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BUREAU OF SHIPS
and
BUREAU OF MEDICINE AND SURGERY
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CONFIDENTIAL

22 November 1946

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/cm 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.

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 (b) 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.

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 readings between 0.1 and 0.01 gamma on external reading will be contaminated 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, readings statistically averaged not above 0.02r beta gamma combined and with no single localized area in excess of 0.1r beta gamma combined.

Exception (b) salt water systems having external readings ninety-four (94) per cent of which are 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 the standards set forth above. All readings are in roentgens per 24 hours (r/day).

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RESTRICTED

DECLASSIFIED 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.
(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.

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ENCLOSURE A

GENERAL RADIOLOGICAL SAFETY PRECAUTIONS
CROSSROADS VESSELS

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(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 work 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.

deep water

(7) All solutions used in decontamination have the ordinary industrial hazards and, in addition, when they have been circulated in a suspect system are a radioactive hazard. Used solutions should be disposed of at least 10 miles at sea or beyond the 100 fathom curve.

(8) Where decontamination of the underwater body of the ship is required all rust and marine growth removed in drydock shall be handled in accordance with instructions in subparagraph (4) above. If wet sandblasting is required for decontamination, the sand should be gathered up and prepared for sinking at sea.

ENCLOSURE A

GENERAL RADIOLOGICAL SAFETY PRECAUTIONS
CROSSROADS VESSELS

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(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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RADIOLOGICAL DECONTAMINATION PROCEDURES.

1. When exterior radiation readings above approved tolerance levels are obtained on radiologically suspect parts of a non-target crossroads 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 muriatic 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 solution into a part of the system in which it is not desired to circulate the acid should be tagged and wired or tied shut.

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, and 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 inhibiter (Rodene-Navy Spec. 51-I-2a) shall be added in the proportion one part inhibiter 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 nests is dissolved. This may be detected visually. The normality of the acid should be checked during the operation and not allowed to fall below one normal. Where scale is unusually heavy it may be necessary to add additional acid to complete the process. The circulation should in any case be for at least two (2) hours, but not over four (4).
(7) Upon completion of circulation drain the system completely to remove all acid. Drain all pockets, particularly the lines which were blanked off (drains from baffle pan and vapor line). Flush the system thoroughly by circulating fresh water and pumping overboard. Flush baffles particularly, and remainder of inside of shell thoroughly by firehose through the sight ports and redrain. The acid removed should be handled as a contaminated material.
(8) The system shall then be flushed out with a boiler compound solution to neutralize any residual acidity.
(9) The plant may then be reassembled, replacing any zincs which were removed, and placed in operation. If a monitor is available it is desirable to check the sufficiency of the treatment before proceeding to break down the acid circulating system and reassemble the plant. All distilled fresh water manufactured in the first twenty-four (24) hours after placing the plant back in operation shall be dumped overboard.
(10) Upon remonitoring it may be found that certain parts of the system still have readings above tolerance. Where these parts are extensive a complete reapplication of the procedure may be necessary. Generally if all scale is removed from the shell and tube nest it will be found easier and more effective to disassemble the unit above tolerance and clean either manually or by separate acid washing. All parts which occasionally have been found to require separate treatment are cited:

(a) At least one set of baffles at the top of first effect shell.
(b) Distiller condenser heads.
(c) Brine overboard discharge line at elbows and valves.
(d) Some parts of brine overboard pump where acid circulation was incomplete or ineffective.
(e) Strainers on the suction side of the salt water pump.

A-1. Badger type evaporators having double A or Triple A heat exchangers shall be boiled out for 96 hours at a temperature of 200° Fahrenheit using one pound of boiler compound to ten gallons of water. Associated salt water piping should be cleaned as specified for the fire and flushing systems.

