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PUBLICATION OF REPORT "EXPOSURE RATE REDUCTION ON BIKINI ISLAND DUE TO CONCRETE DWELLINGS"

The enclosed report is being considered for publication as an AEC Technical Information Document, TID. Please provide us your comments by November 1, 1973.

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# EXPOSURE RATE REDUCTION ON BIKINI ISLAND DUE TO CONCRETE DWELLINGS

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# EXPOSURE RATE REDUCTION ON BIKINI ISLAND DUE TO CONCRETE DWELLINGS

## INTRODUCTION

During the May 1972 AEC sponsored resurvey of Bikini Atoll measurements were made to determine the reduction of exposure rates at dwelling sites due to the shielding effect of the concrete structures being erected for occupancy by the returning Bikini people. Exposure rates were measured at several points around and within each dwelling using a Baird Atomic NE-148 Scintillation Monitor 904-148, sodium iodide system calibrated with respect to $^{137}Cs$.

The dwellings are constructed of wood and concrete. The floors are concrete slab, not extending beyond the walls of the houses. The concrete slab walls are pierced by windows and, on the longer sides, by entrance ways. The roofing is constructed of wood framing and aluminum sheet.

Local sources of sand and coral aggregate suitable for use in making concrete were identified by AEC prior to construction as having the minimum radioactive material content of those available on the atoll. The architectural drawings of the dwellings that were developed by the Office of Trust Territory, Department of Interior, in consultation with the Bikini people, were reviewed by the AEC staff. Recommendations were made that would reduce radiation levels and thus keep exposures as low as feasible.

A total of 33 structures were examined. These were in various stages of construction that varied from floor slab only to essentially complete and occupied (by the contractor supervisor). The locations of the structures are shown in Figure 1. Figure 2 is a sketch of a completed dwelling.

A typical building layout is indicated in Figure 3, showing the points at which measurements were made: on the center line of each wall, 10 feet out from the wall, 3 feet above the surface of the ground; in the center of the building, at a height of 3 feet; and in the center of the building, on the floor.

FINDINGS

Raw Data

The exposure rates measured are indicated in Table 1, in micro roentgens per hour (μR/h). External exposure rates ranged from 7 μR/hr to 55 μR/hr, with an arithmetic mean value of 20 μR/hr.

Treated Data and Results

Exposure rate reduction factors (RF) were computed for each dwelling except for seven "slab only" sites where no external measurements were made. The reduction factor (RF) is expressed in percent and was determined utilizing the following equation:

$$RF = \left(1 - \frac{\text{Interior Exposure Rate}}{\text{Exterior Exposure Rate}}\right) \times 100$$

The interior exposure rate is that which was observed at the center of the dwelling at a height above the floor of three feet or at contact with the floor. Both values were investigated. The exterior exposure rate used in the above equation was the arithmetical average of the four external exposure rates measured around each dwelling site.

Exposure rate reduction factors for each dwelling are indicated in Table 2 for the floor and three foot height situations. The measurements are stratified according to each aspect of construction encountered. The average interior exposure rate at floor level and at three feet in the center of the dwellings (exluding those filled with masonite and those having only a slab) is about 11 μR/hr.

## CONCLUSIONS

On Bikini Island, exposure rates present from radioactivity remaining post nuclear testing are reduced within the concrete dwellings by a significant amount. Upon completion of the housing construction effort, an exposure reduction factor of about 50% may apply. This is about what was expected provided materials of construction contained low levels of radioactivity. Even greater reduction can be expected when the housing area is covered with one to two inches of coral gravel as has been recommended. Depending on the occupancy time for residents of these houses, total exposure to external radiation can be expected to be reduced accordingly.

## ACKNOWLEDGEMENT

The authors wish to recognize the role of the Department of the Interior and particularly the Office of Trust Territories of the Pacific

Islands in obtaining favorable results of exposure rate reduction in construction of dwellings to be occupied by the Bikini people when they return.

