

REPORT NT-99-6  
MARCH 1999

U.S. NAVY REPORT  
OF ENVIRONMENTAL MONITORING IN  
SASEBO, YOKOSUKA AND NAKAGUSUKU WAN, JAPAN  
FOR RADIOACTIVITY ASSOCIATED WITH  
NAVAL NUCLEAR PROPULSION PLANTS  
1998



NAVAL NUCLEAR PROPULSION PROGRAM  
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INTRODUCTION

The policy of the U.S. Navy is to reduce to the minimum practicable the amounts of radioactivity released from Naval nuclear-powered ships, particularly within twelve miles from shore, including into harbors. Consistent with that policy, the total amount of gamma radioactivity released within all U.S. and foreign harbors visited by nuclear-powered ships in the U.S. Navy was less than 0.002 curie\* in 1998. This amount of radioactivity is too small to have had any measurable effect on the radioactivity of any harbor environment. However, to provide additional assurance that procedures used by the U.S. Navy to control radioactivity are adequate to protect the environment, the Navy conducts periodic radiological environmental monitoring surveys. This report summarizes the results of environmental monitoring in the harbors of Sasebo and Yokosuka and in Nakagusuku Wan on Okinawa Island.

Harbor water and sediment samples are analyzed by a laboratory of the U.S. Department of Energy for cobalt 60 and other gamma emitting radionuclides. Marine life samples have also been collected. These environmental media are analyzed since they are the ones which would most likely reveal any changes in radioactivity concentrations due to nuclear-powered ship operations. Cobalt 60 is specifically analyzed because it is a sensitive tracer used to follow environmental distribution of radioactivity and it is the predominant long-lived radionuclide associated with liquid effluents from U.S. Naval nuclear-powered ship operations. Results of this monitoring show that radioactivity in the harbor environment has not increased above natural background levels as a result of operations by U.S. Naval nuclear-powered ships.

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\* One curie equals  $3.7 \times 10^{10}$  becquerels.

## HARBOR WATER SAMPLES

Harbor water samples are taken once each quarter year in Sasebo, Yokosuka and Nakagusuku Wan in areas where nuclear-powered ships berth and from upstream and downstream locations. Samples are counted using an intrinsic germanium detector with a multichannel analyzer. Procedures for analysis are selected to detect cobalt 60 if its concentration exceeds 3.7 becquerels per liter\*, which is at least thirty times lower than the applicable limits for water set by agencies such as the U.S. Nuclear Regulatory Commission and the International Commission on Radiological Protection. No cobalt 60 was detected in any of the quarterly water samples collected. The harbor water sample locations are shown in Figures 1, 2 and 3.

## HARBOR SEDIMENT SAMPLES

Sediment samples are obtained once each quarter year in Sasebo, Yokosuka and Nakagusuku Wan from preselected locations including U.S. nuclear-powered ship berthing locations and areas away from these berthing locations. This frequency is adequate to monitor nuclear-powered ship operations since the predominant associated radionuclide, cobalt 60, has a half-life slightly in excess of five years, and will not decay to indeterminate levels between surveys. The harbor sediment sample locations are shown in Figures 1, 2, and 3. The samples are collected with a six inch square Birge-Ekman dredge (grapple type sampler) modified to collect only the top one-half to one inch of sediment. This layer was selected because it should be more mobile and more accessible to marine life than deeper layers.

The sediment samples are counted specifically for cobalt 60 and other non-naturally occurring radionuclides using an intrinsic germanium detector with a multichannel analyzer. Results of these analyses show that the most predominant gamma emitting radionuclides are naturally occurring potassium 40 and daughters of uranium and thorium. Cesium 137 was detected in some samples from Sasebo, Yokosuka and Nakagusuku Wan at levels normally associated with fallout from nuclear weapons testing. All Sasebo, Yokosuka and Nakagusuku Wan samples analyzed contained no detectable cobalt 60. Accordingly, the operation of U.S. Naval nuclear powered ships has had no significant effect on the natural background radioactivity levels in Sasebo, Yokosuka and Nakagusuku Wan. Table I summarizes the results of these analyses.

