5.00	NOT REG.
MERCURY	0	0	0.05	0	.20	NOT REG.
SELENIUM	0	0	0.05	0	1.00	NOT REG.
SILVER	0.75	0000354	0.05	1.77E-02	5.00	NOT REG.

ASSUMPTIONS

A) WEIGHT PERCENT BASED ON TOTAL PACKAGE WEIGHT OF 1060 TONS

B) DILUTION FACTOR BASED UPON EP TOXICITY TEST OF EPA SW 846

C) PROJECTED CONCENTRATION IS EQUAL TO (WEIGHT PERCENT)x(DILUTION FACTOR)

D) MINIMUM REGULATED CONCENTRATION IS FROM WAC 173-303-070 (3).(b)

TABLE 4
SSN 600

LIST OF CARCINOGENIC MATERIALS AND CALCULATIONS

CARCINOGENIC MATERIALS	WEIGHT (LBS)	PERCENT OF WEIGHT OF PACKAGE	DW OR NOT REG
COAL TAR EPOXY	76.5	.003753680	NOT REG.
TOTAL CARCINOGENIC MATERIALS	76.5	.003753680	NOT REG.

TABLE 4 (Continued)
SSN 607

LIST OF CARCINOGENIC MATERIALS AND CALCULATIONS

CARCINOGENIC MATERIALS	WEIGHT (LBS)	PERCENT OF WEIGHT OF PACKAGE	DW OR NOT REG.
COAL TAR EPOXY	76.5	.003608491	NOT REG.
TOTAL CARCINOGENIC MATERIALS	76.5	.003608491	NOT REG

TABLE 5

PCB WEIGHTS FOR
SSBN 600

SHEET 1 OF 3

LATEST REV AS OF:
24-Jan-90 08:06

SYSTEM	MATERIAL	MATERIAL WEIGHT	PCB WEIGHT	PPM PCB LEVEL
ISOLATION MNTS	RUBBER	7.02	0.00063	90
PIPING R. C.	INSULATION	12922	1.16	90
ELECTRICAL	CABLE	1761.8	0.2439	138.44
ELECT PEN	PACKING	64	0.0036	56
CHILL WATER PPG	INSULATION	* 219.7	0.029	* 130
FREEZE SEAL	INSULATION	1.31	0.0000721	55
VENTILATION COOLING COIL	INSULATION	17.6	0.0053	300
VENTILATION	GASKET	0.55	0.00094	1700
VENTILATION	GASKET	0.69	0.00152	2200
VENTILATION	BEDDING COMP.	21.8	0.1276	5870
VENTILATION	FLEX CONNECT	13.2	0.0033	250
PIPING R. C.	AL PAINT	21.6	0.0592	2740
PIPING OUTSIDE R.C.	AL PAINT	0.123	0.0003	2740
WT DOOR	GREASE	0.5	0.000037	74
DK PLATES	INSUL TAPE	3	0.0003	100

* ESTIMATE FROM SSN 607 DATA

TABLE 5

TABLE 5 (Continued)

PCB WEIGHTS FOR
SSBN 600 SHEET 2 OF 3

LATEST REV AS OF:
24-Jan-90 08:06

SYSTEM	MATERIAL	MATERIAL WEIGHT	PCB WEIGHT	PPM PCB LEVEL	
TRIM AND DRAIN PPG	INSULATION	9.1	0.00056	61	
PIPE HANGER LINERS	MIL-S/R-6855	4.44	0.002	420	****
ELEC CHANNEL RUBBER	MIL-S/R-6855	10	0.0042	420	
ELEC CHANNEL RUBBER	MIL-S/R-6855	5.68	0.0024	420	
FOUNDATION MOUNTS	MIL-S/R-6855	13.5	0.0057	420	
PIPE HANGER	MIL-S/R-6855	17	0.0071	420	
PIPE BLOCK HANGERS	MIL-S/R-6855	124	0.052	420	
PIPE HANGER ATM ANAL.	MIL-S/R-6855	2.2	0.0009	420	
C.W. PIPE HANGERS	MIL-S/R-6855	15	0.0063	420	
ASW PIPE HANGERS	MIL-S/R-6855	2.62	0.0011	420	
FO COMP WTR	MIL-S/R-6855	34.9	0.01466	420	
TRIM AND DRAIN BUMPER	MIL-S/R-6855	0.36	0.00015	420	
TRIM AND DRAIN HANGERS	MIL-S/R-6855	13	0.0055	420	

**** Several samples of MIL-S/R-6855 rubber were tested with results ranging from no detectable PCB's up to 420 ppm PCB's. For purposes of this report, all MIL-SR-6855 material identified during the drawing review was conservatively assigned the highest 420 ppm value.

