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MEMORANDUM TO THE MEMBERS OF THE COMMITTEE TO STUDY NPG

Subject: INTERPRETATION OF THE STANDARDS OF RADIOLOGICAL EXPOSURE

Attached is the study which I have prepared in connection with my duties as a member of the "Committee to Study the Nevada Proving Grounds".

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Director
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INTERPRETATION OF THE STANDARDS OF RADIOLOGICAL EXPOSURE

Operations at the Nevada Proving Grounds involve many special problems in human exposure to nuclear radiations. These problems fall into two distinct groups. The first relates to the personnel of the Test Organization who are participating in the experiments and who have an immediate responsibility for the conduct of the program. The second group of problems pertains to the people who live in the general area of Proving Ground operations and have no connection with the operation itself. Through no desire of their own, these people become more or less exposed due to fallout of bomb debris. It is essential that our criteria of operation be adaptable to both these sets of circumstances.

Philosophy of a Permissible Exposure Limit

As a result of deliberations over a number of years by the National Committee on Radiation Protection, certain principles have evolved which bear upon the general determination of what is a permissible exposure of persons and animals to radioactive materials. These principles apply alike to occupational and non-occupational exposure, but they also recognize that what is acceptable occupationally may not be desirable if applied in the same degree to a large population. Implicit in these distinctions is the recognition of the fact that occupational exposure normally involves adults for a limited span of years, a portion of which ordinarily extends beyond the period of procreation. Occupational exposure, therefore, implies a voluntary acceptance

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of an exposure which in itself will not be experienced throughout the life span, and especially will the genetic considerations be somewhat limited.

With the offsite population, however, the participation is involuntary, the numbers of people involved may become very large, and there is no limitation with respect to age or occupational relationship. Such circumstances, therefore, bring into play the general principle that an exposure level which may be acceptable occupationally should be reduced by an appreciable factor where large populations are concerned. In the Tripartite Conference at Arden House this spring, this principle was concurred in by the representatives of the United Kingdom, Canada, and the United States. It was agreed that where exposures to large populations were involved the permissible limit for occupational exposure might be reduced by a factor which could be as large as 10. These principles have subsequently been adopted by the International Commission on Radiation Protection at the conference at Copenhagen.

A third matter concerns the degree to which radiation exposure may be integrated over a period of time without regard to the rate at which such exposure has been acquired. The permissible limit for gamma exposure in general pre-supposes a uniform rate or at least one that is capable of being averaged over a brief span of time. At the moment the geneticists tend to regard the genetic effects of gamma radiation as related to total exposure, but there is beginning to be some question relative to the possible rate dependence of genetic effects. Somatic injury in general shows very marked rate dependence, and consequently the National Committee on Radiation Protection has felt that

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there should be a definite reduction in total exposure when most of the exposure is acquired at a high rate.

Application of These Principles to the Nevada Proving Grounds Situation

Test Operational Personnel: In such activities as the conduct of nuclear weapons tests, as in the repair of reactors, it is obvious that a uniform exposure rate cannot be the basis for the operation. A special case has therefore been made in terms of the integration of the occupational permissible exposure rate over a reasonable period of time, which most recently has been taken as one-quarter of a year, or thirteen weeks. Via such reasoning, the permissible limit for test operations has been set at 3.9r gamma exposure in thirteen weeks. Operationally, this has in the main been acceptable until the UPSHOT-KNOTHOLE test series with its relatively high onsite contamination and the protracted character of the series. The frequency distributions for the various exposure levels are shown in Table 1 for TUMBLER-SNAPPER and UPSHOT-KNOTHOLE. It is seen that for TUMBLER-SNAPPER approximately 1% of the persons participating exceeded the permissible limit, while for UPSHOT-KNOTHOLE the proportion was nearly 4% in this category.

While it may be stated with considerable certainty that no significant injury is going to result to any individual participating in test operations at the levels mentioned, and while it is true that the same thing would probably have to be said were the limits to be set two or three times as high, it nevertheless is true that there is no threshold to significant injury in this field, and the legal position of the Commission at once deteriorates if there is deliberate departure from what may be generally considered a reasonable interpretation of the accepted permissible limit.

