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ABSTRACT

The appreciation of the potential hazard of ionizing radiation led to the setting up of national, and later, international commissions for the defining of standards of protection for the occupationally exposed worker in the use of ionizing radiation. However, in the last twenty years, with the large scale development of nuclear energy, the need for adequate protection against ionizing radiation has become even more important. This code of practice for the use of ionizing radiations in secondary schools was compiled and recommended by the Occupational Health Committee of the National Health and Medical Research Council of Australia. The publication comprises eight outline sections--(1) Introduction, (2) Modes of Irradiation, (3) General Rules, (4) Control of Sources, (5) Storage and Labeling, (6) Handling of Sources, (7) Disposal of Sources, and (8) The Degree of the Hazard. (KK)

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CODE OF PRACTICE FOR THE USE OF IONIZING RADIATIONS IN SECONDARY SCHOOLS

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CODE OF PRACTICE ON THE USE OF IONIZING RADIATIONS IN SECONDARY SCHOOLS

Recommended by the Occupational Health Committee of the National Health and Medical Research Council of Australia, May,* **1965.**

1. INTRODUCTION

1.1 In a Code of Practice intended for schools it appears desirable to indicate the basic philosophy behind the current approach to hazards associated with the use of ionizing radiations.

1.2 Very early in the history of its use, it was realised that ionizing radiation was capable of causing bodily injury. For example, it was within a year of the discovery of X-rays that the first report of skin damage due to over exposure to the rays appeared in the literature. This appreciation of the potential hazard of ionizing radiation led to the setting up of national, and later, international commissions for the defining of standards of protection for the occupationally exposed worker in the use of ionizing radiation. However, in the last twenty years, with the large scale development of nuclear energy the need for adequate protection against ionizing radiation has become even more important.

1.3 It is known that all types of ionizing radiation are capable of causing damage to living cells. They are, therefore, all a potential hazard. However, throughout history mankind has been exposed to a wide variety of hazardous factors in his environment, to many of which he has been able to make a successful adjustment. Human life has always involved efforts to estimate and compare risks and to balance hazard against benefit to be gained. For example, drugs that save very large numbers of lives can, under certain circumstances, cause injury or death.

1.4 Therefore, any discussion of the hazards of ionizing radiation may be misleading if proper emphasis is not given also the beneficial aspects of many procedures that involve radiation exposure. The fact is well established that the benefits of the medical use of radiation in diagnosis and therapy far outweigh the hazards and that, given adequate measures, the use of radioactive substances and the peaceful use of nuclear energy represents great technological advances which are playing an increasing part in improving the lot of man.

1.5 It must be appreciated that man has always lived in an environment which includes ionizing radiation at a very low level of intensity. He has always been subject to radiation exposure from cosmic rays and from naturally occurring radioactive substances in his body, in the food he eats, in the water he drinks, in the air he breathes, in the earth on which he lives and in building materials. Whether continuous exposure to this low level of radiation is deleterious to man is still a matter of speculation. The obvious fact is that it cannot be avoided and it is, therefore, normal for man to live in this environment. At the other end of the scale, there is a much higher level of exposure to radiation which is known to be harmful. The knowledge in this area has accumulated from the use of radiation in the treatment of certain diseases, the study of the medical history of early workers in the field of radiation, the experience gained from the detonation of nuclear weapons, the study of the infrequent accidents in atomic energy establishments and experimentation on animals.

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* This code was prepared by the Radiation Technical Sub-Committee of the Occupational Health Committee of the National Health and Medical Research Council. The members of the Sub-Committee at the time of adoption of the Code were:— Mr. D. J. Stevens (Chairman), Dr. A. Bell, Dr. A. J. Christophers, Mr. I. J. Ferris, Mr. D. W. Keam, Mr. B. King, Dr. A. M. McArthur, Dr. G. H. McQueen, Dr. H. M. L. Murray, Dr. E. M. Rathus, Dr. G. C. Smith, Dr. A R. W. Wilson and Mr. B. W. Worthley.

