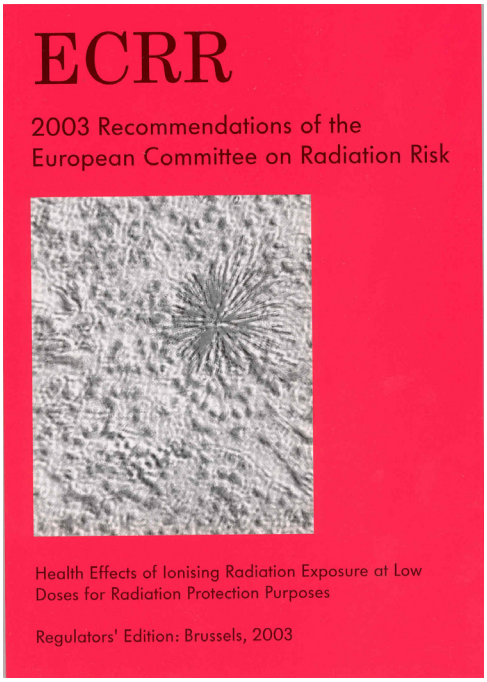

ECRR2003
A NEW SOURCE OF ADVICE ON THE HEALTH EFFECTS OF IONISING RADIATION

This first report of the European Committee on Radiation Risk is intended for regulators and those who have to make decisions about the health effects of radioactive releases. It presents a rational model for calculating the health risks of exposure to ionizing radiation. Unlike the existing framework of modelling radiation risk, the ECRR model uses evidence from the most recent research, from new discoveries in radiation biology and from human epidemiology to create a system of calculation which gives results which are in agreement both with the mechanism of radiation action at the level of the living cell and observation of disease in exposed populations.

This follows concerns about the conventional risk models advised by the International Commission on Radiological Protection, a body which has been widely criticised for lack of balance and for being self appointed and too close to the nuclear industry. The ICRP model entirely fails to explain ill health in populations exposed to internal radioactivity. The ECRR cites massive amounts of evidence; examples are effects following Chernobyl, the persistent 10-fold excess of childhood leukaemia near Sellafield, lymphoma in veterans exposed to depleted Uranium dust during the Gulf War and the Balkans, and breast cancer in the cohort of women who were adolescent during 1957 - '63 when nuclear weapons-testing was at its height. The UK government is sufficiently worried about the inability of the ICRP model to explain or predict such clear evidence of harm from internal radioactive exposures that in 2001 it set up its own Committee Examining Radiation Risk from Internal Emitters (CERRIE). Dr Chris Busby who is Scientific Secretary to the ECRR is a founder member of CERRIE and also sits on the UK Ministry of Defence Depleted Uranium Oversight Board (DUOB). In this volume, the committee explains how the present risk model came to be universally used, and points out its scientific shortcomings. It also addresses the ethical basis of releasing radioactive materials to the environment.

The volume is essential reading for anyone involved in legislation in this area and should also be of interest to members of the public who need to estimate the effects of nuclear discharges.

Summary of contents

The report outlines the committee's findings regarding the effects on human health of exposure to ionising radiation and presents a new model for assessing these risks. It is intended for decision-makers and others who are interested in this area and aims to provide a concise description of the model developed by the committee and the evidence on which it depends. The development of the model begins with an analysis of the present risk model of

the International Commission on Radiological Protection (ICRP) which is the basis of and dominates all present radiation risk legislation. The committee regards this ICRP model as essentially flawed as regards its application to exposure to internal radioisotopes but for pragmatic reasons to do with the existence of historical exposure data has agreed to adjust for the errors in the ICRP model by defining isotope and exposure specific weighting factors for internal exposures so that the calculation of effective dose (in Sieverts) remains. Thus, with the new system, the overall risk factors for fatal cancer published by ICRP and other risk agencies may be used largely unchanged and legislation based upon these may also be used unchanged. It is the calculation of the dose which is altered by the committee's model.

1. The European Committee on Radiation Risk arose out of criticisms of the risk models of the ICRP which were explicitly identified at the European Parliament STOA workshop in February 1998; subsequently it was agreed that an alternative view should be sought regarding the health effects of low level radiation. The committee consists of scientists and risk specialists from within Europe but takes evidence and advice from scientists and experts based in other countries.

