

A Facsimile Report



Reproduced by

**UNITED STATES
DEPARTMENT OF ENERGY**

Technical Information Center

P. O. Box 62

Oak Ridge, TN 37830



17pg

WASH -- 734

DO NOT DISCARD
NO FICHE

8209150112 820818
PDR FOIA
SULLIVAB2-349 PDR

UNCLASSIFIED

WASH-734

RADIOACTIVE WASTE

I

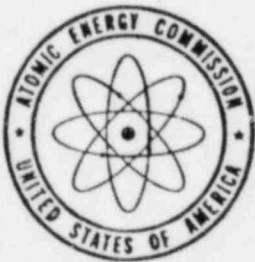
UNITED STATES ATOMIC ENERGY COMMISSION

UNITED STATES' SEA DISPOSAL OPERATIONS
A SUMMARY TO DECEMBER 1956

By
Arnold B. Joseph

August 1957
[TISE Issuance Date]

Engineering Development Branch
Division of Reactor Development
Washington, D. C.



Technical Information Service Extension, Oak Ridge, Tenn.

UNCLASSIFIED

WASH-734

UNITED STATES' SEA DISPOSAL OPERATIONS

A SUMMARY TO DECEMBER 1956

by

Arnold B. Joseph, Sanitary Engineer
Engineering Development Branch
Division of Reactor Development
U. S. Atomic Energy Commission
Washington, D. C.

SYNOPSIS

Some atomic energy activities in the United States have been disposing of radioactive wastes at selected ocean disposal sites since as early as 1946. It is the purpose of this report to describe the extent of these disposal operations including a summary of types of packaging used, and of places where the wastes are dumped. The status of related oceanographic research (1956) is briefly touched upon.

WASH-734

'UNITED STATES' SEA DISPOSAL OPERATIONS

A SUMMARY TO DECEMBER 1956

Sea disposal is a convenient method for disposing of certain types of radioactive wastes. The United States has disposed and is disposing of wastes containing limited quantities of radioactivity in both the Pacific Ocean and the Atlantic Ocean. The practice had its inception in 1946. It began as an infrequent, garbage disposal type of operation. Drums of low level, contaminated trash simply were taken out to a convenient location and put overboard. Little administrative or technical control of these operations was required or exercised. As sea disposal operations expanded, changes in packaging methods and in dumping procedure followed. At the present time these operations are deemed to be under adequate control to preclude hazards in handling or disposal.

The wastes which are dumped at sea are heterogeneous in character and as a rule contain quantities of activity normally associated with laboratory operations. They are the kind of trashy materials which evolve from laboratory experimentation and from decontamination operations. For the most part, they consist of solid materials such as paper wipes, rags, maps, ashes, animal carcasses and contaminated laboratory paraphernalia. Some liquids containing radioactivity in the concentration range of microcuries per liter have been packaged and dumped. Other liquids have been incorporated in cement mixtures or with chemical gelling materials prior to packaging and dumping. Because the wastes and their contaminating radioisotopes are heterogeneous in character, it is

difficult to determine accurately the total quantities of radioactivity involved. Since the material is of no value very little analytical work is warranted to determine these quantities. The objective is to dispose of the materials as efficiently and conveniently as possible so as to eliminate the nuisance and possible hazard associated with large waste accumulations.

Tables 1 and 2 summarize the currently available information on radioactive wastes dumped in the oceans by the United States. The information supplied on the Atlantic Ocean operations appears to be more detailed, but the only numbers which can be authenticated are the total numbers of drums dumped annually. All of the other numbers are judgmental estimates. The categorized numbers of drums are probably close to actuality whereas the estimated curie content could be off as much as a factor of 10.

Waste Packaging for Sea Disposal

The great bulk of radioactive wastes which is deposited in the sea is contained in 55 gallon drums. Several different methods of utilizing these drums for waste packaging are used, depending on the radioactivity of the waste; some of the most prevalent are illustrated in plates 1 and 2. Second hand drums, reconditioned in some cases, are used throughout. Many of the drums are without tops.

Two other types of packages have been employed; these are illustrated in plates 3 and 4. The glove box package, plate 3, is used solely in the San Francisco area. A small vault has been used as an expedient package by an east coast installation. Approximately

30 of these packages are dumped annually in the Atlantic Ocean in a designated dumping area off Norfolk, Virginia.