TABLE 5 (Continued)

TABLE 5 (Continued)

PCB WEIGHTS FOR
SSBN 600

SHEET 3 OF 3

LATEST REV AS OF:
24-Jan-90 08:19

SYSTEM	MATERIAL	MATERIAL WEIGHT	PCB WEIGHT	PPM PCB LEVEL
STRUCTURE	SPOOL MTS.	116	0.01044	90
STRUCTURE	RESILIENT MTS.	5.8	0.00052	90
STRUCTURE	SOUND MTS.	0.22	0.00002	90
LABLE PLATES	TAPE	0.031	0.0000067	214
INSULATION	CORK	80	0.0128	160
INSULATION	FOAM	428	0.0244	57
TOTAL			1.7864558	

TABLE 5 (Continued)

TABLE 5 (Continued)

PCB WEIGHTS FOR
SSN 607 SHEET 1 OF 3

LATEST REV AS OF:
24-Jan-90 08:41

SYSTEM	MATERIAL	MATERIAL WEIGHT	PCB WEIGHT	PPM PCB LEVEL
ISOLATION MNTS	RUBBER	1.31	0.000118	90
ELECTRICAL	CABLE	2178	0.3201	146.97
ELECT PEN	PACKINS	86.5	0.0048	56
CHILL WATER PPG	INSULATION	219.7	0.029	130
VENTILATION COOLING COIL	INSULATION	17.6	0.012	660
VENTILATION	GASKET	**0.55	0.00094	**1700
VENTILATION	GASKET	**0.69	0.00152	**2200
VENTILATION	FLEX CONNECT	9.22	0.0023	250
PIPING R. C.	AL PAINT	21.6	0.0592	2740
PIPING OUTSIDE R.C.	AL PAINT	0.094	0.00026	2740
FUEL OIL	LAGGING	45	0.00054	12
WT DOOR	GREASE	0.5	0.000037	74
DK PLATES	INSUL TAPE	6	0.0006	100

** ESTIMATE FROM SSN 600 DATA

TABLE 5 (Continued)

PCB WEIGHTS FOR
SSN 607

TABLE 5 (Continued)

LATEST REV AS OF:
24-Jan-90 08:41

SYSTEM	MATERIAL	MATERIAL WEIGHT	PCB WEIGHT	PPM PCB LEVEL
TRIM AND DRAIN PPS	INSULATION	3.39	0.0022	650
TRIM AND DRAIN PPS	INSULATION	1.88	0.0008	450
PIPE HANGER LINERS	MIL-S/R-6855	1.49	0.906	420
ELEC CHANNEL RUBBER	MIL-S/R-6855	10	0.0042	420
ELEC CHANNEL RUBBER	MIL-S/R-6855	6.2	0.0026	420
FOUNDATION MOUNTS	MIL-S/R-6855	40	0.0168	420
PIPE HANGER	MIL-S/R-6855	19	0.008	420
PIPE BLOCK HANGERS	MIL-S/R-6855	100	0.042	420
PIPE HANGER ATM ANAL.	MIL-S/R-6855	2.2	0.0007	335
C.W. PIPE HANGERS	MIL-S/R-6855	15	0.0063	420
ASW PIPE HANGERS	MIL-S/R-6855	21.64	0.00909	420
FO COMP WTR	MIL-S/R-6855	2.4	0.00101	420
TRIM AND DRAIN HANGERS	MIL-S/R-6855	5.8	0.0024	420

TABLE 5 (Continued)

PCB WEIGHTS FOR
SSN 607 SHEET 3 OF 3

LATEST REV AS OF:
24-Jan-90 08:41

SYSTEM	MATERIAL	MATERIAL WEIGHT	PCB WEIGHT	PPM PCB LEVEL
STRUCTURE	FND DMP	1.31	0.000118	90
INSULATION	CORK	300	0.048	160
INSULATION	FOAM	100	0.0058	57
TAPE	UKNOWN	1	0.0469	*** 46900
TOTAL			0.634333	

*** This small piece of double backed adhesive tape was holding a sign in place. It was removed and no similar tape was found.