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\*One becquerel per liter equals  $2.7 \times 10^{-8}$  microcurie per milliliter.

TABLE I  
RESULTS OF HARBOR SEDIMENT SAMPLES

SASEBO HARBOR

| Quarter         | Number of Samples | Number of Samples with Detectable Co-60 | Range of Co-60 Analytical Results (Bq/kg) | Range of Other Non-Naturally Occurring Radionuclides (Bq/kg) |
|-----------------|-------------------|---|---|--|
| 1 <sup>st</sup> | 17                | 0                                       | <0.59 - <1.06                             | Cs-137: 1.90   |
| 2 <sup>nd</sup> | 17                | 0                                       | <0.44 - <0.86                             | Cs-137: 0.63 - 2.02  |
| 3 <sup>rd</sup> | 17                | 0                                       | <0.39 - <0.80                             | Cs-137: 0.71 - 1.59  |
| 4 <sup>th</sup> | 17                | 0                                       | <0.51 - <0.95                             | Cs-137: 0.97 - 2.32  |

YOKOSUKA HARBOR

| Quarter         | Number of Samples | Number of Samples with Detectable Co-60 | Range of Co-60 Analytical Results (Bq/kg) | Range of Other Non-Naturally Occurring Radionuclides (Bq/kg) |
|-----------------|-------------------|---|---|--|
| 1 <sup>st</sup> | 16                | 0                                       | <0.44 - <0.77                             | Cs-137: 0.40 - 2.45  |
| 2 <sup>nd</sup> | 16                | 0                                       | <0.46 - <0.86                             | Cs-137: 0.51 - 1.72  |
| 3 <sup>rd</sup> | 16                | 0                                       | <0.44 - <0.81                             | Cs-137: 0.78 - 1.40  |
| 4 <sup>th</sup> | 16                | 0                                       | <0.39 - <0.70                             | Cs-137: 0.41 - 0.80  |

Notes:

- (1) Results with a "<" symbol contained less than the minimum detectable activity. The minimum detectable activity may differ from sample to sample or quarter to quarter due to differences in the amount of naturally occurring radioactivity in each sample, differences in detection equipment, statistical fluctuations and variations in sample size.
- (2) Values given as "<X - <Y" reflect the range of minimum detectable activities measured for individual samples.
- (3) One becquerel per kilogram (Bq/kg) equals 0.027 picocurie per gram.

TABLE I  
RESULTS OF HARBOR SEDIMENT SAMPLES - CONTINUED

NAKAGUSUKU WAN

| Quarter         | Number of Samples | Number of Samples with Detectable Co-60 | Range of Co-60 Analytical Results (Bq/kg) | Range of Other Non-Naturally Occurring Radionuclides (Bq/kg) |
|-----------------|-------------------|---|---|--|
| 1 <sup>st</sup> | 12                | 0                                       | <0.10 - <0.64                             | None   |
| 2 <sup>nd</sup> | 12                | 0                                       | <0.36 - <0.52                             | None   |
| 3 <sup>rd</sup> | 12                | 0                                       | <0.25 - <0.63                             | None   |
| 4 <sup>th</sup> | 12                | 0                                       | <0.26 - <0.77                             | Cs-137: 0.76   |

Notes:

- (1) Results with a "<" symbol contained less than the minimum detectable activity. The minimum detectable activity may differ from sample to sample or quarter to quarter due to differences in the amount of naturally occurring radioactivity in each sample, differences in detection equipment, statistical fluctuations and variations in sample size.
- (2) Values given as "<X - <Y" reflect the range of minimum detectable activities measured for individual samples.
- (3) One becquerel per kilogram (Bq/kg) equals 0.027 picocurie per gram.