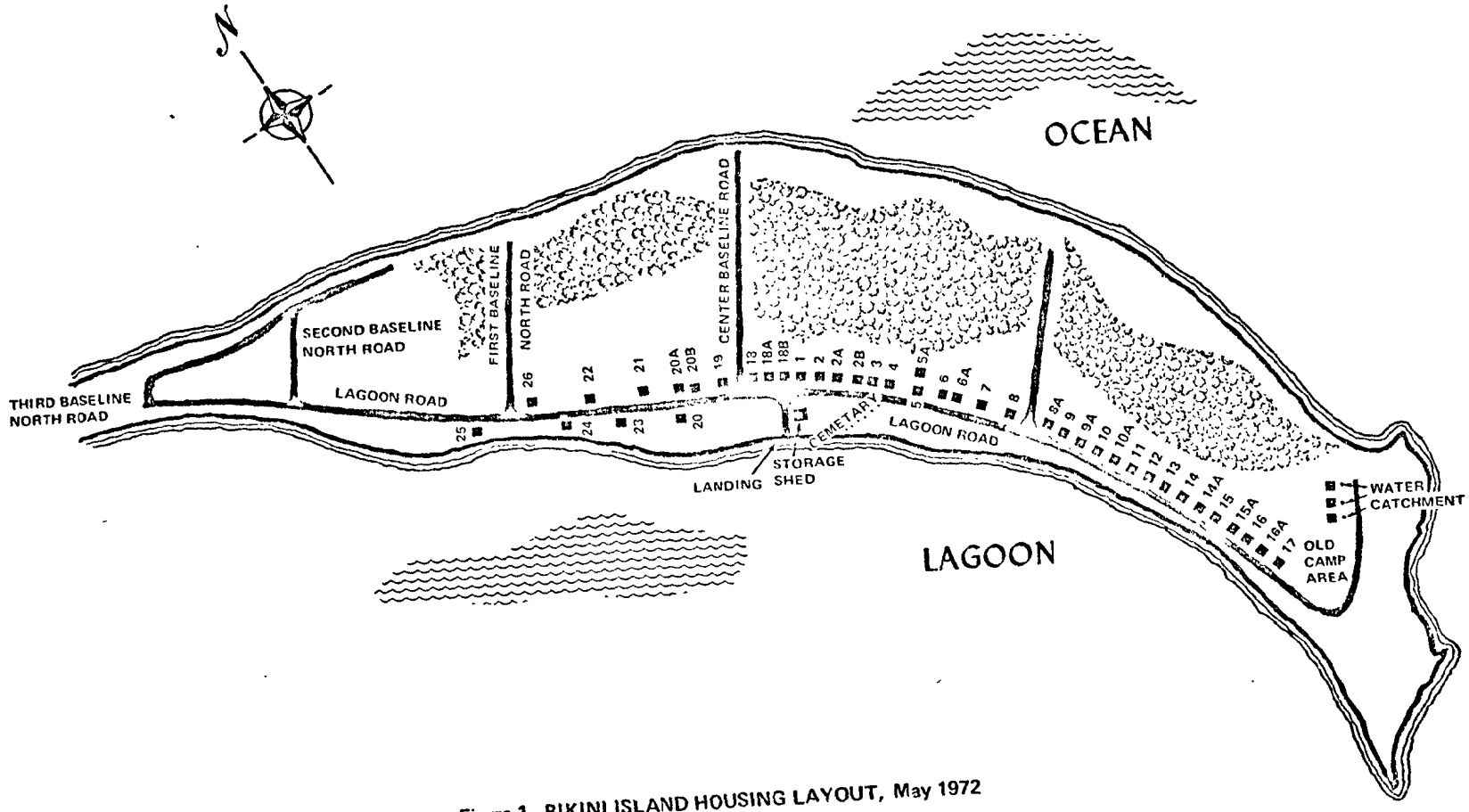
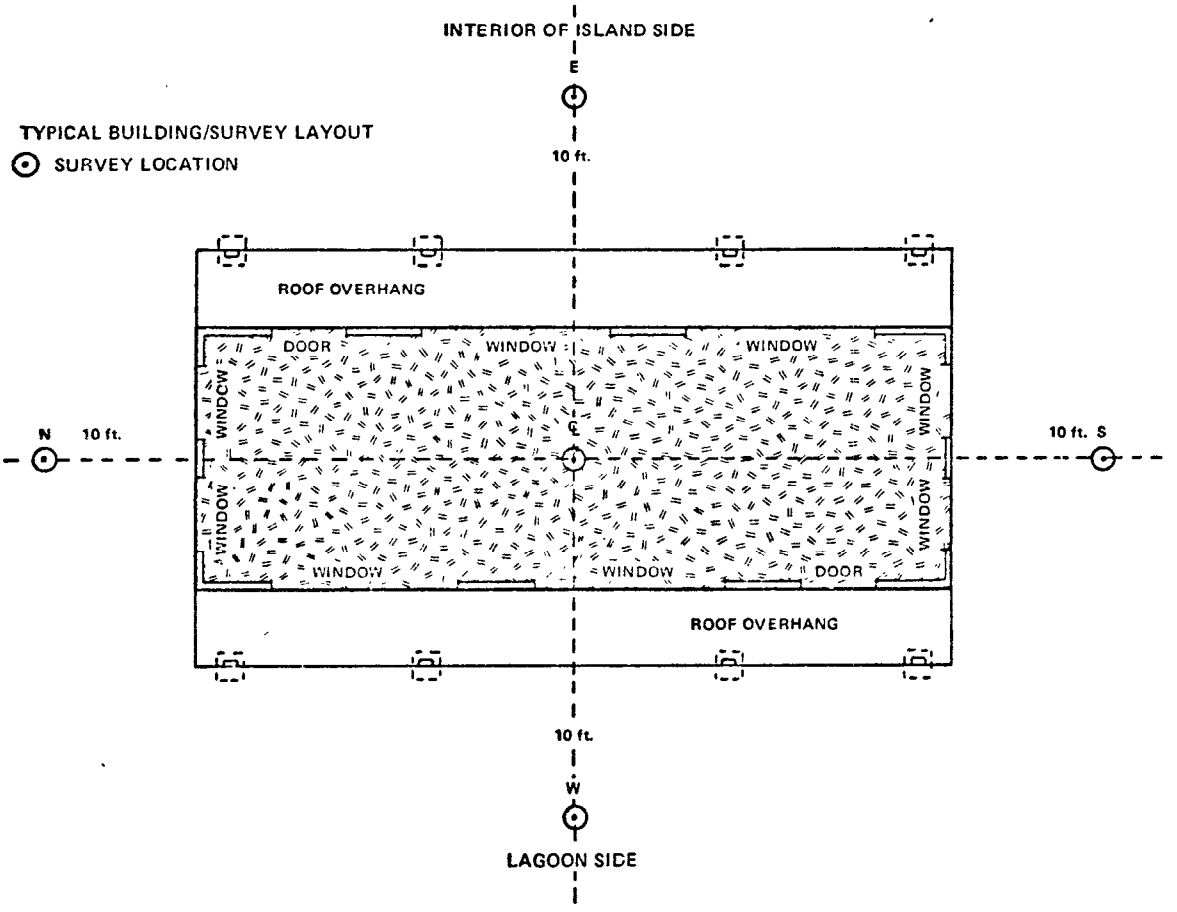