B. SALT WATER SYSTEMS

The following steps shall be used in cleaning those portions of the salt water systems which monitoring reveals to be so contaminated as to exceed established tolerance levels. The salt water systems involved include fire and flushing systems, salt water sides of cooling systems with associated heat exchangers except condensers, pumps and drainage piping associated with these systems. Parts of systems showing acceptable monitor readings should be excluded from the cleaning process if they can be included.

(1) Place a large mixing tank on deck in a suitable location to run a hose or piping to the suction side of a pump covering the system to be treated. Arrange the suction of the pump, if possible, to allow taking suction on the mixing tank, salt water or on air alternately. Provide recirculating connections by hose from parts of the system most remote from the pump and lead back to discharge into the mixing tank.

(2) Fill special mixing tank with solution of one gallon 18° Baume commercial muriatic acid to ten gallons fresh water and two ounces inhibiter (Rodene-Navy Spec. 51-I-2a) if available.

(3) Drain systems to be cleaned as completely as possible using drain connections on pumps and as available at low points of systems. Open outlets or vents in systems to permit air to enter for effecting complete drainage. Water thus drained may be pumped overboard in the harbor or at sea.

(4) Fill system with acid solution from mixing tank introducing through pumps selected. The systems should be filled completely with the solution which will probably involve the preparation of several mixes. Outlets on the system are to be opened until it is determined by flow that the decontamination solution has reached that part of the system. As each line is filled, the associated outlet is closed until all parts are filled and all outlets closed.

(5) After the system has been filled completely, recirculate the acid solution using the pump and the recirculating lines provided back to the mixing tank. This process should be continued for about four (4) hours During this period the normality of the acid should be checked by sampling and acid added as needed to maintain at least 1/2 normal strength.

(6) Upon completion of decontamination circulation, if the ship is in dock, drain acid solution from system as completely as possible using drains provided and collect solution in suitable containers for disposal as prescribed for contaminated materials. If the vessel is at sea, discharge the solution overboard upon completion of circulation using drains found to be contaminated. For vessels in harbors or

alongside piers, the acid solution shall be drained into containers provided. Drain lines outboard of sea valves are considered as parts of the hull and shall be treated with the underwater body as required at first drydocking.

(7) After draining acid solution, flush the entire system thoroughly with salt water for at least one hour using all available outlets for discharge. For ships not at sea this water may be pumped into harbors.

(8) After the salt water flushing, prepare a neutralizing solution in the special mixing tank using 50 pounds of boiler compound to 1,000 gallons of water. Drain the system and fill the neutralizing solution using the same process as for the decontaminating solution. Recirculate the neutralizing solution for at least thirty minutes.

(9) As a final step in the process, shift the pump back to sea suction and flush the entire system thoroughly with salt water using each outlet for thirty minutes.

(10) Remonitoring after decontamination may reveal that the system has not been entirely reduced to tolerance limits. In such cases, the troublesome areas generally will be found in pockets in the system such as large valves, at reducer stations or in stagnant sections of lines. When such cases occur, the parts remaining above tolerance should be removed if practicable and any remaining collection of scale, silt or fouling removed manually. The part should then be given an acid dip in a one normal solution of muriatic acid and fresh water for about ten minutes to remove any residue and then thoroughly neutralized and rinsed. When large parts of systems or a whole system remain above tolerance after applying the above methods, the system shall be given a second acid treatment as set forth above. If the system then fails to respond, the Bureau of Ships shall be advised of the conditions and necessary instructions requested.

C. CONDENSERS EXCEPT MAIN CONDENSERS.

Salt water sides of all condensers except main condensers which show readings above accpptable limits shall be treated as follows:

(1) Completely drain condenser and remove zincs. Place zincs aside for disposal as required for contaminated materials removed.

(2) Set up mixing tank in convenient location on deck equipped with hose to lead to condenser for filling with solution by gravity.

(3) Fill mixing tank with solution of one gallon 18° Baume commercial muriatic acid to twenty gallons of fresh water, and two ounces of inhibitor (Rodene-Navy Spec. 51-1-2a).

