Radiation exposure

Moving standards in 1950s

INTERNATIONAL recommendations on exposure to "ionizing radiations" were in a state of flux in the 1950s, when British nuclear weapons tests in Australia were at their height. According to Joseph Rotblat, the radiation physicist and past secretary-general of the Pugwash conferences, the central issue was the existence (or otherwise) of a threshold exposure, below which radiation would have no harmful effect.

The history was this. Britain had taken the lead (paradoxically, in the light of present Australian accusations) in radiation protection in 1921, with the establishment of the British X-ray and Radium Protection Committee — whose recommendations were first adopted internationally[1] in 1928, and promulgated by the Second International Congress of Radiology at Stockholm. At the time, those most in danger were hospital workers using X-rays and radium for treatment of patients. The known dangers were then said to be "injuries to the superficial tissues" and " derangements of the internal organs and changes in the blood". Protection measures were defined in terms of thicknesses of lead and similar materials between workers and radiation sources, rather than in amounts of radiation, although the röentgen (a measure of X-ray exposure) was introduced at the same conference.

The concepts of "tolerance" levels first appears in the international recommendations[2] of the Zurich radiology conference of 1934, which concluded that "the evidence at present available appears to suggest that under satisfactory working conditions a person in normal health can tolerate exposure to X-rays to an extent of about 0.2 international röentgens (r) per day...nonsimilar tolerance dose is at present available in the case of radium gamma rays". The procedural recommendations which then follow are "generally in harmony" with a 0.2 r threshold.

These recommendations remained in force, unchanged, for 16 years, through the 1939–45 war, Fermi's development of the atomic pile and the construction and use of atomic weapons. With the establishment of the International Commission on Radiological Protection (ICRP) at the sixth international congress on radiology in London in 1950, new recommendations[3] were published in 1951 and were considerably more extensive than those of 1934. These were in force during the early to middle part of Britain's tests in Australia. The first exhaustive recommendations of ICRP, including limits on internal exposure to radionuclides, however, did not appear until 1954, half way through the tests.

According to ICRP's 1951 recommendations, "the effects to be considered" were:

- Superficial injuries.
- General effects on the body, particularly the blood and blood-forming organs, for example production of anaemia and leukaemias.
- The induction of malignant tumours.
- Other deleterious effects including cataract, obesity, impaired fertility and reduction of life-span.
- Genetic effects.

Also "the previously accepted value of 1 r per week for maximum permissible exposure of external radiation itself needs revision in the light of the radiation to which workers are now exposed...the figure... seems very close to the probable threshold for adverse effects". Allowed levels were thus halved.

While thus including a reference to "thresholds", however, ICRP 1951 adds that "in view of the unsatisfactory nature of much of the evidence on which our judgements must be based, coupled with the knowledge that radiation effects are irreversible and cumulative, it is recommended that every effort be made to reduce exposure to all types of ionizing radiations to the lowest possible level".

The ICRP 1951 document also limits exposure to fast neutrons (measured in terms of energy absorbed per gram of tissue) to not more that one-tenth of that permitted for X-rays, thus introducing the concept of "relative biological effectiveness" of radiations. It was assumed that neutrons have an average tenfold greater effectiveness (in terms of damaging ion pairs per joule of energy deposited) than X-rays.

The revision[4] of ICRP 1951 in 1954 was essentially a new document (92 pages compared with seven), much of it concerned with setting — for the first time — maximum permissible body burdens and concentrations in air and water of a large number of radioactive isotopes. ICRP 1954 also makes the first definitions of the rad and rem, radiation units still effectively in use (except for a numerical factor). The recommendations also suggest limiting the exposure "of a large population" to levels a factor of ten below those permitted for occupational exposures.

The 1954 recommendations finally laid to rest the concept of threshold. "Since no radiation level higher than the natural background can be regarded as absolutely 'safe', the problem is to choose a practical level that, in the light of present knowledge, involves a negligible risk".

ICRP 1954 also considers in much more detail than the 1950 recommendations the exposure of "critical organs". X-ray doses were limited to 0.3 r per week to the blood-forming organs, gonads and eyes (roughly a fifth the pre-war whole body value) and 0.6 r per week to the skin.

The 1954 recommendations also limit "temporary" exposure. "Since it is generally impossible to predict how long a person may be occupationally exposed to radiation", say the recommendations, "it is prudent to assume that it may continue throughout his life. Therefore "temporary" exposure at levels higher than the permissible weekly dose should not be permitted", a recommendation which might be considered to apply, for example, to soldiers and others exposed to the effects of British tests in Australia.

All these recommendations were further revised[5] in 1958, and more recently. Current recommendations[6] are in ICRP publication 26, published in 1978.

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1. *Br. J. Radiology* **1**, 359 (1928)
2. *Br. J. Radiology* **7**, 695 (1934)
3. *Br. J. Radiology* **24**, 46 (1951)
4. *Br. J. Radiology Supplement no.* 6 (1955)
5. *ICRP Publication no. 1*, Pergamon Press, London (1959)
6. *Ann. ICRP* **1-2** (1977–9)

Halley's comet

Japanese launch

Tokyo

JAPAN's first Halley's comet probe (MST5) was successfully launched from the Uchinoura Space Center, Kagoshima, on Tuesday, 8 January.

The satellite, given the name *Sakigake* (Pioneer), orbited the Earth until Friday and was then sent on its way towards Halley by a puff of propellant gas released on command from the control centre. It will now go on to orbit the Sun almost one and a half times before passing about six million kilometres from Halley's comet in early March 1986. Japan thus becomes the third country — after the United States and the Soviet Union — to have successfully sent a satellite into interplanetary space.

The launch came after a series of delays, caused at first by bad weather and then by a malfunctioning nozzle, but is a resounding success for the new Mu-3SII launcher.

The 138-kg MST5 satellite is itself largely a test craft for the main Planet A Halley's comet probe, which will be launched in August. But as well as testing the various new control and communication subsystems, the satellite carries a range of scientific equipment. Observations will be made of plasma waves and electromagnetic wave radiations from the comet; of the interplanetary magnetic field; and of the temperature, velocity and density of ions in the solar wind. The launch has been arranged so that when the main probe Planet A, which will be carrying a camera to take ultraviolet pictures of the comet's hydrogen coma, is close to the comet, the test satellite MST5 will be situated downstream in the solar wind from the Sun. By coordinating the two sets of observations it should be possible to understand how the solar wind "blows" the long plasma tail of the comet away from the Sun.

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