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THE RISK OF CHILDHOOD LEUKAEMIA NEAR NUCLEAR ESTABLISHMENTS

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ABSTRACT

Childhood leukaemia has been reported to be increased in communities living near a number of nuclear sites in the United Kingdom. The National Radiological Protection Board has, over the last three and a half years, published the results of a series of studies giving radiation doses and risks calculated for some of these populations. The studies have all indicated that it is most unlikely that radiation doses arising from releases of radioactive materials into the environment could have contributed to any increase in the leukaemia incidence in local communities. In the absence of any other obvious causative agent, however, there remains some concern that the radiation doses and risks of leukaemia have been underestimated. This report, therefore, summarises the methods used in the analyses by the Board, examines possible sources of uncertainty in the calculations, and considers the extent to which more information is required.

6. SUMMARY AND CONCLUSIONS

1. The main uncertainties in the analysis of radiation doses and risks of leukaemia to children and young persons living in the vicinity of nuclear establishments and the evidence available to support the calculations have been considered in this report. The results obtained from the Board's study of radiation doses and risks in Seascale have been used as an example. In that study, the doses and risks calculated from the Sellafield discharges were lower, by a factor of about 300, than those needed to account for the 5 cases of fatal leukaemia observed in the population between 1950 and 1980.

2. Uncertainties in the age-dependent risk coefficients for radiation-induced leukaemia and in the quality factor for high LET (alpha particle) radiation (Q=20) cannot account for this discrepancy. Any increase in these

parameters would also apply to radiation doses from natural radiation which is the main contributor to the calculated risk from both high and low LET radiation.

3. The main sources of uncertainty in the analysis are associated with the calculation of radiation doses from intakes of radionuclides and external exposure. As far as possible levels of radionuclides in foods and other environmental materials were based on measurements. Where appropriate information was not available it had to be derived from the discharge data.

4. In the period up to the closure of the Windscale piles in 1957 the main contributor to radiation exposure of the Seascale population from the Sellafield discharges was external radiation from short-lived ^{41}Ar released from the piles. Doses from this source cannot be substantiated and were based on reported discharges using atmospheric dispersion models as a basis for calculating exposure. Uncertainties in the release of ^{41}Ar are considered to be ±50%.

5. Following the closure of the Windscale piles the main source of exposure was the consumption of radionuclides in foods, particularly ^{90}Sr, ^{137}Cs, ^{239}Pu and ^{241}Am. The main evidence available for validating calculated intakes of radionuclides comes from measurements of ^{137}Cs and ^{239}Pu in persons from Seascale or the surrounding area. These measurements suggest that, if anything, doses from intakes of these radionuclides are likely to have been overestimated because of conservative assumptions in the calculations. More information on the levels of these and other long-lived radionuclides in the population (^{90}Sr and ^{241}Am) would be valuable for checking the calculated intakes.

6. Inhalation has been a less important pathway of exposure to releases from the Sellafield plant than ingestion. Information available on the concentration of long-lived radionuclides in soils in the Seascale area gives limited support to the calculated air concentrations, and hence intakes by inhalation.

7. The main areas where further information is needed for improving estimates of doses to the population from intakes of radionuclides include: the uptake and distribution of radionuclides in fetal tissues following intakes by the mother; the effect of age on the behaviour of radionuclides in the body; age related changes in the sensitivity of tissues to radiation and the location of sensitive cells in relation to internally deposited radionuclides. There

is, however, no indication that uncertainties in these parameters could have contributed to any substantial underestimates of doses and risks.

8. The Seascale analysis was based on radiation doses received by children with average habits; it is clearly not appropriate to identify children with extremes of behaviour and then assume them to be typical of the population as a whole for comparison with epidemiological results. There could be a few children in the population who received doses from the Sellafield discharges that are substantially higher than those received by children with average habits. However, even if the dose received by an individual child was increased, in some unknown way, by a factor of 10 or even 100 over that calculated for the average child, the risk of leukaemia would still be less than 1 in 1000.

9. One feature of the results obtained for different nuclear sites is the wide range in radiation doses that have been calculated for local communities, reflecting differences in the amounts of radioactive materials released into the local environment. If plant discharges had been implicated in the increased incidence of leukaemia then a correlation between the change in incidence and the calculated radiation doses for the different communities might have been expected. This has not been observed; in general, increases in reported risk have varied between factors of about 2 and 10 for differences in radiation doses varying by several orders of magnitude.

10. A wide range of parameters is involved in the calculation of the risk of leukaemia to children and young persons living near nuclear establishments. An examination of the main factors influencing the calculations for the Seascale population has not indicated that any of the uncertainties in the analysis are such as to suggest that radiation doses and risks at Seascale could have been substantially underestimated. Similar considerations apply to other sites in the UK where an increased incidence of childhood leukaemia in local communities has been reported. For the present it is therefore difficult to explain the observed incidence of leukaemia on the basis of environmental activity arising from nuclear sites.

11. Whilst much is known about the role of ionising radiation in inducing leukaemia, other agents have also been implicated. These include genetic factors, drugs, chemicals, and toxic materials. Infectious agents, particularly viruses, have long been suspected as a cause of human leukaemia and have been demonstrated to be a leukaemogenic agent in experimental animals. Despite extensive effort however, a viral origin for the human leukaemias has not been unequivocally proven. Socio-economic status also

influences the incidence of leukaemia in the population, higher social classes having an elevated incidence of leukaemia. Clearly, much more information is required on all the factors that can give rise to childhood leukaemia in a population before it will be possible to state with confidence that in any situation a particular factor is the main causative agent.