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Frank Cluff, Safety Advisory Group, NV

DISPOSAL OF SCRAP MATERIAL AT BIKINI ATOLL

In response to your request for consideration of proper disposal of contaminated scrap material for the Bikini cleanup operation, the following guidance is provided:

Background - Past radiological surveys and particularly the 1967 survey identified a number of locations among the islands of Bikini Atoll having quantities of scrap material containing induced radioactivity. Such scrap locations are described in the Health and Safety Laboratory report HASL-190 entitled, "External Radiation Levels on Bikini Atoll - May, 1967," dated December, 1967. These locations, which are on islands near former testing sites, may be identified as: (a) the Aomen-Iroi Complex in the north-central part of the atoll, (b) the island of Mam and the blasted bunker just west of Mam and Bravo Crater in the northwest part of the atoll, and (c) an area generally defined as the island of Enidrik and the western portion of the Aerokoj-Ineman Complex in the south central part of the atoll. Also, the possibility cannot be ruled out that there may be some contaminated scrap on Bikini Island, as increased levels of radiation were observed there on a cable spool and only a small fraction of the area was checked due to dense vegetation. Additionally, there are three test facility locations in shallow water on the reef between the Aomen-Iroi Complex and Mam which were not monitored during the '67 survey and which should be checked for contaminated scrap.

The Ad Hoc Committee established by AEC to evaluate the radiological hazards of resettlement of the Bikini Atoll recommended a number of measures one of which was that "Radioactive scrap should be removed from the islands adjacent to former shot sites." In discussions on the need for such removal it was pointed out that this material is scrap metal containing induced radioactivity and that natives collect and find use for all such materials. The scrap is in the form of metal embedded in concrete, chunks of metal lying on top of the ground surface, and scraps of metal mixed with the top layers of sand and soil. It is not expected that removal of the scrap containing induced radioactivity will make any great reduction in radiation levels on the near test islands since there are quantities of radionuclides, primarily  $^{60}\text{Co}$  and  $^{137}\text{Cs}$ , in the top layers of sand and soil of these islands.

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w/ T Mc-Craw who had discussed w/ Dr. [unclear]*

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It was concluded that some radiation exposure could be avoided through removal of contaminated scrap metal such that it would be unavailable to native collectors.

Objectives - Following the August 1968 trip to Bikini, a report on the visit was prepared by AEC staff containing an attachment addressing the question of purpose and objective for scrap removal at Bikini Atoll. Recommendations 1 through 4 of this statement, known as Attachment 6 to that trip report, appear to be a proper assessment of what is needed. This Attachment 6 is provided for your use.

Scrap Disposal - If cost, time, and man-power were unlimited, disposal of all scrap metal containing any induced radioactivity in the very deep ocean outside the reef would more certainly make the scrap unavailable to the returning natives. More realistically there are a number of factors to be considered:

1. The location of channels in the reef through which boats loaded with scrap must pass is such that disposal outside the reef for scrap locations in the northern portion of the atoll will involve a 25 to 30 mile round trip. Currents may be very strong in these channels.
2. Except for a trace quantity, the radionuclide in the contaminated metal scrap is  $^{60}\text{Co}$  with a half-life of about five years. This may be compared with the 30 year half-life of  $^{137}\text{Cs}$  which is a major component of soil radioactivity of the near test islands. The scrap contaminant will decay through six half-life periods reaching about 1% of its 1967 value while the  $^{137}\text{Cs}$  in soil of the near test islands is being reduced to 50% of its 1967 level.
3. Disposal of metal debris, which will sink to the bottom, in water 150 to 200 feet deep inside or outside the lagoon will make the scrap unavailable to the natives. Such material should not be recoverable without use of special equipment at these depths.
4. The lagoon and ocean floors in the area of test locations already contain a total quantity of scrap expected to be in excess of that found on land. In fact, the added quantity from the land areas would probably be a very small fraction of this total.

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5. Disposal inside the reef would make scrap removal operations less weather and wind dependent since trips into open water and possibly into rough seas would not be needed.
6. The identification of metal scrap containing induced radioactivity and requiring disposal must be made under field conditions using portable radiation detection instruments and in most cases in the presence of an elevated above ground gamma radiation field. The identification of hot spots in soil will take place under similar circumstances.

With these factors in mind it is suggested that the following guidelines be applied:

1. A careful search should be made for all contaminated scrap that may be collectable by the returning natives. Scrap metal containing induced radioactivity and showing contact readings measurable above local background should be collected for disposal. The need for removal of other materials such as soil from any hot spots containing plutonium or other radionuclides will be a matter for case-by-case determinations in the field with recommendations made by the AEC Radiological Safety Advisor.
2. Disposal of metal scrap containing radioactivity in water having a depth of about 150 to 200 feet will make these materials unavailable to the native population. These depths are approximately equivalent to the deeper parts of the lagoon.
3. A disposal site for each of the three near test areas, as described on page 1, containing the contaminated scrap may be chosen inside or outside the reef with a minimum distance of one mile to the nearest island or islet. A record of positions should be made and included in final reports. If any markers are used they should be removed at the end of cleanup operations.
4. Considering the possibility of future salvage of ships, metal scrap containing induced radioactivity is not to be placed within the prohibited area located in the east end of the lagoon (refer to H. O. 6032 published by U. S. Naval Oceanographic Office).
5. Except when collected by those authorized to do so, no samples of metals containing induced radioactivity are to be retained or transported from Bikini Atoll.

