

## Appendix B - CURRENT DIRECTIVES

Subject: Radiological Clearance and Decontamination Procedures for Crossroads Non-target Vessels.

BUSHIPS Code 180-A  
All/Crossroads/S99-(2)

NAVY DEPARTMENT  
BUREAU OF SHIPS  
and  
BUREAU OF MEDICINE AND SURGERY  
Washington 25, D.C.

Corrected for Joint  
BuShips - BuMed ltr  
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CONFIDENTIAL

From: BuShips - BuMed.  
To: Distribution List.

Subject: Radiological Clearance and Decontamination  
Procedures for Crossroads Non-target Vessels.

- References: (a) CWSF Conf. Ltr. P2-4 (WSF-07-bn) Serial 0564 of 11/18/46.  
(b) CNO Conf. Ltr. Op-602/cn 021 P602(SC) S67-1 of 27 August 1946.  
(c) CJTF-1 Conf. Ltr. ser 079 of 9 Sept. 1946.  
(d) BuShips-BuMed Conf. Spdltr ser 1381 of 24 Sept. 1946.  
(e) BuShips Conf. Spdltr ser 1383 of 26 Sept. 1946.  
(f) BuShips-BuMed Conf. disp 141550Z of October.  
(g) BuShips-BuMed Conf. Spdltr All/Crossroads/S99-2 of 6 Nov. 1946.

- Enclosures: (A) General Radiological Safety Precautions.  
(B) Approved Decontamination Methods.

1. The operating portion of Joint Task Force One included a large number of non-target vessels. Many of these vessels entered Bikini Lagoon subsequent to Test Baker, and at a time when radioactive materials were suspended in the waters in low concentrations. Some of this material contaminated most portions of the vessels exposed to the water of the lagoon. Thus evaporators, condensers, salt water cooling systems with their heat exchangers, fire and flushing systems, underwater bodies of hulls, and fittings and equipage in contact with the sea water were contaminated in varying degrees when used in the lagoon after Test Baker. The radioactive material was found to be concentrated principally in marine growth, rust and salt scale deposits on the affected surfaces. The quantities of radioactive materials present were, in general, found to be in proportion to the quantities of fouling, scale, and rust present on the exposed surfaces and to the length of time during which they were in contact with the contaminated water.

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2. All of the ships involved (target vessels not included) have low radiation intensities and small amounts of contaminating materials. They present no danger from external radiation. Any danger to personnel which may exist involves the introduction of contaminating toxic materials into the body. This can occur in any one of three ways, namely: (a) by the inhalation of contaminated dust or inhalation of fumes or vapors from heating contaminated materials; (b) by way of the mouth from contaminated hands or through ingestion of water or food which is contaminated; or (c) by absorption of contaminated material through cuts or wounds. Considering the relatively small quantities of toxic material present in any one ship and the great amount of gross material with which it is mixed (marine growth, scale, rust) and the quantities of this gross material necessary to gain access to the body in order to produce physical injury due to radioactive effects, it is NOT LIKELY that personnel engaged in routine operations or maintenance of these vessels will suffer injury. It is CERTAIN they will not suffer injury if the precautions directed are followed, and the established clearance procedures complied with. The Bureau of Medicine and Surgery has established certain tolerance limits on the basis of recommendations made by an advisory board of experts in this field of toxicology. These are in conformity with nationally accepted standards for safety in regard to external radiation and to radioactive hazards within the body. For reasons of absolute safety and to insure that no form of radiological hazard may arise subsequently regardless of the ultimate disposal of the ships, clearances will be granted only in accordance with these standards.

3. Reference (a) established a radiological monitoring and clearance organization to determine the extent of radioactive contamination existing on any Crossroads vessel in the West Coast or Pearl Harbor area. The monitoring results disclose what portions of the vessel require decontamination to reduce the radioactive materials to a level at which they could never give rise to a question of hazard. Reference (b) assigns the Bureau of Medicine and Surgery cognizance and responsibility for the establishment of radiological safety tolerances and regulations. Reference (c) also charges the Bureau of Ships with responsibility for developing methods and equipment for radiological decontamination of ships.

4. Enclosure (A) is a compilation of all general radiological safety precautions to be observed in handling contaminated materials and in carrying out decontamination procedures. Enclosure (B) contains all currently approved decontamination measures to be used in obtaining Operational Clearance, and Final Radiological Clearance, and supersedes references (c) to (g) inclusive. Include as much of this as possible in "at sea" work.