All packages are weighted with concrete or other materials so that the average package density is sufficiently greater than sea water to assure sinking.

United States Atlantic Ocean Waste Dumpings

The wastes were categorized as in Table 1 because these groupings lump together wastes which are more or less of a kind and also uniform in concentration and amount of radioactivity. A brief description of the measure of radioactivity in these categories of packages follows.

The category of combustible solids includes materials which are usually contaminated with mixed fission products or other beta-gamma emitters having half lives greater than one year. Dose rates up to 500 milliroentgens per hour at the surface of any package containing these wastes have been measured. The amount of radioactivity contained in the drum packages ranges from 0 to 1000 millicuries; the average is estimated to be nearer 50.

The category of other contaminated equipment includes such things as laboratory equipment and used air filters. Contamination is by beta-gamma emitters with half lives greater than one year. The amount of contamination ranges somewhat higher than the combustibles - as high as 30 curies per drum. The median figure, however, is probably closer to 200 millicuries per drum. These packaged wastes can register as high as one roentgen per hour at the package surface.

The category of irradiated materials includes reactor fuel samples and other reactor experiment materials and byproducts of isotope production.

These materials have fairly high specific activities. Containing packages, as can be seen in plate 1, have limited preformed spaces for wastes with lead and concrete shielding taking up most of the volume of the 55 gallon drums. The amount of radioactivity is usually limited to approximately 10 curies per package. Emitted radiation at the surface of a drum may be as much as one roentgen per hour.

The category of solidified liquids includes only low level liquid wastes. No other liquid wastes are disposed of at sea by the U. S. The radioactivity may be as concentrated to as much as one microcurie per milliliter and a drum package may contain as many as 100 millicuries. Some drums of solidified liquids read as high as one roentgen per hour at the surface of the drum.

Radioactive wastes from U. S. operations are deposited in three areas of the Atlantic Ocean that have been previously designated by the Navy as "explosives dumping areas." Toxic chemical wastes and defunct munitions were dumped in these areas for several years before addition of radioactive wastes. Each of these areas is a 15 mile square, theoretically. The northernmost area is centered at $41^{\circ}33'$ N Latitude, $65^{\circ}30'$ W Longitude. Very few drums of wastes are dumped there - possibly 20 - 30 gallon drum packages, or less, per year since 1951. The southernmost dump area is centered at $36^{\circ}30'$ N Latitude, $74^{\circ}18'$ W Longitude.

This dump receives low level, tracer experimentation wastes including animal carcasses. These wastes are uniquely packaged in small vaults as described in Plate 4. Some 20±10 such vaults have been dumped annually in this area since 1953. The dump area which received the wastes listed in Table 1 is centered at 38°30' N Latitude, 72°06' W Longitude.

All of these areas are located at the edge of the continental shelf where the water is about 1000 fathoms deep.

U. S. Pacific Ocean Waste Dumpings

The radioactive wastes dumped in the Pacific Ocean are to a large degree similar in character and make-up to the wastes dumped in the Atlantic. Wastes dumped in the Pacific do not include as many drums of reactor irradiated materials. However, they do include more weighted drums of low level liquids. Many of the first drums of wastes dumped had clean-up type material which evolved from operating particle accelerators. These were principally alpha emitting wastes, consequently of long half lives. It is estimated that some 30 curies of alpha activity had been dumped through 1953.

Radioactive wastes from U. S. operations are dumped in three areas of the Pacific Ocean. A few drums of wastes, mostly from radioisotope tracer experimentation at the University of Washington, were dumped in the ocean west of Seattle, Washington. They were taken out by the University's oceanographic research vessel.

Since 1953, radioactive wastes from the Southern California area, listed in part B of Table 2, have been dumped at sea. The dumping area, 60 miles from the mainland, is located over a 1000

fathom deep "pot hole" in the Santa Cruz basin at $33^{\circ}39'$ N,
 $119^{\circ}28'$ W.

The area with the longest history of receiving radioactive wastes lies South of Farallon Islands, West of San Francisco, California. Three separate locations have been designated as dumping "spots." These are shown as 1, 2, and 3 on Plate 5. Number 1 was the original site selected in 1946. Three tugloads were dumped there. Later that same year, the dumping location was changed to the spot marked 2. This was used until 1951 when spot 3 was designated. Since Jan. 1954, waste goes to area 2.