Provision has been made in the operational plans of each of the more recent series so that the permissible limit may be exceeded where the Test Director finds that the requirements for the successful completion of the operation require a departure from standards of safety that are in normal operation, and that an unknown increase in hazard be accepted. Such a decision is thus one of command responsibility and the figure given, such as that of 20r for pilot exposure for a particular operation, is in the nature of an upper limit for such departure and does not constitute a re-statement of what is to be considered safe and acceptable practice.

Offsite Communities: Here, in accordance with the principles mentioned previously, the population groups include pregnant women and young children, as well as a considerable fraction of the population in the active child-bearing age, so the criterion of occupational exposure which has been mentioned is not acceptable as a lifetime proposition. Such a criterion would result in an annual total exposure of slightly over 15r. A factor of 5 would give a maximum total exposure of 3r. From the practical point of view, since we have already operated at a slightly different figure, we may state that a figure of 3.9r applied to offsite communities over a period of a year constitutes a workable relationship although a considerable number of authorities may consider the factor applied here to be too low. The figure which is here discussed is one of actual gamma exposure as measured by a reliable indicator of total body irradiation.

Methods of Determination of Dosage

For the onsite personnel, methods have been reasonably well standardized, but it should be noted that there has been a tendency to accept changes in methodology with neither critical evaluation of the meaning of such changes nor with adequate cross-calibration of the alternative techniques. For photodosimetry, a standard film badge must be employed whose sensitivity characteristics have been adequately studied and every detail in processing technique determined and stabilized. The same must be said of any pocket dosimeter or other instrument used. It is not the intention here to discuss the merits and demerits of the various systems of measurement, but it is pertinent to stress the essential requirement of standardization and the consistent following of technical requirements.

For the offsite populations, no better procedure has come to light than the use of the fission product decay curve based upon careful measurements some time after the total fallout has been established. The integration under this curve for the requisite number of weeks gives a figure for total exposure which cannot be exceeded under any circumstances. Experience in the field has given the magnitude of the factors which may be applied to this theoretical exposure to make due allowance for environmental decay and individual behavior with relation to the exposure field. However the result may be expressed, it seems most practical to obtain a base figure derived from instrumental observations and which is straightforward and logically to be explained, and then to apply the correction factor to this so that there is no confusion about where the element of uncertainty and of judgment has entered into the decision.

Discussion

In the presentation of these criteria, airborne contamination with its inhalation problems, and water contamination by fission products have not been mentioned. We have no evidence at the present time which would indicate that where the requirements expressed in terms of gamma exposure have been met that there need be concern with regard to inhalation or the ingestion of contaminating material in drinking water. It is likely, for both water and air contamination, that the important isotopes are actually Strontium^{89} and Strontium^{90} which appear to be relatively soluble and thus capable of early transport to bone from either system concerned. In no case does the likelihood of acquiring anything like the permissible limit of these isotopes appear significant.

In relating local exoosures to general body exposure, it is the general practice to permit five times the general body exposure to such regions as the hands and feet, and to the face, exclusive of the lens of the eye. This special consideration has not been discussed since under the usual Radsafe precautions such local exposures are easily kept within the permissible level provided the total body exposure is properly restricted.

Recommendation

It is recommended, and found to be in conformity with the present principles of determining permissible exposure limits, that for test operation personnel the total body gamma exposure be limited to 3.9r in thirteen weeks, and that the same figure be applied to the offsite communities with the further qualification in the latter case that this is the total figure for the year. In general, this implies a single test series in any given year.

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TABLE 1

PERSONNEL EXPOSURES

TOTAL EXPOSURE Roentgens	NUMBER OF INDIVIDUALS Tumbler-Snapper		NUMBER OF INDIVIDUALS Upshot-Knothole	
0. - 0.4	1561		1904	
0.5 - 0.9	195		441	
1.0 - 1.4	124		267	
1.5 - 1.9	106		153	
2.0 - 2.4	80		129	
2.5 - 2.9	48		91	
3.0 - 3.4	24		95	
3.5 - 3.9	13	2151	95	3175
4.0 - 4.4	9		43	
4.5 - 4.9	5		12	
5.0 - 5.4	0		7	
5.5 - 5.9	2		10	
6.0 - 6.4	2		8	
6.5 - 6.9	3		10	
7.0 - 7.4	0		6	
7.5 - 7.9	1		9	
8.0 - 8.4	0		3	
8.5 - 8.9	0		4	
9.0 - 9.4	1		2	
9.5 - 9.9	0		0	
10.0 - 11.9			0	
12.0 - 13.9			0	
14.0 - 15.9			2	
16.0 - 17.9		23	4	120
		2174		3295

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Table 1.