MARINE LIFE SAMPLES

An evaluation by the U. S. Environmental Protection Agency shows that the cobalt 60 from Naval nuclear propulsion plants is in the form of metallic corrosion product particles which do not appear to be concentrated in the food chain. However, samples of marine life such as mollusks, crustaceans, and marine plants were collected from the harbors in 1998. Marine life samples were also analyzed using a germanium detector with a multichannel analyzer. No cobalt 60 has been detected in these samples of marine life. The results of these analyses are shown in Table II.

TABLE II  
RESULTS OF MARINE LIFE SAMPLES

SASEBO HARBOR

| Sample Type | Co-60 Analytical Results (Bq/kg) | Other Non-Naturally Occurring Radionuclides (Bq/kg) |
|-------------|----------------------------------|---|
| Mollusk     | <0.20                            | None  |
| Crustacean  | <0.17                            | None  |
| Plant       | <0.24                            | None  |

YOKOSUKA HARBOR

| Sample Type | Co-60 Analytical Results (Bq/kg) | Other Non-Naturally Occurring Radionuclides (Bq/kg) |
|-------------|----------------------------------|---|
| Mollusk     | <0.12                            | None  |
| Crustacean  | N/A                              | N/A   |
| Plant       | N/A                              | N/A   |

NAKAGUSUKU WAN

| Sample Type | Co-60 Analytical Results (Bq/kg) | Other Non-Naturally Occurring Radionuclides (Bq/kg) |
|-------------|----------------------------------|---|
| Mollusk     | <0.22                            | None  |
| Crustacean  | <0.22                            | None  |
| Plants      | <0.29                            | None  |

Notes:

- (1) Results with a "<" symbol contained less than the minimum detectable activity. The minimum detectable activity may differ from sample to sample or quarter to quarter due to differences in the amount of naturally occurring radioactivity in each sample, differences in detection equipment, statistical fluctuations and variations in sample size.
- (2) One becquerel per kilogram (Bq/kg) equals 0.027 picocurie per gram.
- (3) N/A = Not Available. Marine plant and crustacean samples were not available in Yokosuka harbor.

## CONCLUSION

The results of this environmental monitoring show that there has been no increase in radioactivity above natural background levels in the Sasebo, Yokosuka and Nakagusuku Wan environment as a result of U.S. Navy nuclear-powered ship operations. These results confirm that procedures used by the U.S. Navy to control radioactivity are effective in protecting the environment and the health and safety of the general public.

**FIGURE 1**  
**ENVIRONMENTAL MONITORING**  
**SURVEY CHART**  
**SASEBO HARBOR, JAPAN**

The map shows Sasebo Harbor and surrounding areas. Key features include:

- Topography:** Contour lines indicating elevation. Notable peaks include Aigo San (240.4 m), Tokura San (197.4 m), and Osaki Yama (184.3 m).
- Water Bodies:** Sasebo Wan, Ebisu Wan, and various smaller bays and inlets like Iono Ura and Sake Ura.
- Islands and Shoals:** Benten Shima, O. Se, Taka Shima, Ebisu Shima, and others.
- Sample Points:**
  - Harbor Water Sample Points:** Indicated by triangles (▲).
  - Harbor Sediment Sample Points:** Indicated by circles (○).
- Infrastructure:** Roads, railways, and various buildings are shown.
- Navigation:** A compass rose indicates North, and coordinates 33° 07' N and 129° 44' E are marked.
- Scale:** A scale bar indicates a distance of one kilometer.

