BASIC HEALTH AND SAFETY STANDARDS

In recognition of the demonstrated fact that ionizing radiations can be harmful to man, the Agency's Statute authorizes it to adopt "standards of safety for protection of health and minimization of danger to life and property".

In March 1960 the Board of Governors approved a document, entitled "The Agency's Health and Safety Measures", which provided that the Agency's responsibility regarding health and safety required it to promulgate standards of two broad types: first, basic safety standards which prescribe maximum permissible levels of exposure to radiation and fundamental operational principles; and second, detailed operational standards relating to particular fields of application.

Standards of the second type have already been issued by the Agency with regard to the handling of radioisotopes (December 1958); the transport of radioactive materials (May 1961); and construction and operation of research reactors and critical assemblies (May 1961). Standards are in preparation dealing with the disposal of radioactive substances into the sea and fresh water.

During 1960 the Secretariat prepared a draft relating to basic safety standards, the first of the two broad areas identified by the Board. Subsequently the Director General convened a panel of experts to discuss the Secretariat's draft. The panel was chaired by Professor L. Bignard of France and included experts from 11 countries and from various interested national organizations. The panel met for the first time at the Agency's headquarters from 29 October to 2 November 1960. Following this initial series of meetings draft basic safety standards were circulated for comments to all Member States and to interested international organizations. The comments received were considered at a second series of meetings of the panel held from 29 May to 2 June 1961. A document embodying the conclusions of the panel was then transmitted to the Board of Governors for consideration at its meeting in March of this year. The Board decided to accept the document as a working paper and requested the Director General to submit it again to the meeting of the Board in June.

Maximum Permissible Doses

As indicated earlier, the Agency's Health and Safety Measures as approved by the Board of Governors in March 1960 states that the Agency's Basic Safety Standards shall have two parts, one prescribing maximum permissible levels of exposure to radiation, the other stating fundamental operational principles.

In determining maximum permissible doses, the Secretariat and the panel were guided by a further provision in the Agency's Health and Safety Measures which stipulated that the Agency's safety standards "shall in so far as possible harmonize with standards published by international organizations of recognized competence in the matter and be designed to invite international acceptance" and that these standards "be based, to the extent possible, on the recommendations of the International Commission on Radiological Protection (ICRP)".

Maximum permissible doses are stated in terms of a unit of measure called the rem. * The definition of this unit is a complicated one. It may give an idea of its value to state that the average dental X-ray delivers about 5 rems to the patient's jaw, and that in a routine chest X-ray a dose of about 0.3 rem is received in the chest.

The Agency's basic philosophy in establishing maximum permissible doses follows that which guided the work of the ICRP, stated as follows in that body's 1959 report:

> "Any departure from environmental conditions in which man has evolved may entail a risk of deleterious effects. It is therefore assumed that long continued exposure to ionizing radiation additional to that due to natural radiation involves some risk. However, man cannot entirely dispense with the use of ionizing radiations, and therefore the problem in practice is to limit the dose to that which involves a risk that is not unacceptable to the individual and to the population at large. This is called a 'permissible dose'."

While establishing dose levels which are termed "permissible", the Agency's standards emphasize the desirability of keeping the exposure of individuals and the number of individuals exposed as low as practicable.

The maximum permissible doses include doses which may arise both from internal radiation, that is from inhalation or ingestion of radioactive substances, or from external radiation, that which arises from sources outside the body. An appended table shows the concentrations of various nuclides which, if breathed in during working hours over a three-month

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* *The rem is the absorbed dose of any ionizing radiation which has the same biological effectiveness as one rad of X-radiation. The rad is the unit of absorbed dose and one rad is 100 ergs per gram.*

period, would result in maximum permissible doses to workers for that period. If external radiation is also present, these concentrations would have to be reduced proportionately.

The maximum permissible doses do not include any doses resulting from exposure to natural radiation or doses to patients as a result of medical examination or treatment, although the doses received from these sources were borne in mind in determining the maximum permissible doses.

The standards aim to minimize two types of radiation injuries, called somatic and genetic injuries, respectively. Somatic injuries manifest themselves in the exposed individual, and include leukaemia and other malignant diseases, impairment of fertility, cataracts and shortening of life. Genetic injuries manifest themselves in the descendants of the exposed individuals, and may not be apparent for many generations.