FIGURES

Figure 1

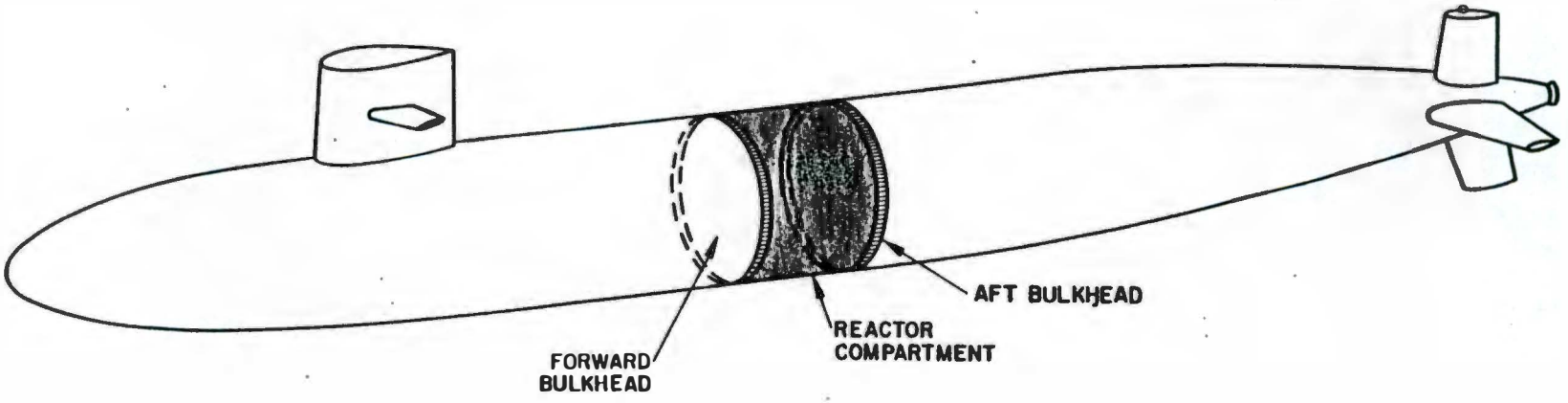
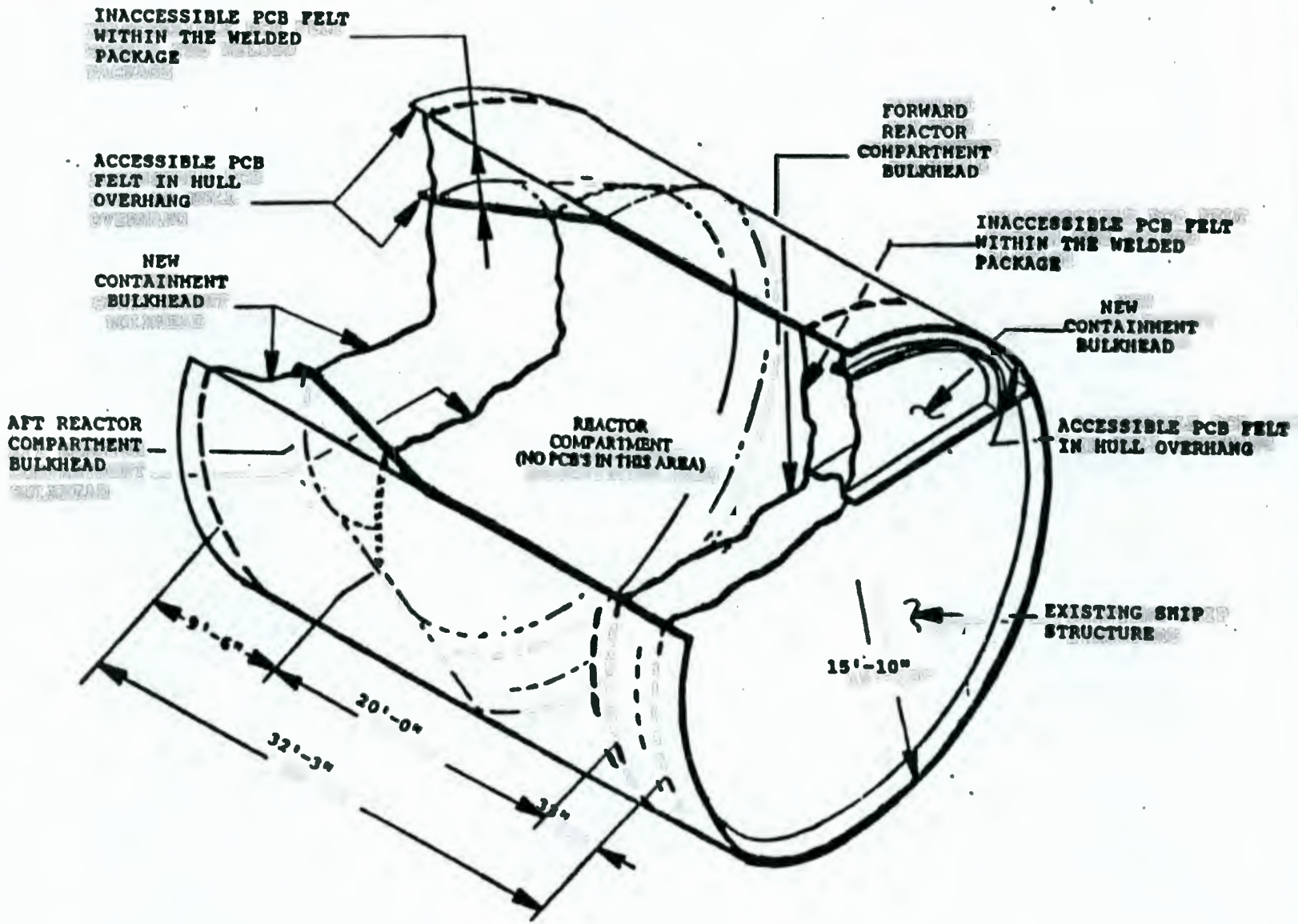