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5. Clearances are defined as follows:

(1) Operational Clearance indicates that all normal operations, repairs and maintenance can be carried out without radiological hazard provided the precautions set forth in Enclosure (A) for handling contaminated materials are observed. This is the clearance required for the normal operation of active ships.

(2) Final Clearance indicates that no radiological hazard of any type, no matter how remote, exists on the ship and that further monitoring is not required. It will apply in like manner to operating ships and to ships destined for inactivation or disposal. Before final clearance can be granted the monitors' reports and recommendations for such clearance must be forwarded to Chief of the Bureau of Medicine and Surgery and the Chief of the Bureau of Ships, one complete set of reports to each Bureau. Inasmuch as this is the clearance required of all ships prior to inactivation or disposal, it is desirable that all ships satisfy the requirements for final clearance as early as practicable.

6. Clearances are granted as follows:

(1) Operational Clearance is granted by the Commander, Western Sea Frontier on recommendation of CWSF Ship Clearance Board in accordance with safety tolerances and practices established by BuMed and in accordance with the procedures for clearance, monitoring and reporting established jointly by BuShips - BuMed.

(2) Final Clearance is granted by BuShips with the advice and concurrence of BuMed after review of the complete and final monitoring report for the individual ship.

7. The criteria for clearance are:

(1) The existence of any areas of radioactivity with readings in excess of 0.1r gamma or 0.5r gamma beta combined is considered as above safety tolerance for external radiation and will be immediately decontaminated or disposed of, and there will be taken such other precautions as are required to insure safety of personnel. Serious radioactive hazard, not involving external radiation, will exist in enclosed salt water systems which give a reading of 0.1r gamma through the metal of the system. All areas of contamination within closed salt water systems with

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readings between 0.1 and 0.01 gamma on external reading will be decontaminated immediately.

(2) Operational Clearance MAY be granted for urgent reasons when readings are:

- (a) Maximum, shielded, between 0.1 and 0.001r gamma
- (b) Maximum, unshielded, between 0.5 and 0.005r beta gamma combined except underwater bodies with surface readings having statistical averages between 0.5 and 0.02 beta gamma combined.

Operational Clearance will be granted when readings are:

- (a) Maximum, shielded, between 0.01 and 0.001r gamma
- (b) Maximum, unshielded, between 0.5 and 0.005r beta gamma combined except hulls of ships external surface readings having statistical averages between 0.05 and 0.02 beta gamma combined.

(3) Final Clearance will be granted when readings are:

- (a) Maximum, shielded, not above 0.001r gamma
- (b) Maximum, unshielded, not above 0.005 gamma beta combined

Exception (a)

"Underwater body, at least twenty readings as equally spaced as practicable, ten on each side, statistically averaged do not exceed 0.02r beta gamma combined with no single localized area in excess of 0.1r beta gamma combined. For clearance purposes, the underwater body will be considered to include all salt water injections and overboards to the first sea valve. The same criteria as specified for clearance of underwater bodies will apply to anchors, anchor chain, chain lockers, and underwater bodies of small boats."

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Exception (b)

"Salt water systems when ninety-four (94) per cent of the total areas exposed to sea water in the systems have external readings not above 0.001r gamma, five (5) per cent not above 0.005r gamma, and one (1) per cent not above 0.01r gamma."

8. Responsible individuals expedite final clearances by seeing that necessary cleaning is done to bring contaminated areas within the final clearance levels prior to submitting reports with requests for final clearance.

9. Drydocking for radiological purposes will not be required when the following conditions exist: Exterior underwater surfaces (including sea water intakes and overboard discharges from the opening in the hull to the first valve) have averaged statistical readings less than 0.02r combined beta and gamma with no localized area above 0.1r beta gamma. Docking will be referred to the Bureau of Ships for decisions.

10. All radiation intensity readings will be corrected to 1 October 1946 for purposes of assessing radiological hazards and granting clearance. No differentiation will be made between wet and dry conditions of surfaces in applying in the standards set forth above. All readings are in roentgens per 24 hours (r/day).

/s/ ROSS T. MC INTIRE,  
ROSS T. MC INTIRE,  
Vice-Admiral, USN  
Chief of Bureau of  
Medicine and Surgery

/s/ EARLE W. MILLS,  
EARLE W. MILLS  
Vice-Admiral, USN  
Chief of Bureau of Ships

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ENCLOSURE (A): General Radiological Safety Precautions, Crossroads Vessels.