Figure 1. BIKINI ISLAND HOUSING LAYOUT, May 1972

Figure 2. SKETCH OF COMPLETED DWELLING

BIKINI ISLAND HOUSING GAMMA SURVEY SURVEY LAYOUT




READINGS OBTAINED AS INDICATED AT 3 FOOT HEIGHT EXCEPT AT CENTER OF HOUSE WHERE A CONTACT READING WAS ALSO OBTAINED.

Figure 3.

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Bikini Island Housing Gamma Survey  All readings in μR/hr.  May 1972

Table 1

| House No. | N.10'@3' | S.10'@3' | E.10'@3' | W.10'@3' | Interior Floor | Interior +3' | Remarks |
|---|---|---|---|---|---|---|---|
| 1 | - | - | - | - | 6 | 10 | Slab only |
| 2 | - | - | - | - | 8 | 10 | Slab only |
| 2A | - | - | - | - | 8 | 10 | Slab only |
| 2B | - | - | - | - | 9 | 10 | Slab only |
| 3 | - | - | - | - | 8 | 8 | Slab only |
| 4 | 7 | 7 | 7 | 7 | 5 | 5 | Walls, slab & roof |
| 5 | 9 | 10 | 9 | 10 | 7 | 7 | Slab and walls |
| 5A | 10 | 11 | 10 | 12 | 7 | 7 | Slab and walls |
| 6 | 15 | 12 | 11 | 12 | 9 | 9 | Slab only |
| 6A | 11 | 14 | 11 | 11 | 8 | 8 | Slab only |
| 7 | 19 | 19 | 27 | 19 | 11 | 11 | Slab only |
| 8 | 42 | 25 | 42 | 22 | 12 | 12 | Slab and walls |
| 8A | 25 | 27 | 21 | 38 | 14 | 14 | Slab and walls |
| 9 | 19 | 21 | 17 | 36 | 10 | 10 | Slab and walls |
| 9A | 26 | 45 | 26 | 42 | 15 | 16 | Slab, walls & roof |
| 10 | 19 | 17 | 16 | 17 | 10 | 10 | Slab, walls and ro. |
| 10A | 18 | 23 | 18 | 22 | 8 | 9 | Slab, walls & roof |
| 11 | 24 | 35 | 20 | 20 | 10 | 11 | Slab, walls & roof |
| 12 | 19 | 16 | 23 | 20 | 10 | 10 | Slab, walls & roof |
| 13 | 20 | 20 | 20 | 15 | 9 | 9 | Slab, walls & roof Bldg. filled w/masonite |
| 14 | 35 | 19 | 18 | 20 | 11 | 11 | Slab, walls & roof. Bldg. filled w/masonite |
| 14A | 10 | 10 | 12 | 15 | 6 | 6 | Slab, walls & roof Bldg. filled w/masonite |
| 15 | 19 | 26 | 17 | 24 | 11 | 12 | Slab, walls & Roof Bldg filled w/masonite |
| 15A | 15 | 11 | 25 | 15 | 6 | 7 | Slab, walls & Roof Bldg. filled w/masonite |
| 16 | 14 | 14 | 10 | 25 | 10 | 11 | Slab, walls & roof |
| 16A | 20 | 20 | 10 | 18 | 8 | 9 | Slab, walls & roof |
| 17 | 9 | 15 | 15 | 18 | 7 | 7 | Slab, walls & roof (Occupied) |
| 18 | 10 | 20 | 13 | 10 | 7 | 9 | Slab and walls |
| 18A | - | - | - | - | 11 | 15 | Slab only |
| 18B | - | - | - | - | 11 | 11 | Slab only |
| 19 | 16 | 18 | 14 | 16 | 9 | 10 | Slab and walls |
| 20 | 14 | 12 | 20 | 11 | 9 | 10 | Slab and walls |
| 20A | 25 | 19 | 15 | 16 | 11 | 12 | Slab and walls |
| 20B | 28 | 10 | 16 | 14 | 7 | 9 | Slab and walls |
| 21 | 50 | 23 | 45 | 50 | 18 | 20 | Slab, walls & roof |
| 22 | 40 | 55 | 20 | 40 | 17 | 20 | Slab and walls |
| 23 | 21 | 15 | 16 | 23 | 8 | 10 | Slab, walls & roof |
| 24 | 30 | 30 | 24 | 27 | 14 | 15 | Slab & walls |
| 25 | 30 | 40 | 27 | 10 | 14 | 15 | Slab & walls |
| 26 | 25 | 27 | 30 | 15 | 15 | 15 | Slab & walls |