(4) Fill condenser and associated piping with solution preparing additional mixes as necessary to fill completely. Insure complete filling by leaving vents open to release air and to check when full by flow from vents. Place containers at vents to collect solution which will escape from boiling action of acid.

(5) Circulate solution through condenser if possible for one hour, otherwise allow to stand in condenser for one hour. If in harbor drain off solution and dispose of as required for contaminated materials removed. If at sea, discharge solution overboard through regular overboard lines.

(6) Flush entire system completely for one hour using salt water and discharging overboard.

(7) Using mixing tank provided, fill condenser with neutralizing solution of fifty pounds boiler compound to 1,000 gallons of water. Circulate if possible or allow this solution to stand in condenser for at least thirty minutes. Then reflush thoroughly using salt water and discharge overboard.

(8) Remonitor condenser. If readings are still above tolerance levels, remove all necessary inspection plates and determine location of remaining contamination. If heads are contaminated, remove scale and fouling from surfaces manually and brush with one normal acid mixture until readings have reached tolerance levels. If tubes show contamination remaining, punch tubes using rod and wet rag to remove material adhering to surface. Follow this by lancing thoroughly with water. Collect and dispose of all removed material as required by Radiological Safety Precautions (Enclosure (A).

(9) Make complete inspection of condenser to locate and repair any damage which may have been caused in the process with special attention to tube ends which are packed. Put air test on condenser and remedy any leaks.

D. MAIN CONDENSERS

1. Main condensers which show monitor readings above final clearance limits should be treated in accordance with the following procedure:

(1) Drain condenser and remove zincs. Set zincs aside for disposal in accordance with procedures set forth for disposing of contaminated materials by Radiological Safety Precautions.

(2) Remove all scale, rust and marine growth from inside of condenser heads by scrapers and wire brushes keeping the surface wet at all times. If radioactive materials are still present in measurable quantities, scrub condenser heads and salt water sides of tube sheets with ordinary scrub brush and a solution of one gallon of 12° Baume commercial muriatic acid to ten gallons of fresh water and two ounces of inhibitor (Rodene-Navy Spec. 51-I-2a) if available. Flush off surfaces thoroughly with salt water to remove acid.

(3) If tubes show readings above final clearance limits, punch tubes with a rod and wet rag to remove material adhering to surface and wash out with a water lance.

(4) Collect and dispose of all loose material removed in accordance with instructions for handling contaminated materials in Radiological Safety Instructions.

(5) On completion of above work flush condenser thoroughly with salt water discharging overboard for at least one hour.

(6) Remonitor, and if readings are still above limits, repeat the process.

E. UNDERWATER BODY

1. The necessity for drydocking ships for decontamination purposes generally will be determined by listing and trimming the suspect vessels as much as practicable by shifting liquids and monitoring portions of underwater bodies thus exposed. Readings of at least ten representative areas on each side of the exposed underwater body will be taken with readings spaced as evenly as practicable. The average of these readings on each side will be considered as representative of the general radiological condition of the underwater body. If the average of the readings so obtained is .020 or less roentgens/day combined beta and gamma corrected to 1 October 1946, the underwater body will be considered as meeting the requirements for final clearance and no further precautions are required. On vessels being drydocked for other reasons, the underwater body will be systemmatically monitored in drydock as outlined in the standard monitor forms. The average intensity of radiation on the underwater body so determined will then be used in the same manner as when listing the ship to determine whether decontamination is required. When the average underwater body readings as specified above is found to be above .020 roentgens/day, the underwater body will require decontamination in drydock and the following procedure shall be followed:

(1) Remove marine growth using long handled scrapers. During this operation the sides of the ship and the drydock floor shall be kept wet at all times to prevent the formation of dust. Upon completion of scraping, the sides and bottom of the ship shall be hosed down vigorously using salt water at high pressure. Materials removed shall be gathered up and disposed of as prescribed for contaminated materials in the Radiological Safety Precautions (Enclosure (A).