1.6 From this evidence and from the knowledge that man has always lived in an environment of radiation it can be concluded that exposure to radiation up to a certain level can be accepted throughout the working life of a radiation worker without any significant risk of injury to the individual. This value is called the *maximum permissible dose*. It should, nevertheless, be emphasised that the evidence, while extensive, is not conclusive, particularly in relation to the effects of low doses of radiation when continued for long periods of time. A natural corollary of these observations is that all doses of ionizing radiation should be kept as low as practicable.

2. MODES OF IRRADIATION

2.1 The possible modes of irradiation can be divided into two types; external irradiation and internal irradiation.

2.2 External irradiation is due to the exposure to X-rays or radiations from sealed or unsealed radioactive sources external to the body.

2.2.1 A sealed source is defined as " a discrete amount of radioactive substance within a tight, firm and inactive enclosure which effectively prevents the loss of radioactive substances during routine use. In the presence of gaseous radio-isotopes a source would be regarded as sealed only if the enclosure is gas tight.".

2.3 The level of exposure from X-rays is dependent on—

2.3.1 The operating factors of the X-ray tube (kVp and mA);
2.3.2 The duration of exposure;
2.3.3 The protective barriers between the tube and the body;
2.3.4 The distance between the tube and the body.

2.4 The level of exposure to the radiations from radioactive substances external to the body is dependent on—

2.4.1 The type of radioactive substance;
2.4.2 The activity of radioactive substance;
2.4.3 The distance between the source and the body;
2.4.4 The protective barrier between the source and the body;
2.4.5 The duration of exposure to the rays.

2.5 Internal irradiation is a result of ingestion or inhalation of radioactive substances into the body with resultant exposure of the body as a whole and/or organs of the body into which such substances may be selectively absorbed.

2.6 The amount of radioactivity taken into the body depends on a variety of factors including—

2.6.1 The activity of the radioactive substance being handled.
2.6.2 Its physical state (e.g., liquid, gas, powder, massive solid, &c.).
2.6.3 Its concentration.
2.6.4 Methods of handling.
2.6.5 Personal hygiene.
2.6.6 The duration of handling.

2.7 The level of exposure resulting from the entry of a particular amount of radioactivity into the body depends upon—

2.7.1 The type and energy of the radiation it emits.
2.7.2 Its solubility and physical form.
2.7.3 The characteristics of the radioactive substance at the biological level (e.g. certain radioactive substances are selectively absorbed by certain organs of the body, such as iodine by the thyroid and radium and strontium by bone).

2.8 It is as well to recognise the degree of hazard associated with the two basic modes of irradiation. The handling of an unsealed radioactive substance may pose a much greater problem than the handling of a sealed radioactive substance of the same activity. This is illustrated by the luminous wrist watch. Many people wear such watches which contain small quantities of radioactivity (generally due to radium) in the luminous paint on the dial and hands. As a result such people are subject to external irradiation, but the level of dose received is a very small fraction of the maximum permissible. However, if the same quantity of radium were retained in the body, this could exceed the maximum permissible body burden for radium.

3. GENERAL RULES

3.1 The use of ionizing radiation in schools shall be solely for the performance of simple experiments to demonstrate fundamental principles, and the sources used and the methods of using such sources shall be such as to ensure that the degree of hazard is negligible.

3.2 The activity of individual sealed sources* should be the minimum practicable and shall in all cases be no greater than that listed as the minimum prescribed amount under or the maximum amount exempted from the relevant Radioactive Substances Legislation.

3.3 It is appreciated that licensing requirements for radioactive sources may vary from area to area, but it is emphasised that radioactive sources suitable for education purposes in schools, should never need to exceed the minimum quantities embraced by the definition of "a radioactive substance" as specified by legislation. Schools deciding to avail themselves of the opportunity to use radioactive sources should acquaint themselves with the requirements of the relevant Health Departments.

