possible to the routine work of the public service, preventing the howlers which are at present perpetrated by the generalists and helping also to ensure that major issues of public policy are dealt with in a manner that is technically sound and, with luck, imaginative as well. One unconvenanted benefit would be that the hosts of advisory committees which at present litter Whitehall could be reduced in number — one of the present government's ambitions. Perhaps the first British Prime Minister who happens to be a scientist might take up the shamefully neglected cause of making the British Civil Service more competent.

Radiation standards not yet for changing

The chequered history (see page 550) of the report on low-level ionizing radiation, published last week by the US National Academy of Sciences, should not detract from its value. The report was commissioned by the Environmental Protection Agency and has been prepared by the academy's Committee on the Biological Effects of Ionizing Radiation. It is popularly known as BEIR III to distinguish it from an earlier report in 1972 and from the first draft of this document (released just over a year ago before all the members of the committee had had their say). The issues with which it deals are of great importance, not merely for regulatory agencies such as the Environmental Protection Agency, for those concerned with industrial health and safety (not only in the nuclear industry) but also for the public at large, rightly concerned that there should be a judicious assessment of the potential hazards of ionizing radiation, especially that produced by the nuclear industry. The public importance of the topic has of course been keenly appreciated for the past quarter of a century, with the result that attempts to calculate the hazards of radiation have been made by national governments, independent organizations such as national academies and even by the United Nations. The particular value of BEIR III stems from that feature for which it is likely to be most criticized — for by including the opinions of members of the committee dissenting on scientific grounds from the main report, it serves to dramatize the uncertainties that persist in this difficult field.

The abiding difficulty in the estimation of the consequences of radiation exposure is that of extrapolating downwards, from the often tragic experience of people who happened to be living in Hiroshima and Nagasaki in 1945, those who were treated with X rays for a variety of diseases such as rheumatoid arthritis or ankylosing spondylitis in the 1930s or those who worked as radiographers before the hazards of radiation were fully appreciated, to the rest of us, whose organs receive 100 mrem a year (in round numbers) from natural and unnatural causes — cosmic rays, natural radioactivity such as potassium-40, visits to the orthopaedics people, airline travel and the like. Hitherto, most serious studies of how the extrapolation should be carried out have been based on the assumption that the risk of damage is proportional to the dose of radiation. (The days have long since gone when it was permissible to talk of a "threshold" dose below which radiation entailed no risk of damage.) BEIR III breaks new ground by flirting seriously with the notion that the relationship between the risk of damage and the dose of radiation that produces it may not be linear after all, but rather quadratic, at least where the induction of some kinds of cancers is concerned. (On the genetic consequences of radiation exposure, BEIR III follows earlier studies in affirming that only the linear extrapolation is prudent in the present state of knowledge or, rather, ignorance.) This is why the report has engendered controversy among its authors even before publication.

Superficially, it is true, even to entertain the possibility that the rate of induction of some kind of cancer may be proportional not to D (where D is dose) but to $\alpha+\beta D+\gamma D^2$ (where α is the spontaneous rate, and β and γ are constants to be adjusted to fit the data) looks like a way of resurrecting the threshold hypothesis. For if γ is positive, extrapolation downwards from large to small D will suggest that the risk of harm by small doses of radiation, such as those attributable to krypton-85 in the atmosphere, for example, will be disproportionately less than those attributable to large doses.

The argument of BEIR III by way of justification is plausible but not conclusive. To their credit, the authors have acknowledged this to be the case. The conjecture that to cause a cancer it may be necessary to break the same DNA molecule at two places (not just one) before natural repair mechanisms have had time to do their work is modestly advanced, with as full a list of the objections as anybody could ask for. The experimental data bearing on this point which are marshalled by the report are impressive, but derive mostly from animal studies. The document acknowledges that the information available about the causation of human cancer is not "robust" enough to distinguish between the possible dose–response models, although there is some reason to think that skin cancer does not turn up at low doses of radiation, that the relationship between leukaemia induction and radiation dose among the Japanese bomb survivors is adequately represented by a quadratic relationship but that the risk of breast cancer is linearly related to the dose of radiation.

Inevitably, a quadratic rather than a linear relationship implies that the risk of cancer induction after exposure to small doses of radiation is reduced. BEIR III includes comparisons of the calculated risks based on the two assumptions which suggest that the risk of cancer induction after exposure to, say, 10 rads of ionizing radiation will be halved if the relationship between risk and dose is quadratic, not linear. Superficially, that represents a substantial change, for which reason it is relevant that the earlier calculations (like those of BEIR III) are accompanied by large (and unavoidable) errors; the new estimates, based on the quadratic assumption, do not lie all that far outside the errors of earlier calculations. A more serious difficulty (to which one of the dissenters, Professor Edward Radford, draws attention) is the element of arbitrariness in the way in which BEIR III had to calculate the parameters in its quadratic relationship between risk and dose from a few clumps of data relating to high acute exposures.

How, then, should the regulatory agencies respond to BEIR III? Some, no doubt, will be tempted to say that present regulations for occupational exposure to radiation might safely be relaxed, although not by very much. It will be a mistake, however, if BEIR III is taken as a licence for such a step. For the report itself is properly so hedged about with qualifications (and packed with interesting but complicated evidence to suggest how sensitivity to radiation may vary with age, sex and genetic constitution) that it cannot be regarded as the last work on the subject. Accordingly, the regulatory agencies should for the time being stick to the assumptions on which their calculations have hitherto been based while setting out more energetically to test the interesting proposal put forward by BEIR III. Perhaps the most conspicuous omission from the report is the committee's own assessment of the work that needs to be done more adequately to underpin its argument and conclusion. It is, however, plain that much can be done to test the conclusions of BEIR III. Animal experiments designed to test the risk of specific kinds of tumours after exposure to radiation could help to distinguish between the linear and quadratic hypotheses. BEIR III itself makes much of the results of the classic epidemiological study by Court-Brown and Doll on the incidence of tumours of people treated with X rays for ankylosing spondylitis. It is too much to ask that the regulatory agencies and the nuclear industries throughout the world should apply the same care to the study of the health of the only substantial group now exposed to relatively large doses of radiation—those occupationally exposed in nuclear plants?