Maximum permissible doses are prescribed for four classes in the population, as follows:

(a) Workers directly engaged in radiation work;

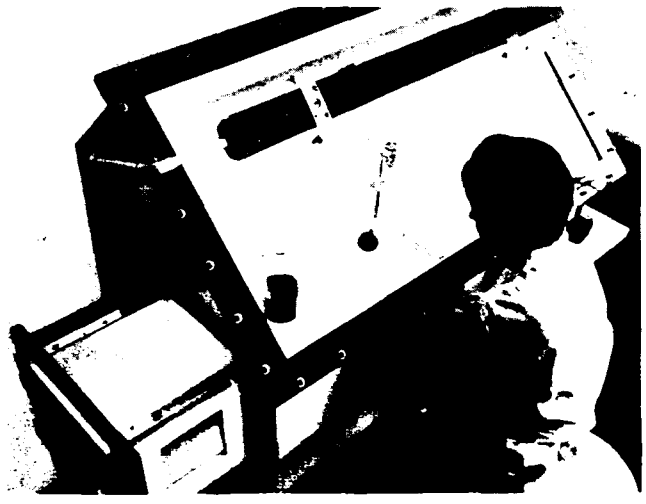
(b) Workers who are not directly engaged in radiation work but who remain or pass where they may be exposed to ionizing radiations or radioactive substances;

(c) Individual members of the public; and

(d) Whole national populations.

For radiation workers, the possibility of somatic injury to the exposed individuals was borne most in mind in determining permissible doses, although, as will be shown, the genetic hazard was not ignored. Special attention was paid to organs of the body judged to be most sensitive to radiation damage, namely, the gonads, blood forming organs, and lenses of the eyes. For these organs and for exposure to the whole body,

A way of protecting workers in atomic energy establishments from radiation is shown in this picture of a staff member at the IAEA's Seibersdorf Laboratory preparing a dilution of radioactive substances inside a glove box



the Agency's standards prescribe that the dose in rems accumulated by any radiation worker should not exceed five times the age of the worker less 18. Thus, no radiation worker should have accumulated more than 60 rems by age 30, for example.

The maximum doses prescribed for radiation workers take note also of the fact that the nature and magnitude of bodily injury caused to a person depend not only on the accumulated amount of radiation absorbed but also on the rate of absorption. Thus, a relatively large dose delivered in a short period may cause severe somatic injury, whereas the same t l dose spread over a longer period might have a considerably smaller effect. The reason for this is that human tissues possess in varying degree the ability to recover from the effects of radiation, probably by replacing damaged cells with new ones.

Accordingly, in addition to prescribing maximum accumulated doses for radiation workers according to the formula mentioned above, the Agency's standards also specify maximum exposures for such workers within each three-month period. Such maxima are stipulated, not only for the most radiation-sensitive organs, i. e. the gonads, blood forming organs, and lenses of the eyes, but for other organs as well. These quarterly maxima for radiation workers are as follows:

Gonads	3 rems
Blood forming organs	3 rems
Lenses of the eyes	3 rems
Whole body	3 rems
Bone	8 rems
Thyroid	8 rems
Skin of the whole body	8 rems
Hands, forearms, feet and ankles	20 rems
Any other single organ	4 rems

It is further stipulated that no worker under the age of 16 shall be employed for work involving ionizing radiation.

Where emergency work involving exposure to external radiation above permissible limits becomes necessary, the Agency's standards provide that such emergency doses for any worker should not exceed 12 rems to the whole body in any one year. Subsequent exposure of such overexposed workers must then be limited so that within five years their accumulated dose will once again conform to the prescribed level.

The standards also make provision for medical surveillance and adjustment of subsequent exposures when workers sustain abnormally high doses as a result of accidents.

To guard against excessive single exposures, maximum doses for the next two groups, namely, workers who may be in exposed areas as a result of their employment, and other individual members of the public, were also specified on a periodic basis, the period established being a year. The permissible doses prescribed (in rems) compare with maximum

doses prescribed for radiation workers (if the quarterly rates allowed the latter are accumulated on an annual basis) as follows:

	(a) Radiation Workers	(b) Other Workers	(c) Members of Public
Whole body	12	1.5	0.5
Gonads	12	1.5	0.5
Blood forming organs	12	1.5	0.5
Lenses of the eye	12	1.5	0.5
Bone	30	3	3
Thyroid	30	3	3
Skin of the whole body	30	3	3
Hands, forearms, feet and ankles	75	7.5	-
Any other single organ	15	1.5	1.5

In interpreting the above table, it is essential to understand that the 12 rems shown as permissible to a radiation worker for the whole body, gonads, blood forming organs and lenses of the eye, are permissible only if such doses do not cause the accumulated dose to those organs to exceed five times the worker's age less 18, the formula for maximum accumulated dose cited earlier. Furthermore, it is to be understood that the annual permissible doses shown for radiation workers cannot all be incurred at one exposure, since they represent accumulations of four quarterly maxima, whereas the doses shown for the other two groups may, within the standards, be incurred in single exposures.

