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RADIATION PROTECTION GUIDANCE RELEVANT TO ENIWETOK

Within the United States essentially all radiation protection activity is based on issuances of the:

Federal Radiation Council (FRC)

National Council on Radiation Protection and Measurements (NCRP)

International Commission on Radiological Protection (ICRP)

International Atomic Energy Agency (IAEA)

The recommendations which follow were derived using the philosophy and numerical values contained in ICRP, NCRP and FRC publications, with the most extensive use being made of the first. A summary of recommendations from these bodies is presented in Attachment _____ .

The basic principles of radiation protection are applicable everywhere. In the case of Eniwetok, fundamental decisions relate to the exposure standards to be used in the evaluation of the radiological survey findings and the cleanup and rehabilitation options. The objectives for control of radiation exposures drawn from ICRP Publication 9 are:

1. To prevent acute radiation effects, and
2. To limit the risks of late effects to an acceptable level.

ICRP developed the concept of "acceptable risk" and has taken the view that unless man wishes to dispense with activities involving exposures to ionizing radiation, he must recognize that there is a degree of risk and must limit the radiation dose to a level at which the assumed risk is deemed to be acceptable to the individual and to society in view of the benefits derived from such activities. Nuclear tests at Eniwetok were of benefit to the security of the U. S. and many other peoples. The benefits of current interest are those associated with recovery of their homeland by the Eniwetok people. For planned

or controlled exposures of individuals and populations, the ICRP has recommended the term "dose limit." Recommended dose limits are thought to be associated with a very low degree of risk.

Where the source of exposure is subject to control, it is desirable and reasonable to set specific dose limitations. In this manner the associated risk is judged to be appropriately small in relation to the resulting benefits. The limitation must be set at a sufficiently low level so that any further reduction in risk would not justify the effort required to accomplish it. Such risks to members of the public from man-made sources of radiation should be less than or equal to other risks regularly accepted in everyday life. They should also be justifiable in terms of benefits that would not otherwise be received.

ICRP states that since any exposure may involve some degree of risk, the Commission recommends that any unnecessary exposure be avoided, and that all doses be kept as low as is readily achievable, economic and social consideration being taken into account.

REMEDIAL MEASURES

Engineering and advisory actions are the two categories of remedial measures considered.

1. Engineering actions taken during cleanup and rehabilitation operations provide a basis for measurement or other determination of effectiveness and adverse impact. Good initial assurance of satisfactory completion can be given.
2. Advisory actions cover those activities of the returning people and their professional counselors in response to instructions and technical advice on land use, housing sites, dietary usages, etc. Results will be achieved over a long period and depend on the conscientious use of advice and counsel and require continuing exchange of information between inhabitants and technical sources. Because of time, human factors, pressures, and qualifications, less than optimum effectiveness may be expected, despite a strong initial will by the Eniwetok people to cooperate at the outset.

Engineering actions are those upon which the U. S. parties to cleanup and rehabilitation should place the greatest reliance for assuring continuing "as low as practicable exposures." If the U. S. leaves the atoll in nominally safe condition, it can put the control in the hands of the people with a high degree of confidence that predicted exposures will not be exceeded to any significant degree. Advisory actions should be considered as a bonus in the exposure reduction planning.

If total exposures from all pathways exceed the recommended guides, remedial actions to reduce and control such exposures are judged to be needed. The guides are chosen recognizing that exposures of Eniwetok residents will be protracted in duration and that the health consequences of long-term low-level exposures are not now fully known and may never be known. Considering the exposure reduction achieved by engineering actions, it must be possible to maintain exposures of people below recommended levels; otherwise the U. S. parties must deliberate whether cleanup and rehabilitation of the atoll should be initiated now or at some later time.

The area of plutonium in soils is one for which there is no general agreement as to the quantitative relationship between levels in soils and dosages to be expected through the inhalation pathway, the primary one through which man can receive a significant dose from plutonium. The ICRP recommends a maximum permissible average concentration (MCP) of 1 picocurie per cubic meter (pCi/m^3) of air for "insoluble" plutonium and $0.06 \text{ pCi}/\text{m}^3$ for "soluble" plutonium for unrestricted areas. While the plutonium in the soil at Eniwetok is thought to be typical of world-wide fallout, and therefore insoluble, we will use the $0.06 \text{ pCi}/\text{m}^3$ value for the sake of conservatism.

A guide for assessing the importance of a certain soil level of Pu on Eniwetok can be arrived at by a set of conservative assumptions regarding the resuspension pathway. This is the "critical" pathway since

the inhalation route to man is more hazardous than the soil-root pathway for ingestion of plants by man. These assumptions are:

1. Plutonium in soil is resuspended at rates similar to the soil material, e. g., the specific activity of soil equals the specific activity of air particulates.
2. All particles in air originate from local soil.
3. Plutonium in air is all in the respirable range of particle size and is soluble in lung fluids.

The average mean value for airborne particulate concentration for ~~the~~ 30 locations is 38 micrograms per cubic meter ($\text{microgram}/\text{m}^3$).*

Assuming, to be conservative, that the average airborne particulate concentration level at Eniwetok is $150 \text{ microgram}/\text{m}^3$, and further assuming that all of this particulate matter consists of local soil (i. e., no salt spray from the ocean), one obtains a value of 400 pCi/gm as an average surface soil concentration which corresponds to the ICRP guide for maximum permissible average airborne concentration of plutonium.

In the evaluation of the radiological condition of Eniwetok, we will apply the criteria that areas in which any soil samples show concentrations greater than 400 pCi/gm should receive corrective action, areas which show soil concentrations between 40 and 400 pCi/gm may receive corrective action, depending on other conditions present, and areas showing less than 40 pCi/gm do not require corrective action because of the presence of plutonium alone.

*Air Quality Data, 1966 Edition, APTD 68-9, published by the U. S. Department of Health, Education, and Welfare.

RECOMMENDED GUIDES

The dose limits issued by ICRP are recommended as the basic guidance for control of exposures to individuals at Eniwetok. This is recommended with provisos that:

1. The full amount of the numerical values should not be used for allowable exposures from a single man-made source, in this case radioactivity from weapons tests. This is applied so that the Eniwetok people will not be denied benefits of future nuclear technology because they are receiving exposures from man-made radiation to levels of acceptable standards.
2. Environmental and medical followup surveys and studies are performed such that the full range of radiation exposures of individual members of the Eniwetok population will be known. (ICRP) does not contemplate measurement of individual exposures.)
3. Exposures are kept as low as practical.

SURVEY, CLEANUP AND REHABILITATION EVALUATION

It is recommended in this context that:

1. A limit of 50 percent of the ICRP dose limits for individuals be used. This assumes (because of the small population size and the planned medical and environmental followup) that the range of annual exposure levels for persons receiving the higher exposures will be known. The following values apply:

Gonads, red bone marrow	0.25 rem/yr
Skin, bone, thyroid	1.50 rem/yr (0.75) ^e rem/yr, childrens thyroid)
Hand, and forearms; feet and ankles	3.75 rem/yr
Other single organs	0.75 rem/yr

2. A limit for gonadal exposure of the population be 5 rems in 30 years. This is based on the genetic dose coming primarily from ¹³⁷cesium that has a radiological half-life of 30 years.

3. The guidance for ²³⁹plutonium in soil be:
 - < 40 pCi/gm - corrective action not required
 - 40 to 400 pCi/gm - corrective action determined on a case-by-case basis considering other conditions present.
 - > 400 pCi/gm - corrective action required.