Figure 1. Typical Submarine with Reactor Compartment Identified



TYPICAL DISPOSAL PACKAGE PCB AREAS

FIGURE 2

Figure 2

OK
ERJ

Can

RC DISPOSAL PACKAGE
HAZARDOUS MATERIAL REPORT FORM

COGNIZANT CODE: 270.4 - 5215
PHONE NO.: 476-4564

NAME: J. FORNES
DATE: 9/23/89

SHIP	EX SSN 600
SYSTEM	VARIOUS
COMPONENT OF SYSTEM	BULKHEAD STUFFING TUBE
ITEM	PLUG (PC 21)
LOCATION	VARIOUS
STATUS (Intact, partially removed, etc.)	INTACT
APPLICABLE DRAWINGS	302-1716063
TYPE OF MATERIAL	SYNTHETIC RUBBER
QUANTITY (number of pieces)	AS REQ'D
SIZE (volume or dimensions)	—
WEIGHT	—
SAMPLE TAKEN? (If so, give sample number)	NO
PHOTO TAKEN? (If so, give sample number)	NO
CONTENT OF MATERIAL	SYNTHETIC RUBBER
SOURCE OF MATERIAL CONTENT INFORMATION (LAB ANALYSIS, MIL-STD, ETC)	MIL-R-15624 40-50 DUROMETER
CATEGORY OF MATERIAL: SAFE = ENVIRONMENTALLY SAFE MATL KHM = KNOWN HAZARDOUS MATL PHM = POTENTIALLY HAZARDOUS MATL	SAFE FACTORY TO 445 DATE: OCT 01 1989
RECOMMENDED CORRECTIVE ACTION	NONE
MATL PREVIOUSLY IDENTIFIED AS HAZARD?	
REMARKS	FOR PLUGGING COAX TUBE

FIGURE 3

CHEMICAL ANALYSIS REPORT
LABORATORY DIVISION
PSNS 4730/483 (12-88)

REPORT NO. E89-1432
89PS10078 004

SAMPLE IDENTIFICATION "607 EPR O-Ring N-21082-033 Lot 01

DATE Sept 14, 1989

ORDER NO. 2645990001001

	RESULTS
Cadmium	<0.01 % by weight
Copper	<0.01
Nickel	<0.01
Zinc	1.8
Lead	<0.01
Chromium (total)	<0.01
Barium	<0.01
Silver	<0.01

COMMENTS: Sample weight: 0.1678g

"ALYST SIGNATURE Catherine Honeywell

ANALYST SIGNATURE

BRANCH HEAD SIGNATURE

CODE 7343

DISTRIBUTION: S/38, c/1445, c/2300.1, c/134.3 c/200.1

FIGURE 4.