Table 2

| House No. | Avg. External μR/hr | Interior Floor μR/hr | Interior + 3 ft. μR/hr | Reduction Factor Floor | Reduction Factor + 3 ft. |
|---|---|---|---|---|---|
| Slab only | | | | | |
| 6 | 12.5 | 9 | 9 | 28% | 28% |
| 6A | 11.75 | 8 | 8 | 32% | 32% |
| | | | Average | 30% | 30% |
| Slab & walls | | | | | |
| 5 | 9.5 | 7 | 7 | 26% | 26 |
| 5A | 10.75 | 7 | 7 | 35 | 35 |
| 7 | 21 | 11 | 11 | 48 | 48 |
| 8 | 32.75 | 12 | 12 | 63 | 63 |
| 8A | 27.75 | 14 | 14 | 48 | 48 |
| 9 | 23.25 | 10 | 10 | 58 | 58 |
| 18 | 13.25 | 7 | 9 | 47 | 32 |
| 19 | 16 | 9 | 10 | 44 | 38 |
| 20 | 14.25 | 9 | 10 | 37 | 30 |
| 20A | 18.75 | 11 | 12 | 41 | 36 |
| 20B | 15 | 7 | 9 | 33 | 40 |
| 22 | 38.75 | 17 | 20 | 56 | 48 |
| 24 | 27.75 | 14 | 15 | 50 | 46 |
| 25 | 26.75 | 14 | 15 | 48 | 44 |
| 26 | 24.25 | 15 | 15 | 38 | 38 |
| | | | Average | 46% | 42% |

Slab, Walls and Roof

Table 2

| House No. | External µR/hr | Interior Floor µR/hr | Interior + 3 ft. µR/hr | Reduction Factor % Floor | + 3 Ft. |
|---|---|---|---|---|---|
| 4 | 7 | 5 | 5 | 30 | 30 |
| 9A | 34.75 | 15 | 16 | 57 | 54 |
| 10 | 17.25 | 10 | 10 | 33 | 33 |
| 10A | 20.25 | 8 | 9 | 60 | 56 |
| 11 | 24.75 | 10 | 11 | 60 | 56 |
| 12 | 19.5 | 10 | 10 | 39 | 39 |
| 16 | 15.75 | 10 | 11 | 37 | 30 |
| 16A | 17 | 8 | 9 | 53 | 47 |
| 21 | 42 | 18 | 20 | 57 | 52 |
| 23 | 18.75 | 8 | 10 | 57 | 47 |
| | | | Average = | 48% | 44% |
| Slab, walls, roof Bldg. filled w/masonite | | | | | |
| 13 | 18.75 | 9 | 9 | 52 | 52 |
| 14 | 23 | 11 | 11 | 52 | 52 |
| 14A | 11.75 | 6 | 6 | 49 | 49 |
| 15 | 21.5 | 11 | 12 | 49 | 44 |
| 15A | 16.5 | 6 | 7 | 64 | 58 |
| | | | Average = | 53% | 51% |
| Slab, walls and roof, occupied | | | | | |
| 17 | 14.25 | 7 | 7 | 51 | 51 |

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