Because of such uncontrollable factors as sudden inclement weather and malfunctioning equipment some (few) packages of wastes have been deposited in alternative areas. An estimation of the possible variations is shown as the dashed polygon on Plate 1. It is believed that all dumpings have been made within the outlined area. Vessels which carry the wastes out to sea do not leave port when it is known the weather will be inclement or the seas heavy. Loran or Shoran navigation is utilized to give as great a degree of control of position as is possible.

Status of Oceanographic Research (1956)

The status of oceanographic research in the United States has been very well described by Dr. Charles E. Renn in his paper "Disposal of Radioactive Wastes at Sea" which was presented at the 1955 Atoms for Peace Congress in Geneva, Switzerland, and is published in the Proceedings of that Congress.

Little is known of the fate of radioisotopes added to the sea, especially those bound up in waste materials in packages.

Not much more is known of natural geophysical, geochemical and biochemical processes taking place in the oceans. Principal deterrents to scientific determinations of these processes lie with the difficulties of making pelagic measurements. As ways are found to make the necessary measurements, explanations of the processes will follow close behind.

The oceanographic institutes of the United States have expressed a keen interest in radiological processes not only to ascribe the fate of radioisotopes but also as a tool for oceanographic research. Continuing liaison is maintained between the U. S. atomic energy industry and oceanographers not only through individual contacts and associations but also by means of special conferences called to consider problems of ocean disposal. Most of the oceanographic institutions are engaged in making radiological measurements of one kind or another as part of their daily routine. Consideration is being given to survey type of investigations of one or more existing radioactive waste dumping areas in order to accumulate pertinent quantitative data concerning these operations. This survey would entail the taking and analyzing of bottom samples, water samples in the area and perhaps some insitu measurements of radioactivity. Much more work of this nature, and in the laboratory as well, will have to be accomplished before ocean disposal of radioactive wastes on any large scale can be considered.

Table 1

Yearly Summaries of Radioactive Wastes Dumped in the
Atlantic Ocean by the United States

NUMBERS OF 55 GALLON DRUMS

<u>CATEGORY OF WASTE</u>	<u>1951</u>	<u>1952</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>	<u>1956</u>	<u>TOTAL</u>
Combustible Solids			40	132	301	532	1005
Other contaminated solids	27	132	241	291	324	520	1535
Reactor Irradiated materials			330	466	1295	2220	4311
Solidified liquids			98	281	499	703	1581
Other packages					100 (110 gal)		100
<hr/>							
Total number of packages	27	132	709	1170	2519	3975	8532
Estimated curie content	5	15	420	680	1850	2900	5870

Table 2

Yearly Summaries of Radioactive Wastes Dumped in the
Pacific Ocean by the United States

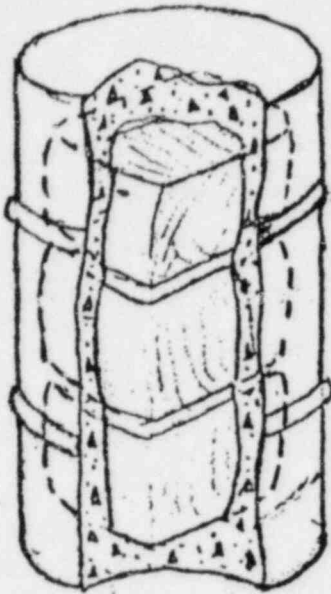
A. Off San Francisco, California

<u>ITEM</u>	<u>1946-1951</u>	<u>1952</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>	<u>1956</u>	<u>TOTAL</u>
1. Number of 55 gallon drums	3000	1132	1448	2100	2300	2600	12,580
2. Number of concrete blocks	19	12	19	36	29	35	150
3. Estimated curie content			*				10,000

*Estimated 30 curies of long lived alpha activity dumped from 1946 through 1953.

