INVITED EDITORIAL

Confusion surrounding irradiated fuel particles released from Windscale

To cite this article: Antony Bexon 2007 J. Radiol. Prot. 27 111

View the article online for updates and enhancements.

Related content

- Uncertainty evaluation and expression in dose and risk assessment
  Penelope Allisy-Roberts and Philip Day

- Some recollections of UNSCEAR
  David Sowby

- Protecting humans and the environment
  Mike Thorne
INVITED EDITORIAL

Confusion surrounding irradiated fuel particles released from Windscale

In 1983, an Advisory Group was formed to investigate claims of an increased incidence of childhood cancer within the vicinity of the Sellafield plant (then Windscale Works) in Cumbria, UK. The Group, chaired by Sir Douglas Black, was specifically asked to review the evidence regarding an alleged cluster of leukaemia cases in children residing in the village of Seascale, approximately 3 km south of the Sellafield plant. The former National Radiological Protection Board (NRPB)\(^1\) was asked by the Advisory Group to review the possible pathways by which members of the public in Seascale might receive radiation doses due to discharges from the Sellafield plant. In estimating such doses, the main sources of exposure were considered to comprise natural background, releases of radionuclides from Sellafield, fallout from the testing of nuclear weapons and medical practices.

Releases of radionuclides from Sellafield were obtained for discharges to sea and to atmosphere, from routine planned operations and as a result of accidents or incidents. This information was collated from published and unpublished sources available at the time of the study. As might be expected, the data for later years of operation of the plant were more detailed than those available for the 1950s. One release of radioactive material recognised as particularly uncertain was that of uranium oxide particles discharged from the piles during operation. Initially, it was estimated that around 440 g of irradiated uranium, with associated radionuclides formed during burn-up, was released, equivalent to around 4 terabecquerels during the period from 1950 to 1957. At the time, the particles were estimated to be in the range from 50 to 700 micrometres in diameter and therefore were not considered respirable. Ingestion doses were estimated, but due to the uncertainties in the estimated releases of irradiated fuel particles, the emphasis of the original study was on the use of measurements of activity concentrations in milk taken from farms in the vicinity in 1958. These values were used to estimate concentrations in other foods, assuming that concentrations were constant during the period from 1953 to 1957. The study on the risks of leukaemia and other cancers in Seascale was published by NRPB in July 1984 [1] at a similar time to the main Black Advisory Group report [2].

Following publication of the study, British Nuclear Fuels Limited (BNFL) became aware of further information regarding the discharges from the plant in the early 1950s and undertook a comprehensive review of archived documents relating to the early operations on the Windscale Piles. As a result of the search, the initial estimate of the releases of irradiated fuel particles was revised from 440 g discharged to 20 kg discharged over the period from 1950 to 1957 with indications that some of the particulate matter released was of respirable size. The particles originated from damage to some fuel elements within the piles during operation or removal. The revised estimate for releases of particulate uranium matter, along with several other revised estimates of releases for other radionuclides, resulted in the clear need for an addendum to the original NRPB report to be produced to provide

\(^1\) NRPB was transferred to form the Radiation Protection Division of the Health Protection Agency (HPA-RPD) on 1 April 2005.
an updated dose assessment. As a result, a revised study was published in April 1986 [3] using revisions to the dosimetry and the estimated discharges. These changes led to a small increase in the estimated numbers of radiation-induced leukaemias. Specifically in relation to the releases of fuel particles, the revised study estimated doses due to a range of exposure pathways. For inhalation pathways, it was assumed that 5% of the material may have been of a respirable size. Taking this into account, doses due to inhalation were only a minor contributor (<0.1% of the total bone marrow dose). For ingestion, the revised study refined the previous approach by using measurements of activity concentrations of $^{90}$Sr in milk in 1958 but applied NRPB foodchain models [4, 5] to get a better picture of how concentrations in food varied over the period of interest. However, this revised approach had little effect on the overall assessment.

A recommendation was made by Sir Douglas Black [2] that a designated body should be formed with significant health representation to help decision-making with regard to permitted radioactive discharges. This led to the formation of the Committee on Medical Aspects of Radiation in the Environment (COMARE) in July 1985. The terms of reference of COMARE were to ‘assess and advise Government on the health effects of natural and man-made radiation in the environment and to assess the adequacy of the available data and the need for further research’. The first report by COMARE [6] dealt with new information that had become available since the Black Report was published and the implications of these data on the conclusions of the Black Report. NRPB was subsequently asked by COMARE to undertake a reassessment of the doses and risks to account for the scientific, dosimetric and epidemiological data that had become available since the first COMARE report. The 1995 NRPB study [7] concluded that most of the dose and hence the risk associated with ionising radiation exposure in Seascale was attributable to natural background radiation. In its fourth report [8], COMARE concluded that although there was a continuing excess of leukaemias and other cancers in 0–24 year-olds between 1984 and 1992, the current estimate of radiation doses to the Seascale population was far too small to account for the observed excess and, consequently, that Sellafield discharges seemed highly unlikely to be the sole cause of the excess cases. In essence, it was impossible to exclude environmental radioactivity (including natural background) as a contributory cause of the cases of leukaemia at Seascale, but it was stressed that there was no firm evidence of any causal relationship between environmental radiation and these leukaemias.

This issue of the journal contains a paper by Andrew Smith and his colleagues that reviews the releases of irradiated fuel particles from the Windscale Piles prior to the fire in 1957. The paper refers to reanalysis of plant data regarding the operation of the piles during this period, making use of log books, meeting notes and other sources of information. This reanalysis reconfirms that the mass of released fuel particles used for the NRPB Addendum was realistically conservative. Further information is provided on a review of the environmental measurement data upon which the original estimates of deposition were based. This is equally important with regard to the NRPB study given that environmental monitoring data in milk were used to determine the estimated intakes through ingestion pathways. It is a testament to the accuracy of the revised estimates of releases that they stand up to scrutiny following a fresh look at the evidence available and the application of modern tools and techniques to reanalyse the associated environmental data.

The output of such a comprehensive review of fuel particle releases would obviously have been extremely useful at the time of the original study. It would have helped to avoid the need for a revision to the study to be produced and the inherent criticism that occurs prior to the issue of revised results. The conclusions in the paper regarding the mass of irradiated fuel particles released and the conclusions surrounding the validity of the associated measurement
data for activity concentrations in milk support the findings of the revised study by NRPB and the study carried out for COMARE in 1995.

References


[5] Simmonds J R 1985 The influence of season of the year on the transfer of radionuclides to terrestrial foods following an accidental release to atmosphere NRPB-M121 (Chilton: NRPB)


Antony Bexon
HPA-RPD, Chilton