**LEGEND**

- ▲ HARBOR WATER SAMPLE POINT
- HARBOR SEDIMENT SAMPLE POINT

SASEBO<sup>O</sup>WAN

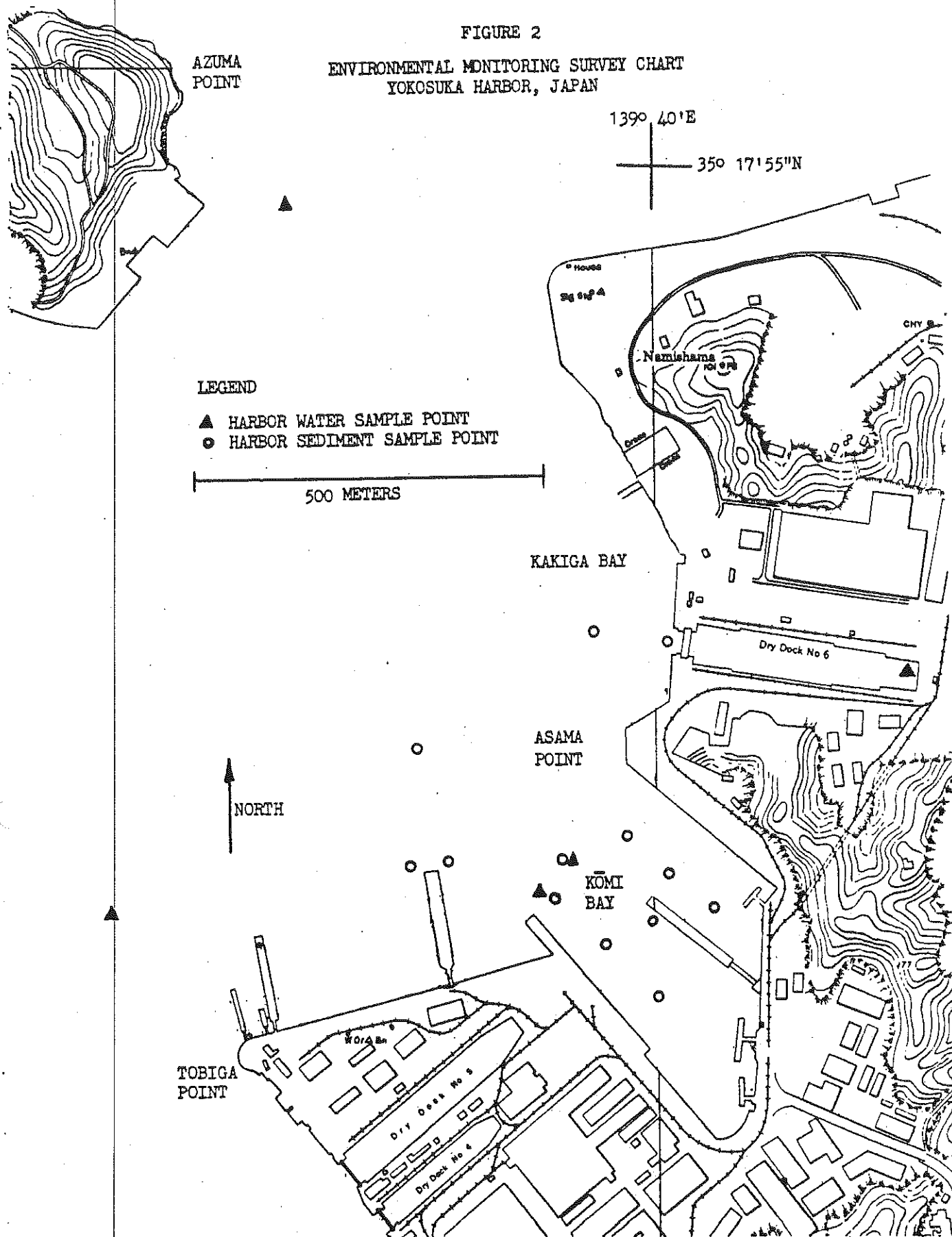
### LEGEND

- ▲ HARBOR WATER SAMPLE POINT  
○ HARBOR SEDIMENT SAMPLE POINT



FIGURE 2

ENVIRONMENTAL MONITORING SURVEY CHART  
YOKOSUKA HARBOR, JAPAN



Three additional sediment and one additional water sampling site are not shown. These are located approximately two thousand yards northeast of the harbor where ships sometimes berth off shore.

