[illegible]

The largest individual 30 year doses for persons born after return occur under the Enjebi living pattern for children born eight years after the return and existing under famine conditions. Under the normal diet pattern the 30 year dose is 4.0 rem; in famine it is 7.5 rem (Table 44 of Dose Assessment). Again assuming famine conditions will exist 25% of the time, we have an upper credible 30 year dose of ((4.0x0.75)+(7.5x0.25))=4.9 rem, or about 163 mrem per year on the average.

It is notable that only the first case, that of adult females for the Enjebi/Northern Island living pattern, exceeds the FRC general population guides of 170 mrem per year of 5 rem per 30 years for the general U.S. population. The excess estimated dose is furthermore very small; 0.6 rem for 30 years, and 13 mrem per year average. The estimated doses are all far below allowances for occupational exposure and below the recommended Action Guides applicable for the general U.S. population. Furthermore, the excesses are more than made up for by the lower average natural background radiation exposure encountered in the Marshall Islands than in the continental United States.

Birth Rate and Generation Time

For most purposes, a generation is taken to be 30 years. In the United States, it is currently a bit shorter, but 30 years is still taken as a convenient simplification. For the Marshall Islands, the Five Year Comprehensive Health Plan gives a breakdown by age of mother (Table V-3, page 120) that shows the age of mothers at the "average" or "middle" birth to be only 23-24 years. However, no information is available on the age of fathers, who seem likely to be older than the mothers, and in any case the usual 30 year interval is used here. It should be noted that to the extent the Enewetak generation is actually shorter, this tends to overestimate dose to the parents of the average child, and thus the genetic health risk estimates.

While genetic risk estimates may be expressed per live birth, thus avoiding any assumptions about future birth rates, it is helpful to attempt to estimate the total risk for the entire next generation of the Enewetak people. As a minimum, we might simply assume a "replacement" birthrate of 453 live births over the next 30 years, or about 15 births per year. As a maximum, we might assume that the average birth rate in the entire Marshall Islands for the 20 years from 1955 to 1975 might apply to the Enewetak population for the next 30 years. From Table III-1 of the final draft of the Marshall Islands 5-year Health plan, one can calculate that the average yearly birth rate for the period (it seems remarkably stable over this period) is 39.7± 4 births per 1,000 of population; for practical purposes 40 per 1000 or about 11 per year for the 273 people assumed to return to Enewetak and about 7 per year for the 180 people assumed to return to Enjebi.

Of course, should the present birth rate and current population growth rate of the order of 3-4% per year continue, the absolute numbers of births will grow during the coming 30 years. Assuming a 4% growth rate, the Enewetak population may include 816 people 15 years from now, and about 33 births might be expected that year, while in thirty years there would be almost 1,500 persons, with well over 60 births per year. It seems unlikely that the population will grow to this extent; in view of the uncertainties involved, perhaps a reasonable assumption would be that there will be not more than roughly 1000 births in the population during the next 30 years.

With exponential population growth, roughtly one-half of the births expected over 30 years will occur during the first 20 years; the remainder will occur during the final 10 years. In view of the uncertainties involved, it seems reasonable to assume as an upper credible limit that there will be 1000 births, the average accumulated parental dose for which will be that accumulated for the first twenty years. However, the doses were calculated for 30 years, and since these are not enormously larger than the 20 year integral doses (see Fig.3 of Dose Assessment), they are used here as upper bound estimates of the doses of genetic significance in calculating genetic risk.

[redacted]

Effects of Ionizing Radiation (BEIR III Report) has been selected for the purpose.

Selection of any of the earlier documents would make rather little difference in the magnitude of the genetic effects estimates.

From Table IV-2 of the 1979 BEIR III Report, we get an estimate of from 5-75 genetic effects in the first generation per rem per million live births. This range may be appropriately scaled for dose or for population size by simple proportionality.

Specific Genetic Risk Estimates

The population dose estimates described allow calculation of an average 30 year population dose for the entire population of the atoll. The 180 people assumed to go back to Enjebi constitute about 40% of the total weighting the Enjebi/Northern Islands and the Southern Islands/Northern Islands dose estimates accordingly, we get ((5.6x0.4)+(0.23x0.6))=2.38 average individual dose integrated over 30 years, or 79 mrem per year (notably, well below the FRC guide for the general population average). The dose proportional adjustment factor is then 2.38/$_1$, and the range of risk from BEIR III is (2.38x5) to (2.38x75), or 11.9 to 178.5 per million live births.

As a minimum estimate, we assumed the present population might just replace itself in 30 years; i.e., 453 births. The risk, then, would be (11.9 to 178.5)x453/1,000,000 = 0.0054 to 0.081 additional cases. Assuming a 10.7% spontaneous risk, we would expect 48.5 cases to occur naturally during the same period. Thus the upper bound risk in this case is that the normally expected 48.50 cases arising during the next 30 years might conceivably increase to as much as 48.56, an increment of less than two tenths of one percent.

Assumption of the higher number of 1000 births in the next 30 years simply increases the absolute numbers proportionately: The risk becomes (11.9 to 178.5)x1,000/1,000,000 = 0.012 to 0.18 additional cases in 30 years, against a spontaneous total of 107 cases.

To provide an upper limit to credible risk of genetic ill health we might consider a child born to a couple born on Enjebi eight years after the return, they would receive as much as 4.9 rem in 30 years, and the risk to a child born to them at age 30 would be roughly 5 times the BEIR III risk for 1 rem, or (5x5) to (5x75)/ 1,000,000 = 25 to 375 per million or roughly 3 chances in 100,000 to 3 chances in 10,000. This is, of course, in addition to the 10.7 chances per hundred normal risk.

Summary

Even using the very conservative assumptions set forth above, the upper credible limit of genetic risk in consequence of the return of the Enewetak people - both dri-Enewetak and dri-Enjebi - is 0.18 additional case in 1000 births over 30 years. This means that it might take five generations before even one extra case appeared, during which time some 500 or more cases will appear spontaneously, regardless of where the people reside.