2. The report begins by identifying the existence of a dissonance between the risk models of the ICRP and epidemiological evidence of increased risk of illness, particularly cancer and leukaemia, in populations exposed to internal radioactive isotopes from anthropogenic sources. The committee addresses the basis in scientific philosophy of the ICRP risk model as applied to such risks and concludes that ICRP models have not arisen out of accepted scientific method. Specifically, ICRP has applied the results of external acute radiation exposure to internal chronic exposures from point sources and has relied mainly on physical models for radiation action to support this. However, these are averaging models and cannot apply to the probabilistic exposures which occur at the cell level. A cell is either hit or not hit; minimum impact is that of a hit and impact increases in multiples of this minimum impact, spread over time. Thus the committee concludes that the epidemiological evidence of internal exposures must take precedence over mechanistic theory-based models in assessing radiation risk from internal sources.

3. The committee examines the ethical basis of principles implicit in the ICRP models and hence in legislation based on them. The committee concludes that the ICRP justifications are based on outmoded philosophical reasoning, specifically the averaging cost-benefit calculations of utilitarianism. Utilitarianism has long been discarded as a foundation for ethical justification of practice owing to its inability to distinguish between just and unjust societies and conditions. It may, for example, be used to underpin a slave society, since it is only overall benefit which is calculated, and not individual benefit. The committee suggests that rights-based philosophies such as Rawls's Theory of Justice or considerations based on the UN Declaration of Human Rights should be applied to the question of avoidable radiation exposures to members of the public resulting from practice. The committee concludes that releases of radioactivity without consent can not be justified ethically since the smallest dose has a finite, if small, probability of fatal harm. In the event that such exposures are permitted, the committee emphasises that the calculation of 'collective dose' should be employed for all practices and time scales of interest so that overall harm may be integrated over the populations.

4. The committee believes that it is not possible accurately to determine 'radiation dose to populations' owing to the problems of averaging over exposure types, cells and individuals and that each exposure should be addressed in terms of its effects at the cell or molecular level. However, in practice this is not possible and so the committee has developed a model which extends that of the ICRP by the inclusion of two new weighting factors in the calculation of effective dose. These are biological and biophysical weighting factors and they address the problem of ionisation density or fractionation in time and space at the cell level arising from internal point sources. In effect, they are

extensions of the ICRP's radiation weighting factors employed to adjust for differences in ionisation density resulting from different quality radiations (e.g. alpha-, beta and gamma).

5. The committee reviews sources of radiation exposure and recommends caution in attempting to gauge the effects of novel exposures by comparison with exposures to natural radiation. Novel exposures include internal exposures to artificial isotopes like Strontium-90 and Plutonium-239 which bind specifically to DNA but also include micrometer range aggregates of isotopes (hot particles) which may consist of entirely man-made isotopes (e.g. Plutonium) or altered forms of natural isotopes (e.g. depleted Uranium). Such comparisons are presently made on the basis of the ICRP concept of 'absorbed dose' which does not accurately assess the consequence for harm at the cell level. Comparisons between external and internal radiation exposures may also result in underestimates of risk since the effects at the cell level may be quantitatively very different.

6. The committee argues that recent discoveries in biology, genetics and cancer research suggest that the ICRP target model of cellular DNA is not a good basis for the analysis of risk and that such physical models of radiation action cannot take precedence over epidemiological studies of exposed populations. Recent results suggest that very little is known about the mechanisms leading from cell impact to clinical disease. The committee reviews the basis of epidemiological studies of exposure and points out that many examples of clear evidence of harm following exposure have been discounted by ICRP on the basis of invalid physical models of radiation action. The committee reinstates such studies as a basis for its estimates of radiation risk.

7. The committee reviews the models of radiation action at the cell level and conclude that the 'linear no threshold' model of the ICRP is unlikely to represent the response of the organism to increasing exposure except for external irradiation and for certain end points in the moderately high dose region. Extrapolations from the Hiroshima lifespan studies can only reflect risk for similar exposures i.e. high dose acute exposures. For low dose exposures the committee concludes, from a review of published work, that health effects relative to the radiation dose are proportionately higher at low doses and that there may be a biphasic dose response from many of these exposures owing to inducible cell repair and the existence of high-sensitivity phase (replicating) cells. Such dose-response relationships may confound the assessment of epidemiological data and the committee points out that the lack of a linear response in the results of epidemiological studies should not be used as an argument against causation.