WAC 173-303-9906 TOXIC DANGEROUS WASTE MIXTURES GRAPH.

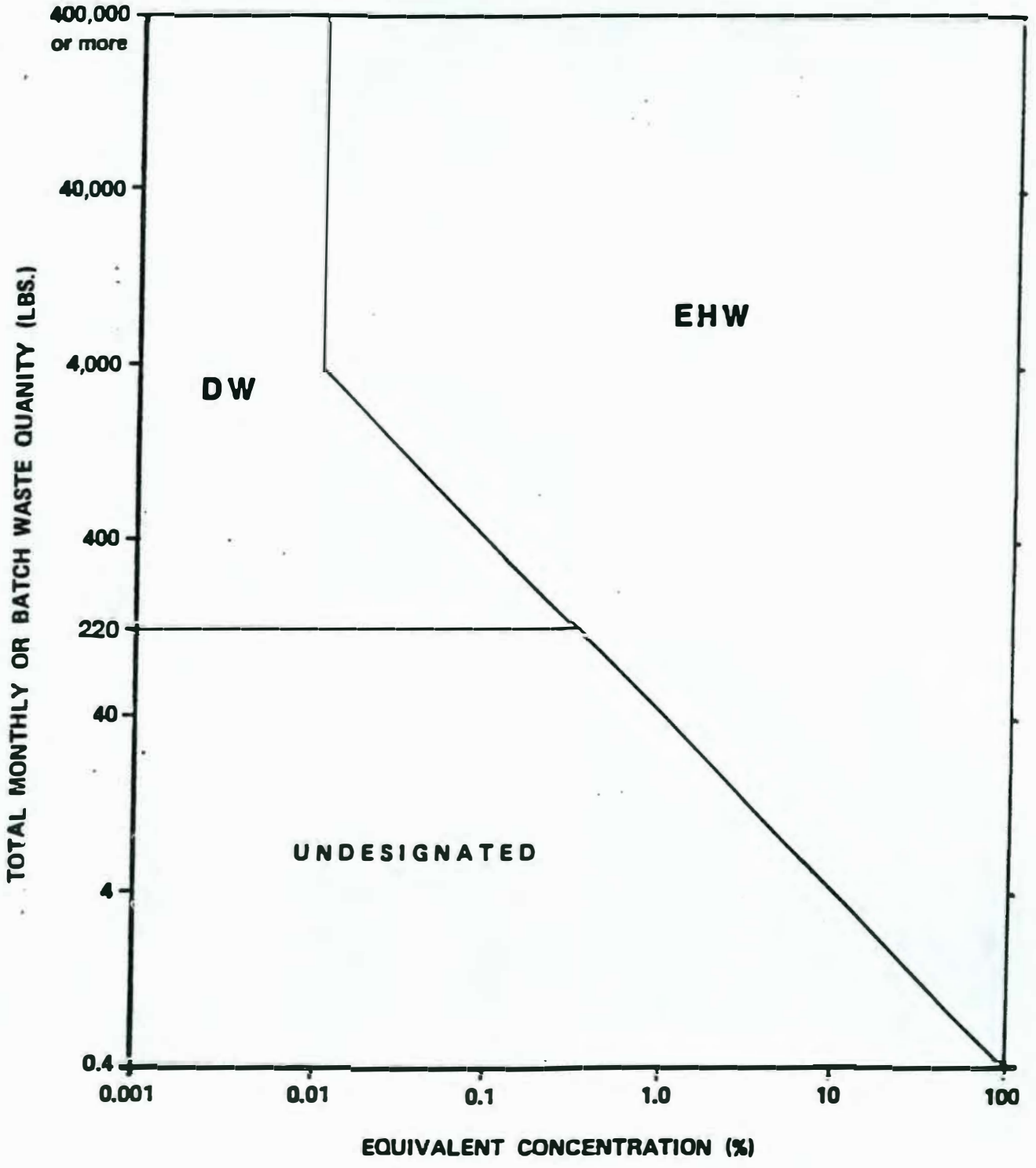


FIGURE 5.