REPORT OF THE UNITED NATIONS SCIENTIFIC COMMITTEE ON THE EFFECTS OF ATOMIC RADIATION

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NOTE

Throughout this report and its annexes cross-references are denoted by a letter followed by a number: the letter refers to the relevant technical annex (see Table of Contents) and the number is that of the relevant paragraph. Within each technical annex, references are made to its individual scientific bibliography by a number without any preceding letter.

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Annex E

METHODS OF MEASUREMENT

Table of Contents

<table>
<thead>
<tr>
<th>Paragraphs</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. INTRODUCTION ................................................................. 1</td>
</tr>
<tr>
<td>Direct measurements ............................................................. 3</td>
</tr>
<tr>
<td>Indirect measurements .......................................................... 5</td>
</tr>
<tr>
<td>II. SAMPLING ........................................................................... 6</td>
</tr>
<tr>
<td>III. RADIOCHEMISTRY AND ACTIVITY MEASUREMENT .............................. 11</td>
</tr>
</tbody>
</table>

I. INTRODUCTION

1. The ultimate purpose of radiological measurements of concern to the Committee is the estimation of tissue dose from natural sources, man-made sources and environmental contamination. In some cases, however, measurements of radioactivity are also of primary concern. It is emphasized that new and improved methods are constantly being developed.

2. It is customary to classify measurements of this nature into categories relating to the method used, i.e., direct or indirect. Direct exposure rate measurements are those made with ionization chambers or instruments calibrated in terms of air ionization. Indirect methods are those where exposure rate is calculated from activity measurement. The rates of exposure from medical and industrial practice and from terrestrial and cosmic radiation fields. They can be valuable, however, if the composition of the field is known and they are adequate for samples of exhaled breath for evaluation of activity measurement. Methods for these are outlined in the following sections. The necessary dose computations are described in annexes B, C, and D.

3. Routine direct determination of external exposures usually involves the measurement of gas ionization, as the relationship between energy absorption and ionization is relatively independent of energy. Any ionization chamber with an air equivalent wall may be used for the measurement, but it must be standardized periodically against a free air chamber.

4. Scintillation counters, films and geiger counters can be used for rough estimation of exposure or exposure rate, but they can give erroneous results in mixed radiation fields. They may be valuable, however, if the composition of the field is known and they have been calibrated under similar conditions.

5. The indirect determination of exposures from radioactive sources, such as deposited fall-out or radioisotopes in the body, is more complex. It involves consideration of methods of sampling, radiochemistry and

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the radium body burden. Standards may be prepared from commercially available radium solutions.31,32

12. The determination of strontium activity in the various materials described above involves preparation of the sample, separation of strontium and measurement of the activity.

13. The preparation depends on the type of sample: (a) soil from which strontium is removed satisfactorily by a 6M HCl leach; and (b) rainwater, foodstuffs and bone, which are best treated by wet or dryashing with subsequent solution in mineral acid. Following this treatment strontium is radiochemically purified. Y90 is allowed to grow to equilibrium, is separated from the parent and measured in a beta counter, thus giving the Sr90 content of the sample.25,26,33-38 The activity of any Sr89 present can be determined by difference. A moderately low background counter (5 to 10 cpm) is satisfactory for all samples but human bone, which requires counters with a background of about 1 cpm. The counting procedure must be calibrated with an absolute standard in order to convert the values obtained to disintegration rate. Reference samples for Sr90 are available for inter-calibration purposes through the Secretariat of the United Nations Scientific Committee on the Effects of Atomic Radiation and also commercially.31

14. The determination of total beta activity involves only preparation of the sample and measurement of the activity. Rainwater activity may be concentrated satisfactorily by evaporation55,58 or by absorption on ion exchange resins.55,56 Air filters or the residues from rainwater may be counted directly or dry-ashed prior to measurement of activity.55,57,38,40 Useful information may be obtained by determination of beta or gamma activity. The conversion of counting data to disintegration rates is difficult; the best standardization is accomplished with mixed fission products from a strong irradiation but natural potassium is more generally available and has suitable radiation characteristics.55

15. The Cs137 burden of humans living in a contaminated environment can best be measured in vivo with a whole body spectrometer.51-53 Gamma spectroscopy is also useful for direct determination of this radioisotope in other materials.44,47 Radiochemical separation techniques have been described which allow measurement of the caesium beta or gamma activity without energy discrimination.33,35,38,39 Adequate standards are not always available until recently.31 An accuracy of ± 25 per cent may be obtained by comparison of the beta activities of the Cs137 with a Sr90 standard. An intercomparison programme for development of Cs137 standards is desirable.51

16. The I131 burden in humans can best be measured in vivo by scintillation counting of the thyroid with energy discrimination.48-51 Also gamma spectroscopy is useful for direct determination of this radioisotope in other materials, though radiochemical techniques have been described which allow measurement of the separated iodine activity.52,53 Adequate standards are commercially available.54

17. The determination of radium involves preparation of a sample solution as for Sr90 followed by measurement either by a radon emanation technique555 or by radiochemical separation and alpha counting of the radium.56,57 Standards are commercially available.31,32

18. The current radiochemical literature describes methods for many other nuclides, (fission products, induced activities, fissionable materials and natural isotopes) which would appear to be completely satisfactory in most instances.

REFERENCES

32. Standard samples are available at The Radiochemical Centre, Amersham, England.
54. Standard samples can be obtained from Nuclear-Chicago Corporation, 223 West Erie Street, Chicago 10, Ill., U.S.A.
Appendix

LIST OF SCIENTIFIC EXPERTS

The scientific experts who have taken part in the preparation of the report while attending Committee sessions as members of national delegations are listed below. The Committee must also express its appreciation to the many individual scientists not directly connected with national delegations whose voluntary co-operation and good will contributed in no small measure to the preparation of the report.

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