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RESTRICTED

ENCLOSURE (A)

GENERAL RADIOLOGICAL SAFETY PRECAUTIONS  
CROSSROADS VESSELS

1. All non-target vessels which entered Bikini Lagoon after the Atomic-bomb tests are more or less contaminated by radioactive materials which were picked up from the water in the lagoon. The parts of the ships which were in contact with sea water are the principal areas which are affected, namely:

- (a) The underwater body of the ship and appendages.
- (b) The interior of the fire and flushing systems.
- (c) The salt water sides of condensers, heat exchangers, salt water pumps and associated salt water piping used while in the lagoon.
- (d) The interior of the evaporators and associated salt water piping.
- (e) The exterior hull and salt water cooling systems of small boats.
- (f) Anchors, anchor chain and chain locker.
- (g) Lines, fenders and similar equipage used at Bikini, also stowages for these items and for small boats.

The majority of the above areas no longer have sufficient hazard from external radiation to be of concern. The potential danger involved at the present time is that of an individual being poisoned by the radioactive materials which are present. The only way the latter action can be dangerous is by an individual eating, breathing, or getting into an open cut or a skin abrasion a sufficient quantity of this radioactive material.

2. The safety precautions which are enumerated herein are designed to prevent any possibility of hazard due to radioactive toxicity.

- (a) At the earliest possible date obtain a complete monitoring in order to know specifically the location and relative quantity of radioactive materials present. Until a suspect unit has been pronounced clear by a monitor it should be regarded as contaminated.
- (b) As soon as practicable thereafter proceed with the authorized decontamination measures for the fouled locations. When these are completed request remonitoring to ascertain if they have been completely effective.

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## ENCLOSURE (A): General Radiological Safety Precautions Crossroads Vessels. (Continued)

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- (c) If it is necessary to open up a contaminated system the following precautions should be observed:
- (1) Keep wet until found clear of contamination all surfaces which have been exposed to salt water. This will effectively prevent extensive amounts of dust forming.
  - (2) If it is necessary to perform any work on a contaminated unit, clean the part thoroughly before working on it. Remove all rust scale, marine growth, and sediment while wet.
  - (3) Skin contact with radioactive materials shall be avoided. For this reason, gloves should be worn when working on a contaminated part or in handling materials which have been removed from contaminated surfaces. When working on a large contaminated surface with which the body comes in contact, such as manual cleaning of the inside of a main condenser or when removing contamination from the underwater body of the ship, long sleeved working clothing, gloves and caps should be worn. Under these circumstances the clothing worn during the work should be laundered daily or on completion of the job. When sandblasting of the underwater body in drydock is required for decontamination, the clothing ordinarily worn in this operation is satisfactory, but should be laundered on completion of the work. During drydock work on contaminated ships, rubber boots should be worn and thoroughly hosed off after completing the work.
  - (4) Observe scrupulous cleanliness in the removal of radioactive materials. Every effort should be made to prevent spreading such materials. They must be kept wet and placed in a closed container for disposal by sinking at sea at the first available opportunity.
  - (5) Tools and equipage used in removal of contaminated materials should be thoroughly cleaned upon completion of work. Rags, fibre brushes, brooms, etc., should be washed upon completion of use or disposed of with the contaminated materials.
  - (6) Where welding, brazing, or flame cutting of contaminated piping or surfaces is accomplished adequate exhaust ventilation must be assured.
  - (7) "All solutions used in decontamination have the ordinary industrial hazards. Used solutions may be dumped at sea,

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ENCLOSURE (A): General Radiological Safety Precautions, Crossroads Vessels. (Continued)

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preferably through contaminated outlets or overboard discharges, or in harbors for ships in port or in drydock. When used solutions are discharged into harbors, the process should be carried out at a slow rate and a flow of water provided to dilute the decontaminating solution about four to one. The solution should also be discharged well clear of docks and shoreline, and at the commencement of an ebb tide if possible."