PERSONNEL EXPOSURES

TUMBLER - SNAPPER

TOTAL EXPOSURE Roentgens	NO. INDIVIDUALS	
0. - 0.4	1561	
0.5 - 0.9	195	
1.0 - 1.4	124	
1.5 - 1.9	106	
2.0 - 2.4	80	
2.5 - 2.9	48	
3.0 - 3.4	24	
3.5 - 3.9	13	2151
4.0 - 4.4	9	
4.5 - 4.9	5	
5.0 - 5.4	0	
5.5 - 5.9	2	
6.0 - 6.4	2	
6.5 - 6.9	3	
7.0 - 7.4	0	
7.5 - 7.9	1	
8.0 - 8.4	0	
8.5 - 8.9	0	
9.0 - 9.4	1	
9.5 - ~~10.0~~ 9.9	0	23
		2174

Double space such tables.

Individual Exposures - Upshot-Knothole

0. - 0.4	1904	
0.5 - 0.9	441	
1.0 - 1.4	267	
1.5 - 1.9	153	
2.0 - 2.4	129	
2.5 - 2.9	91	
3.0 - 3.4	95	
3.5 - 3.9	95	3175
4.0 - 4.4	43	
4.5 - 4.9	12	
5.0 - 5.4	7	
5.5 - 5.9	10	
6.0 - 6.4	8	
6.5 - 6.9	10	
7.0 - 7.4	6	
7.5 - 7.9	9	
8.0 - 8.4	3	
8.5 - 8.9	4	
9.0 - 9.4	2	
9.5 - 9.9	0	
10.0 - 10.4	0	10.0-11.9 0
10.5 - 10.9	0	
11.0 - 11.4	0	
11.5 - 11.9	0	
12.0 - 12.4	0	12.0-13.9 - 0
12.5 - 12.9	0	
13.0 - 13.4	0	
13.5 - 13.9	0	
14.0 - 14.4	0	14.0 - 15.9 - 2
14.5 -14.9	2	
15.0 -15.4	0	
15.5 -15.9	0	
16.0 -16.4	1	16.0 - 17.9 - 4
16.5 -16.9	2	
17.0 -17.4	0	120
17.5 -17.9	1	3295

3175
120
3295

1st meeting

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COMMITTEE TO STUDY OPERATIONAL FUTURE - NEVADA PROVING GROUNDS

AGENDA
FOR MEETING JANUARY 14, 1953
at SFOO, Albuquerque, New Mexico

Introduction - C. L. Tyler, Chairman

Background and purpose of Continental Test Site
Operations conducted at Nevada Proving Grounds to date -
Ranger, January - February 1951
Buster/Jangle, October - November 1951
Tumbler/Snapper, April - June 1952

Areas of Discussion -

1. Have the requirements and reasons for establishing the Continental Test Site changed since its establishment?

2. What can we predict for future use of the Nevada Proving Grounds -

   a. Types of devices to be tested

   b. Capacity, or limitations in capacity, of Proving Grounds
   needed development of facilities of test site

   c. Restrictions on use of Proving Grounds.

3. What will be effect of future tests -

   a. Will they create new problems

   b. Will they increase magnitude of present problems

   c. How will local conditions influence the type and size of tests.

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Areas of Discussion - Continued

4. Existing Problems - How can they best be coped with?

   a. Radiological contamination in the test area

   b. Radiation hazard to general public

   c. Physical damage to individuals and structures

   d. Claims procedures and limitations

   e. Public attitude toward tests

   f. Cost of construction and related problems

5. Do developments to date confirm the decision to establish a continental test site and its location at Nevada? If not, what alternatives are suggested?

Summary -

1. Review conclusions reached in discussion.

2. Establish areas to be explored further.

3. Activate organization to proceed with board - Suggestions or recommendations

4. Schedule date and place of future meeting to continue board actions.

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