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6. Disposal of scrap containing no induced radioactivity such as towers and other materials on Bikini and Eneu and similar materials on other islands requires no special consideration from a radiological viewpoint and is therefore not covered by these guidelines.
7. As discussed in item 3 of Attachment 6, consideration of disposition of undamaged or damaged bunkers must take into account their radiological status and possible utility. In this regard it is expected that bunker contamination levels will be reduced more rapidly than levels in the soil of the near test islands. There is the additional need to obtain input from the Trust Territory representative that reflects desires of the natives in order to determine what use might be made of these structures. These bunkers would not appear to fall in the same category as other more readily removable contaminated scrap material since their potential usefulness is undoubtedly much greater. As for the damaged bunkers on Nam and the sand island west of Bravo Crater, it is suggested that their physical rather than radiological condition is the more important consideration and a decision on their disposition should be made in the field again considering the desires of the returning natives.
8. Any special problems that might be discovered such as plutonium contamination other than in soil or observation of levels of environmental radioactivity (particularly items of the Bikini diet) significantly different from or in addition to that known to the Ad Hoc Committee and contained in HASL 190 and Dr. Gustafson's reports could require additional guidance and should be reported.

Finally, it is known that the distribution of scrap found on these near test islands extends into the shallow water shore areas and on into the deeper parts of the lagoon and ocean. It is suggested that location and removal of this underwater metal scrap is generally not feasible and that any problem with such material is best handled by followup surveys as suggested in item 5 of Attachment 6. It is not intended that item 5 will apply to the cleanup phase of recovery

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and rehabilitation of Bikini Atoll. Rather, this is in the nature of a safeguard to be conducted as a part of followup studies.

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CONSIDERATION OF PURPOSE AND OBJECTIVE FOR RADIOACTIVE  
SCRAP REMOVAL AT BIKINI ATOLL

The contaminated scrap metal on Bikini Atoll has been observed on islands adjacent to test locations. These adjacent islands which lie along the northern and southern rim of the Atoll islands have been subjected to heavy fission product fallout as well as blast, thermal, and prompt radiation along with water waves. The scrap metal on these islands consist of a wide range of sizes. Not all metal pieces in a given area are radioactive. Though two items may be similar in appearance and located side by side, one may show indication of radioactivity while the other does not. Pieces of pipe may show significant levels of radiation on one end and none on the other. Some of the scrap is on the surface, some protrudes from concrete footings, and some is near the ground surface just out of sight. The latter can be found using radiation detectors and scraping the soil to uncover the object.

Results from the 1967 survey indicate that a major contributor to the radiation field in these scrap metal areas is  $^{60}\text{Co}$ . This radionuclide is not a fission product, but rather is induced radioactivity in items of iron and steel which have been subjected to neutron irradiation.  $^{60}\text{Co}$  was found both in the scrap metal and in the soil samples by the 1967 survey.

It is unlikely that removal of the contaminated scrap metal from the islands adjacent to tests will make a significant reduction in the external radiation fields observed there. For the present, the resettlement program is to be limited to the Bikini-Eneu complex, and no use is to be made of the near test islands except possibly short visits to collect food items such as birds, turtles, and their eggs. Removal of contaminated scrap that would otherwise be available can avoid some unnecessary exposure. The effectiveness of this precaution can be further strengthened by periodic surveys of village areas and work areas to ensure that no contaminated scrap is collected on Bikini and Eneu. Therefore, the purpose and objective of the radioactive scrap removal effort are to make this contaminated material unavailable to the population of the Atoll and thereby to prevent radioactive source buildup through scrap collection activities on Bikini and Eneu. The following recommendations are made to achieve the above-stated objective:

1. There should be radiation monitoring capability to support clearing operations on Bikini and Eneu for determining whether test-related objects that are turned up contain elevated levels of radioactivity. This would include a survey of the area on Eneu (when it is cleared) that was used as an aircraft decontamination location.

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2. The island complex and separate islands along the northern and along the southern rim of the Atoll should be cleared of contaminated scrap metal. These would include the Aomen-Odrik complex, Iroij, Nam, Enidrik, and the Aerokoj-Enenan complex. The level of effort desired is the complete removal of all scrap metal on or near the surface of these islands. The final disposition of this material should be such that it is unavailable to the returning population.
3. Undamaged or lightly damaged concrete bunkers should be left in place throughout the Atoll. These are judged to provide a benefit to the returning population as shelter against storms and temporary residence for short periods at locations where no other buildings exist. The observed levels of radiation in reinforcements of bunkers can be expected to be reduced at the same rate or possibly faster than levels in adjacent soil. The bunker with iron aggregate on Aomen should be repaired such that no further flaking of the iron can occur. The steel doors should be removed from all bunkers to prevent accidental entrapment. Rusting climbing rungs, stairways, and any protruding steel on the outside or inside of bunkers should be cut off with disposal along with contaminated debris, with the exception of the large diagonal structural members on the large bunker on Aerokoj which should be left in place. The damaged bunker at the end of the sand island west of Nam should be removed because of the physical hazard it presents and because of its lack of any useful purpose. For the sand island bunker, the radiation level in the twisted steel members is also a consideration.
4. The steel members protruding from concrete footings or forms on the islands listed in 2. above should be removed for disposal. These have no utility for native use and many of the metal members show elevated levels of gamma radiation. Both the steel and concrete parts should be removed.
5. A followup survey should be made within 12 months after return of the population and at appropriate intervals thereafter to ensure that no contaminated scrap has found its way into the village or work area on Bikini or Eneu.

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