- (8) "When decontamination of the underwater body of the ship is required all rust and marine growth removed in dock shall be handled in accordance with instructions in subparagraph (4) above. If wet sandblasting is required for decontamination or is accomplished, no special handling or disposal of sand for radiological purposes is required. In cases where a ship requires underwater body decontamination in drydock and sandblasting is accomplished without preliminary scraping of the fouling and marine growth, the mixture of sand and marine growth removed must be gathered up and disposed of in accordance with instructions in subparagraph (2) above."
- (9) Contaminated piping, valves, and other units which are removed for replacement before decontamination shall be segregated and disposed of at sea.
- (10) Loose contaminated materials which are awaiting disposal should be segregated and labeled to prevent unwitting use or meddling. Open sources of radioactive debris should not be left untended. If necessary to leave a contaminated unit open for a period of time it should be covered temporarily when no work is in progress.

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ENCLOSURE (B): Radiological Decontamination Procedures.

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RESTRICTED

ENCLOSURE (B)

## RADIOLOGICAL DECONTAMINATION PROCEDURES

1. When exterior radiation readings above approved tolerance levels are obtained on radiologically suspect parts on a non-target cross-roads vessels, all ships should carry out the decontamination procedures specified herein for the part affected. This work should be accomplished at the earliest practicable date without interfering with the operating schedule. Attention is directed to the safety precautions outlined in Enclosure (A); all applicable portions must be observed while conducting the decontamination procedure. The principal decontamination agent used is a muritic acid base with other materials added as noted in the procedure for each unit. Several general industrial safety precautions which must be used in handling the acid are noted:

- (a) Mix the acid in open air if possible.
- (b) Pour the acid into the water slowly, never the water into the acid.
- (c) Personnel engaged in handling and mixing acid should wear rubber gloves, splash proof goggles, and acid fume respirators. Bicarbonate of soda solution should be available as a neutralizer in event of spilling or splashing acid on personnel. Soda ash or boiler compound should be available for neutralizing that spilled on the ship.
- (d) When large units such as evaporators and condensers are treated some quantities of hydrogen gas may be given off. If practicable they should be vented to the outside atmosphere. In any event no open lights or sparking devices should be permitted in the immediate vicinity of the operation or vent.
- (e) DO NOT heat the acid solution.
- (f) All connections, many of which may be temporary, made for the purpose of circulating the acid solution shall be tested with plain water before actual operation.
- (g) While the acid solution is circulating a continuous watch shall be maintained on all parts of the system for the purpose of promptly detecting any leaks which may develop and applying remedial measures.
- (h) All valves which are closed to prevent entry of acid solutions into a part of the system in which it is not desired to circulate the acid should be tagged and wired or tied shut.

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ENCLOSURE (B): Radiological Decontamination Procedures. (Continued)  
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2. The procedures given below are the approved radiological decontamination methods for each unit and system which has been found to contain radioactive materials:

A. EVAPORATORS. (Except Badger types having AA or AAA type heat exchangers).

- (1) Evaporators should be given one or more thermal shock treatments to break loose as much scale as possible.
- (2) All loose scale and any zincs in heat exchangers should be removed and prepared for disposition.
- (3) The distilling plant is to be set up to provide for acid circulation through the entire salt water system, i.e. shells, salt water and brine piping, pumps, and heat exchangers. This involves:
  - (a) Positive prevention of the acid solutions getting into the fresh water side of the system shall be accomplished by removal of necessary lines and blanking off the ends.
  - (b) An acid mixing tank should be provided; an ordinary steel tank will suffice. It is desirable that the tank be large enough to mix a sufficient quantity of solution to fill the system, although several mixes may be used to fill the system.
  - (c) A filling line shall be run from the acid tank to the suction side of the pump selected to circulate the acid through the system. A line or lines should be run from the brine discharge or other appropriate drain lines back to the acid mixing tank. Rubber lined firehose may be used for the temporary lines.
- (4) The acid solution should be mixed by adding two parts 18° Baume commercial muriatic acid to 15 parts fresh water. Where salt water or brine lines are steel or galvanized wrought iron pipes an inhibitor (Rodene-Navy Spec. 51-I-2a) shall be added in the proportion one part inhibitor to 100 parts of the commercial acid added.
- (5) Fill the system completely. The shells must be vented as near the top as possible in order to accomplish complete filling of the shell. When the acid solution enters the shells considerable foaming will occur and may come out the vents, buckets should be placed to catch all overflow.
- (6) The acid shall then be continuously recirculated until all scale in the shell and tube nets is dissolved. This may be detected visually. The normality of the acid should be