B. Off Southern California

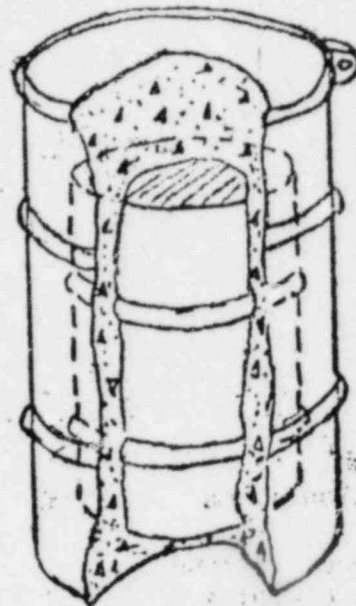
<u>ITEM</u>	<u>1953</u>	<u>1954</u>	<u>1955</u>	<u>1956</u>	<u>TOTAL</u>
1. Number of 55 gallon drums	103	85	271	370	829
2. Estimated curie content	< 1	10	30	< 1	42



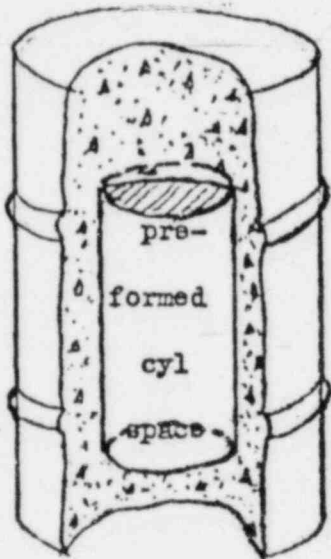
Bale of compressed combustibles



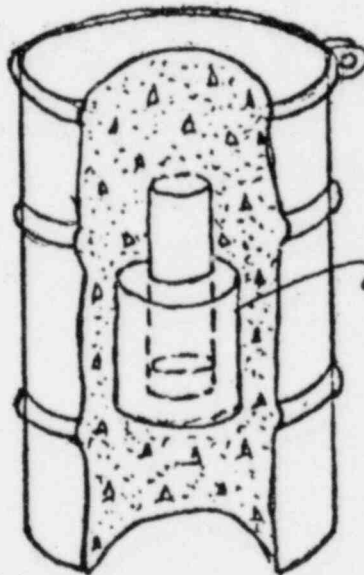
Mixture of waste materials and concrete



30 gallon drum of ashes or solidified liquids



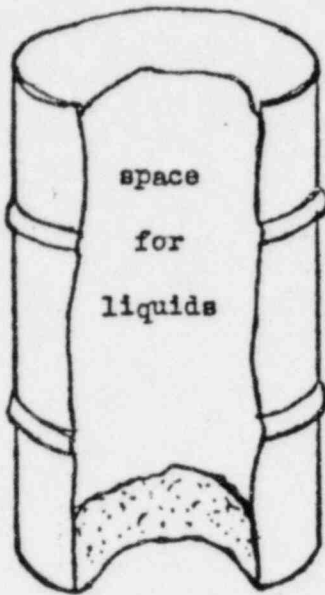
Preformed concentric cylindrical space for more radioactive wastes



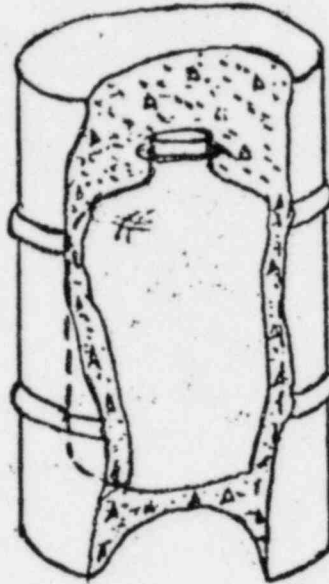
Lead shielded space for irradiated and more radioactive wastes

Plate 1 Cut Away Isometric Views Showing Modifications of 55 Gallon drums for Packaging Radioactive Wastes Which Are Dumped in