Before commenting further on these comparisons of maximum doses for groups (a), (b), and (c), it is desirable to consider the maximum doses prescribed for group (d), the population as a whole. The primary criterion in establishing maximum permissible exposure of whole populations is genetic damage. This is thought to be proportional to the total dose to the gonads received by exposed individuals from conception to the age when reproduction ceases, and to be independent of the rate at which the dose is delivered. Accordingly, the Agency's standards prescribe for the whole population in terms of a "genetically significant dose" defined as the average gonad dose weighted for expected number of children. It is stated that this dose over a period of thirty years shall not exceed 5 rems.

It is now possible to consider further the maximum individual doses prescribed for groups (a), (b) and (c), as shown in the table presented earlier, and the reasons why they vary as they do. It will be noted that, subject to a formula limiting maximum accumulation to sensitive organs, radiation workers were allowed maximum doses several times larger than those allowed other workers, who, in turn, were permitted doses generally larger than those allowed individual members of the public.

As indicated earlier, the hazard of somatic damage was a primary factor in establishing the maxima for radiation workers. At the same time, it was considered that the number of persons in this group is at present very small - about 0.1-0.2 per cent of the population in technologically developed countries - and that most of these persons receive doses which are considerably less than the maximum permissible doses. Consequently, it could be calculated that the contribution which radiation workers as a group would make toward the allowable genetic dose for the population as a whole would be well within the limits of a reasonable compromise between the dangers of radiation exposure and the social benefits to be obtained from peaceful uses of atomic energy.

The same compromise required, however, that drastically reduced doses be prescribed for groups (b) and (c). Since they are numerically much larger than group (a), the consequences of their exposure to the genetic well-being of the population as a whole are proportionately greater. Furthermore, these groups may include children, pregnant women, and individuals subject to other hazards, all of whom are excluded from participation in radiation work. Special solicitude for such persons required that the maximum dose permitted to them as individuals be set lower.

Finally, since members of groups (b) and (c) contribute little to the social benefits obtained from atomic energy, there was little reason to risk deleterious effects from their exposure to radiation.

Fundamental Operational Principles

The Agency's Basic Safety Standards go beyond the work of the ICRP in including, in addition to prescribed maximum permissible doses, a further section entitled "Fundamental Operational Principles". This section sets forth mimimum administrative requirements for effective protection and surveillance of the health of radiation workers and other members of the population who may be exposed to radiation hazards.

It provides for the mandatory registration and licensing of operations which involve exposure to significant amounts of ionizing radiation or radioactive materials. It specifies also certain minimum requirements of administrative organization for radiation protection, such as the designation of a competent person to oversee protection regulations, the instruction of exposed workers, the provision of suitable protective equipment, and the investigation of accidental exposures.

The section further provides for the maintenance of appropriate physical and medical surveillance. Physical surveillance is to include such measures as examining new or changed installations, assessing working methods and protective devices, posting warning signs, monitoring radiation throughout establishments, and assessing doses received by workers, all with the intent of assuring effective compliance with basic safety standards.

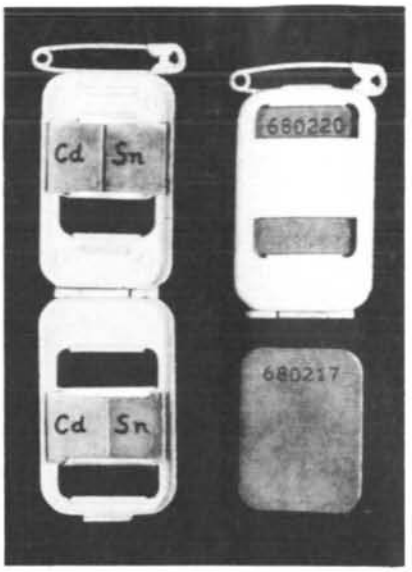
Medical surveillance should include periodic routine medical examinations of workers exposed to radiation and provision for the decontamination and medical treatment of overexposed workers.

The section on Fundamental Operational Principles also indicates the nature of records which must be kept giving the results of monitoring within establishments, and of the exposure of individual workers. On the latter point the document states: "Records of the assessment of individual doses shall be preserved during the lifetime of the person concerned and in any case for at least thirty years after cessation of the work involving exposure to ionizing radiation".

Radiation protection surveillance is also required outside establishments in which radiation sources are present.

Finally, a system of inspection and intervention is provided for, through which competent national authorities can take necessary measures in case of non-compliance, accident, or other situations resulting in excessive exposure.

It is noteworthy that, while the section on "Fundamental Operational Principles" states in general terms what measures should be taken to assure compliance with basic safety standards, it does not specify the detailed manner in which these measures should be carried out. The establishment of such detailed administrative procedures is left to competent national authorities.



Film badge of the type commonly worn by atomic energy workers to assess their exposure to radiation