3.4 Luminous paints used on instruments (e.g., dial of a watch) may contain radioactivity (generally radium). When incorporated in an instrument such paints subject the user to a negligible quantity of external irradiation. However, any attempt to recover the radioactive substance will involve the possible ingestion or inhalation of the radioactive substance and so give rise to internal irradiation of the body. *Under no circumstances should attempts be made to recover the radioactive paint from luminous dials, or to obtain the paint in any other manner.*

* In general, sealed radioactive sources should be used. However, when adequate facilities are provided for their safe handling, storage and use, unsealed radioactive sources may be used in special senior courses for demonstration purposes by teachers only. Permission to use unsealed radioactive sources shall be obtained from the relevant Health Department.

3.5 Many schools will have available some naturally occurring radioactive substances in the form of uranium and thorium compounds. The amount of activity per gram of such compounds is extremely small and because of this, on a weight basis, they are potentially less hazardous than many other chemicals in use in schools (e.g., arsenical compounds). Adequate protection is provided if normal precautions relating to use of other toxic chemical compounds are used. If large quantities of these compounds, or if uranium or thorium ores are held, they should be stored in a ventilated area.

3.6 On no account should attempts be made to separate the more hazardous daughter products, namely radium and mesothorium, from the parent material (uranium and thorium).

3.7 X-ray generators shall not be used in schools, except where the X-ray generators are used for special trade or technical courses. Where such generators are used, it will be necessary for the school to hold a licence under the relevant Radioactive Substances Legislation.

3.8 Where X-ray generators are used for special trade or technical courses the code of practice applicable to that trade shall be used.

4. CONTROL OF SOURCES.

4.1 It shall be the responsibility of one member of the science staff of each school, who shall be designated the Radiation Safety Officer, to supervise the use of radioactive substances within the school.

4.2 The Radiation Safety Officer shall be responsible for the procurement, storage, issue and return of sources and the correct use of all radioactive substances.

4.3 The Radiation Safety Officer shall arrange for routine checks, at intervals not exceeding 6 months, of the efficiency and condition of all sealed sources.

4.4 The teacher in charge of a class shall account for all radioactive sources before the period of instruction is concluded.

4.5 Radioactive sources should be used by a student only when under the direct supervision of a teacher.

5. STORAGE AND LABELLING.

5.1 All radioactive sources shall be kept in a locked metal container.

5.2 Access to this container shall be limited to authorised members of the school staff.

5.3 The metal container shall be permanently labelled in such a manner to indicate that it contains radioactive substances.

5.4 Individual sources should be stored in separate, appropriately labelled, containers or compartments within the locked metal container.

5.5 Each separate sealed source shall be permanently labelled "Radioactive".

5.6 Each source should be quickly identifiable by the user.

6. HANDLING OF SOURCES

6.1 Sealed radioactive sources shall be handled with care and unnecessary handling of sources should be avoided. The following rules shall apply:

- 6.1.1 Radioactive sources shall only be handled by tongs or forceps.
- 6.1.2 Radioactive sources should be at a distance greater than one foot from the user.
- 6.1.3 Sealed alpha emitting radioactive sources shall be handled with extreme care because of the necessarily fragile nature of their construction.

7. DISPOSAL OF SOURCES

7.1 When a radioactive source is no longer required the relevant Health Department should be contacted in order to obtain advice on disposal.

8. THE DEGREE OF THE HAZARD.

8.1 When due consideration is given to the limitation on the type of source, the activity of radioactive substance to be used in schools, and the small total time in any one year such sources will be used by any one teacher or student, the degree of hazard from exposure to ionizing radiation to both teachers and students is negligible. Since some of the students of today will become the radiation workers of tomorrow, it is desirable that they appreciate the nature of the hazard and the degree of care considered necessary in the handling of radioactive substances.

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