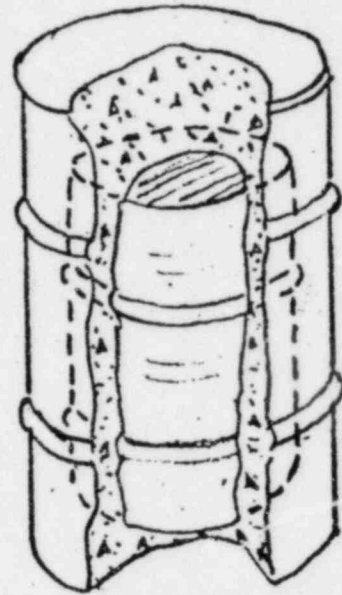
The Atlantic Ocean



Weighted drum for low level liquids



Carboy of low level liquids



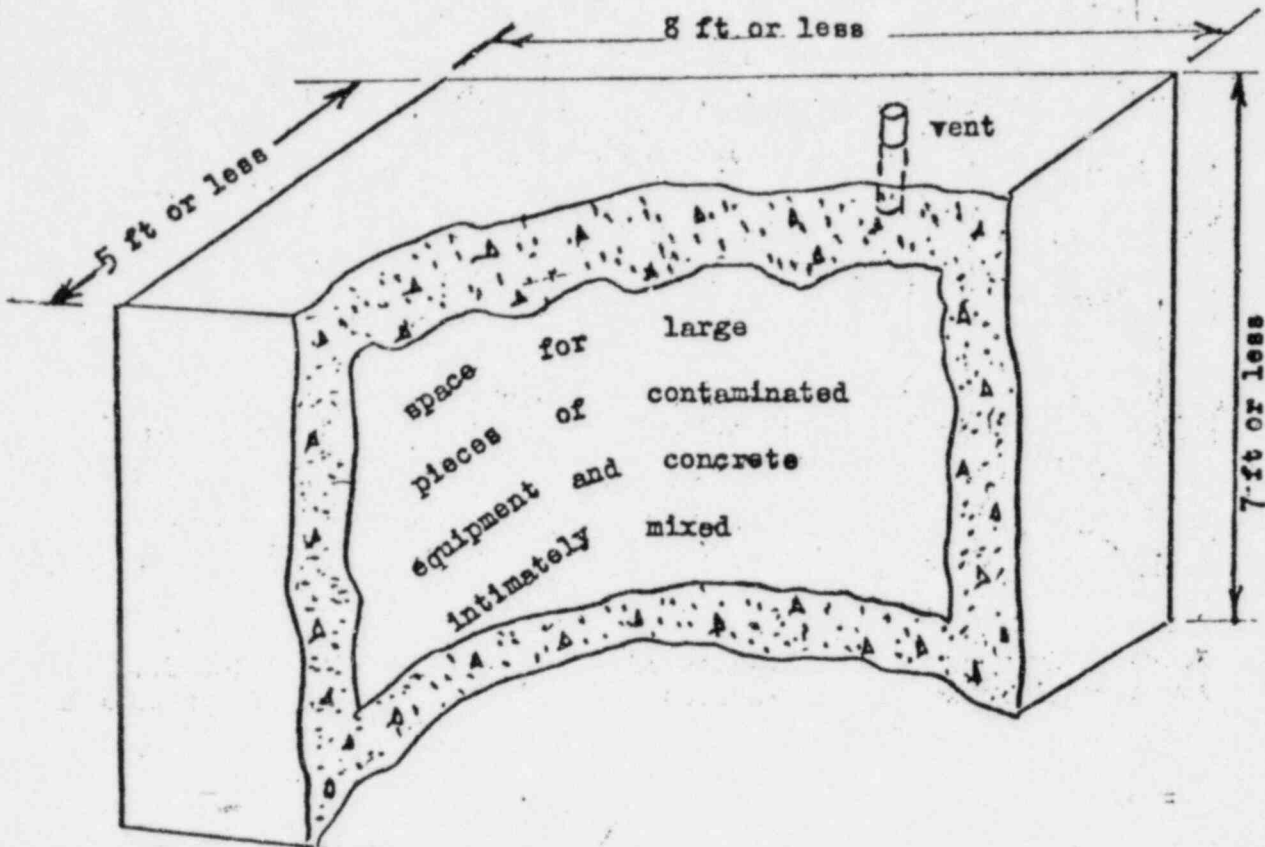
30 gallon drum of solidified liquids



Mixture of solid waste materials and concrete

Plate 2 Cut Away Isometric Views Showing Modifications of 55 Gallon Drums for Packaging Radioactive Wastes Which Are Dumped in