8. In further considering mechanisms of harm, the committee concludes that the ICRP model of radiation risk and its averaging methods exclude effects which result from anisotropy of dose both in space and in time. Thus the ICRP model ignores both high doses to local tissue caused by internal hot particles, and sequential hits to cells causing replication induction and interception (second event), and merely averages all these high risk situations over large tissue mass. For these reasons, the committee concludes that the unadjusted 'absorbed dose' used by ICRP as a basis of risk calculations is flawed, and has replaced it with an adjusted 'absorbed dose' which uses enhancement weightings based on the biophysical and biological aspects of the specific exposure. In addition, the committee draws attention to risks from transmutation from certain elements, notably Carbon-14 and Tritium, and has weighted such exposures accordingly. Weightings are also given to radioactive versions of elements which have a particular biochemical affinity for DNA e.g. Strontium and Barium and certain Auger emitters.

9. The committee reviews the evidence which links radiation exposure to illness on the basis that similar exposures define the risks of such exposures. Thus the committee considers

all the reports of associations between exposure and ill health, from the A-bomb studies to weapons fallout exposures, through nuclear site downwinders, nuclear workers, reprocessing plants, natural background studies and nuclear accidents. The committee draw particular attention to two recent sets of exposure studies which show unequivocal evidence of harm from internal irradiation at low dose. These are the studies of infant leukemia following Chernobyl, and the observation of increased minisatellite DNA mutations following Chernobyl. Both of these sets of studies falsify the ICRP risk models by factors of between 100 and 1000. The committee uses evidence of risk from exposures to internal and external radiation to set the weightings for the calculation of dose in a model which may be applied across all exposure types to estimate health outcomes. Unlike the ICRP the committee extends the analysis from fatal cancer to infant mortality and other causes of ill health including non-specific general health detriment.

10. The committee concludes that the present cancer epidemic is a consequence of exposures to global atmospheric weapons fallout which peaked in the period 1959-63 and that more recent releases of radioisotopes to the environment from the operation of the nuclear fuel cycle will result in significant increases in cancer and other types of ill health.

11. Using both the ECRR's new model and that of the ICRP the committee calculates the total number of deaths resulting from the nuclear project since 1945. The ICRP calculation, based on figures for doses to populations up to 1989 given by the United Nations, results in 1,173,600 deaths from cancer. The ECRR model predicts 61,600,000 deaths from cancer, 1,600,000 infant deaths and 1,900,000 foetal deaths. In addition, the ECRR predicts a 10% loss of life quality integrated over all diseases and conditions in those who were exposed over the period of global weapons fallout.

12. The committee lists its recommendations. The total maximum permissible dose to members of the public arising from all human practices should not be more than 0.1mSv, with a value of 5mSv for nuclear workers. This would severely curtail the operation of nuclear power stations and reprocessing plants, and this reflects the committee's belief that nuclear power is a costly way of producing energy when human health deficits are included in the overall assessment. All new practices must be justified in such a way that the rights of all individuals are considered. Radiation exposures must be kept as low as reasonably achievable using best available technology. Finally, the environmental consequences of radioactive discharges must be assessed in relation to the total environment, including both direct and indirect effects on all living systems.

ECRR2003 is dedicated to Prof. Alice Stewart, who agreed to be its first Chair but who sadly did not live to see the recommendations published.

ECRR2003 (ISBN 1 897761 24 4) is published on behalf of the committee by Green Audit and is available by order from all bookshops, direct from the publishers or by emailing admin@euradcom.org, price EU75.00 or £stg 45. The committee is anxious to make the volume widely available and therefore has set aside copies to be sold at a concession price of EU25 (£stg.15) for those individuals, students, etc. who might find the full price beyond their finances. Application should be made to the secretary by emailing admin@euradcom.org

The committee will be publishing further reports on specific issues relating to radiation and health from time to time and will revise its advice in the light of new research results and following discussion among its members.

ECRR2003 was edited by Dr Chris Busby, with Dr Rosalie Bertell, Prof Inge Schmitz Feuerhake, Prof. Alexey Yablokov and Dr Molly Scott Cato.

46 scientists and others with a knowledge or interest in radiation risk assessment who have assisted in the discussions or in the preparation of the draft documents leading to the final report are listed.