(2) Remonitor the underwater body to obtain the new statistical average of radiation intensity. If the hull then meets the established tolerance limits no further radiological precautions are necessary and normal work may proceed.

(3) If remonitoring after scraping and hosing reveals that established tolerance levels have not yet been met, the underwater body must be wet sandblasted for decontamination purposes. The standard wet sandblasting procedure is satisfactory for this purpose and will remove the radioactive material. Upon completion of the sandblasting, the topside, sides and bottom of the ship and the sides of the dock shall be washed down to collect all sand in the bottom of the dock and the ship remonitored. The sand shall then be collected and disposed of as required for contamination materials removed by Radiological Safety Precautions (Enclosure (A). After removal of the sand, the drydock floor shall be washed down vigorously and the water pumped into the harbor.

F. SHIPS BOATS

1. The ships boats which were used in the lagoon in many cases picked up an amount of radioactivity on the exterior hulls and in the engine cooling systems.

(a) Wood hull boats when found to be above tolerance are to be decontaminated by removing the bottom paint by use of a strong solution of lye and boiler compound. This solution will soften the paint after being applied generously and being allowed to stand for about half hour. The paint may then be scraped off. The scrapings should be treated as contaminated materials and the Safety Precautions given in enclosure (A) observed in their removal and handling. The underwater body should then be washed throughly to remove all lye and boiler compound and remonitored if a monitor is available. The boat should then be repainted in accordance with painting instructions when pronounced clear. Boats fitted with steel rubbing strips on the keels may retain some quantity of radioactive material under the strips where they are rusted or where the wood is partially rotted. In these cases the rubbing strips should be removed, rust cleared off, rotted wood removed, if practicable, and rubbing strip replaced.

(b) Steel hull boats, if readings are above tolerance, should be treated as the underwater body of the ship given in (E) above

(c) Engine cooling systems and tailpipes found to be radioactive shall be treated as specified for the salt water piping by (B) above.

(d) Boat propellers found to be contaminated shall be scraped and then washed with an acid mixture as prepared for the salt water piping.

G. HULL, HULL FITTINGS AND DECK EQUIPMENT.

1. Exposed areas of the ship's hull (other than the underwater body), hull fittings, ground tackle and other deck equipment found to have radiation readings in excess of final clearance limits shall be treated as follows:

(1) Exposed surfaces of the hull or hull fittings, if painted, shall be scrubbed thoroughly with a strong solution of lye and boiler compound using long-handled scrubbers and scraped to remove as much of paint as possible in the process. The lye and boiler compound solution should be made up of about 4 1/2 pounds of lye and 5 pounds of boiler compound to 10 gallons of fresh water. Unpainted or rusty surfaces shall be scrubbed in a similar manner using a solution of one gallon 18° Baume commercial muriatic acid to 10 gallons of fresh water and two ounces of an inhibiter (Rodene-Navy Specs. 51-1-2a) if available. Upon completion of scrubbing each area of one or two square yards hose down vigorously affected parts and decks in the vicinity with salt water to remove all of the solution.

(2) Anchor Chain and Anchors if above final limits shall be sandblasted at the first opportunity. To decontaminate chain lockers which exceed final limits, gather up all loose scale and rust keeping it wet at all times and dispose of in accordance with instructions for contaminated materials in Radiological Safety Precautions. Then hose down decks, bulkheads and overheads vigorously with salt water and pump overboard.

(3) Miscellaneous deck equipment made of fibrous vegetable material such as lines, fenders, brooms, swabs, scrubbers and the like are not susceptible to any known method of decontamination at this time. If any of these items exceed final clearance limits they should be segregated and disposed of as specified for contaminated materials removed in Radiological Safety Precautions.

(4) Deck equipment such as I.G.E. pumps having salt water cooling systems shall be treated by circulating acid solution as prescribed for salt water systems and heat exchangers in section (B) above.

(5) If after the above treatment any of the above parts show readings still above final clearance limits, the processes shall be repeated until limits are set.