The Pacific Ocean

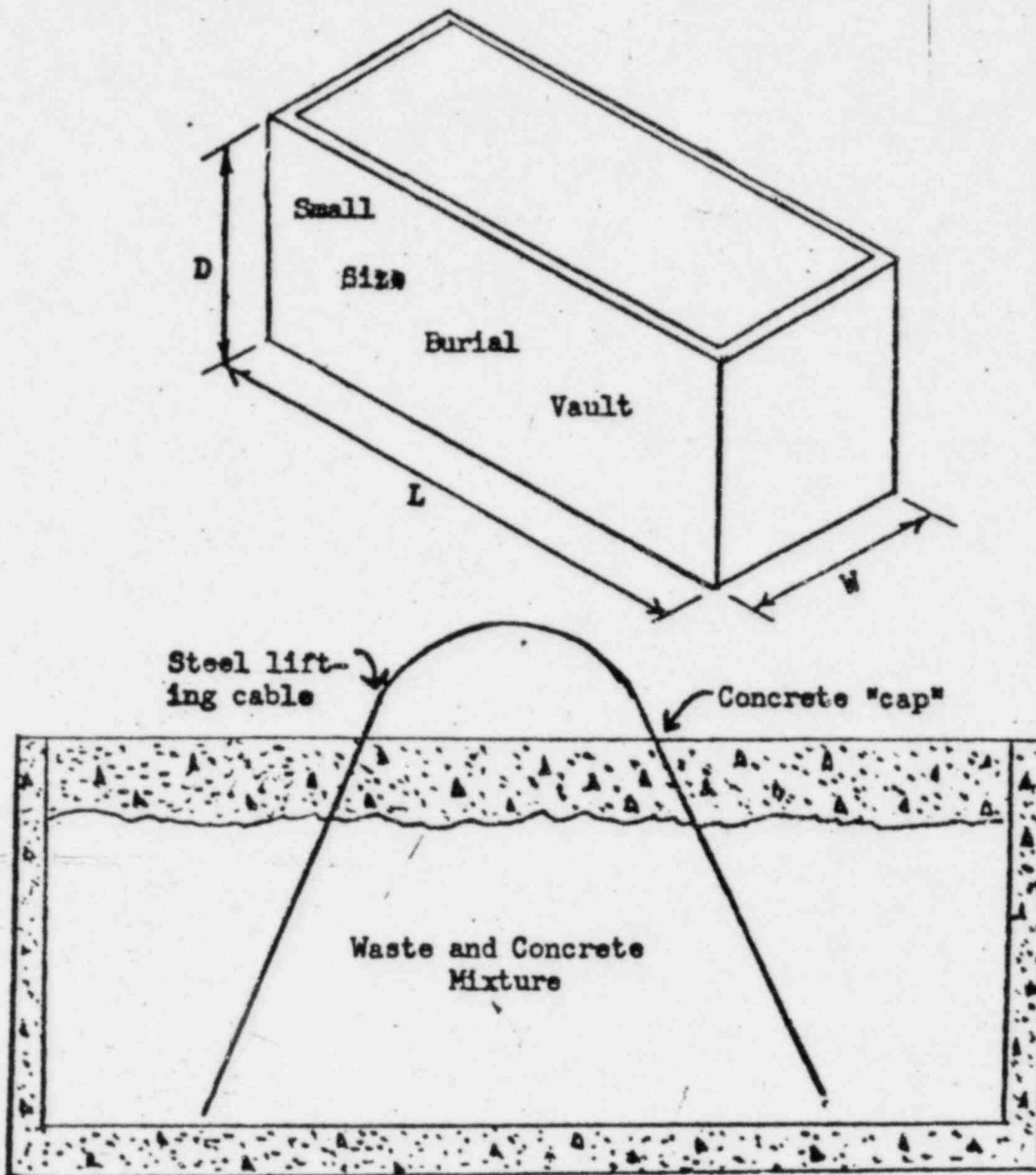


"Glove Box Package"

6 inch, mesh reinforced bottom poured first - then sidewalls outlined - waste is inserted next and then concrete poured up to top level. Mesh reinforced walls and top are a minimum of 6 inches thick.

Plate 3 Cut Away Isometric View Showing How Large Pieces of Solid Radioactive Wastes Are Packaged for Dumping in

The Pacific Ocean



Inches <u>Walls</u>	Thick <u>Bottom</u>	<u>Interior Dimensions</u>			Capacity <u>Cu. Ft.</u>
		<u>L</u>	<u>W</u>	<u>D</u>	
2"	3 ½"	40"	16"	16"	5.9

Empty weight = 600 lb
 Loaded weight = 900 to 1300 lb

Approximately 100 to 120 lb dry waste/vault (well compacted)

Plate 4 - Special Packaging Method for some low level wastes dumped in

The Atlantic Ocean

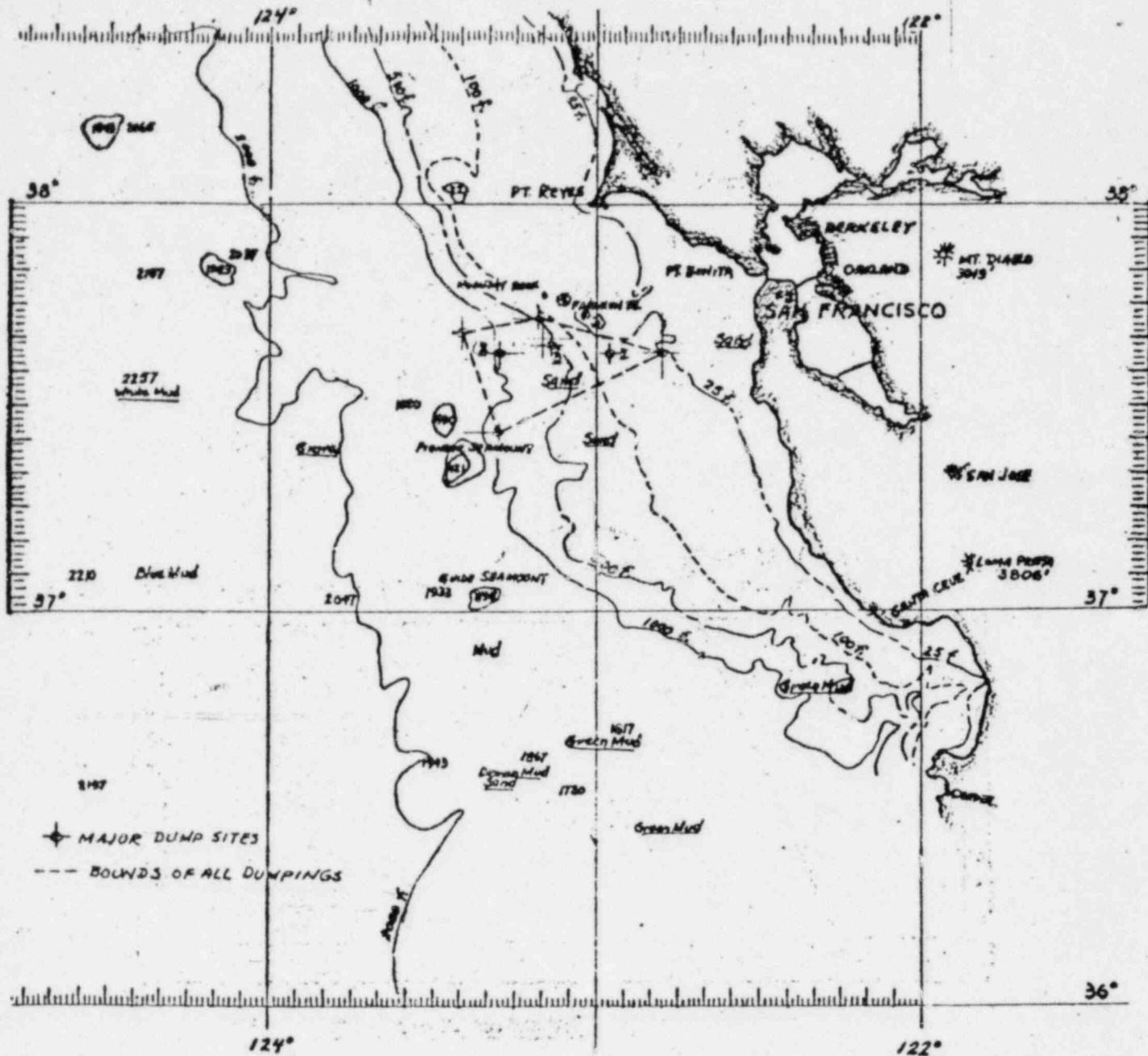


Plate 5 - OCEAN DUMPING SITES - SAN FRANCISCO AREA

Indicated depths in fathoms; contours of 25, 100, 500, 1000 & 2000 fathom depths; bottom materials encountered.