CHANGES IN LIQUID RADIOACTIVE WASTE DISCHARGES FROM SELLAFIELD TO THE IRISH SEA: MONITORING OF THE ENVIRONMENTAL CONSEQUENCES AND RADIOLOGICAL IMPLICATIONS

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INTRODUCTION

In January 1994, British Nuclear Fuels plc (BNFL) were granted revised authorisations for disposal of radioactive wastes from their Sellafield site in Cumbria, UK, including the discharge of liquid effluent to the Irish Sea. The revisions took account of a continuing Government commitment to review authorisations regularly, as well as of new Sellafield plants and changes to existing operations. The new plants of prime importance were the Thermal Oxide Reprocessing Plant (THORP) for the reprocessing of oxide fuels, and the Enhanced Actinide Removal Plant (EARP) for improved treatment mainly of waste streams from the older, Magnox, plant. Revision of the liquid authorisation is described in reference 1. Many of the radionuclide discharge limits reduced significantly, notably for Cs-137, Ru-106 and the actinides, to reflect operation of EARP. Increases in limits, of relatively low radiological significance, were granted for tritium and I-129 which would be produced by operation of THORP. An increase for C-14 covered diversion to sea of Magnox gaseous scrubber liquors, so as to reduce the overall radiological impact of these waste streams. Increases for Sr-90 and especially Tc-99 were to allow discharge, after phased processing through EARP, of liquors which have been stored on site for an optimised period to allow radioactive decay. Tc-99 is not treated by EARP, and Sr-90 is treated less effectively than the actinides or radiocaesium.

DISCHARGES IN 1994

At the time of writing this paper, discharge data and results of environmental monitoring are not complete for 1995, and comment is restricted to 1994. The trends in discharges from 1990-1994 are shown as the histograms in Figures 1-5. Following granting of the revised authorisation, active commissioning of THORP began but no active chemical separation took place in 1994. Diversion of the Magnox scrubber streams resulted in increased discharges of C-14 from a pre-existing level of about 2 TBq y^{-1} to about 8 TBq in 1994. EARP began active commissioning, and discharges of alpha emitters, radiocaesium and Ru-106 decreased as a result. Feeds of decay-stored liquors were also processed in EARP, and increases were observed in discharges of Sr-90 and especially Tc-99.

ENVIRONMENTAL MONITORING

MAFF carry out a comprehensive marine monitoring programme in the UK which is kept under review to take account of any changes in such factors as the discharges themselves, the habits of critical groups, and environmental conditions. The results of this monitoring are published annually, most recently for 1994 (2). Selected results of this monitoring are presented in Figures 1-6 to indicate trends in data as a result of changes in Sellafield discharges. In addition, significant monitoring of radionuclides in sea water, especially for Tc-99, has been carried out and the results will be published in due course.

Figure 1 presents concentrations of Ru-106 observed in winkles (*Littorina littorea*) from Nethertown, 5km north of Sellafield, which are of significance for the critical group of seafood consumers. Reference 2 considers sampling and analytical uncertainties; for the purposes of this paper representative ±10% error bars have been ascribed to concentration data. Figure 1 shows that Ru-106 concentrations in recent years have fluctuated mostly in line with the discharges, and the reduced discharges of 1994 have been reflected in lower concentrations.

Figures 2 and 3 present data for Pu-239/240 and Am-241 in winkles from Nethertown. Decreases in concentrations were observed in 1994 in response to reduced discharges. This would appear to indicate a component of uptake due to current discharges, in addition to the influence of the historic inventory in the Sellafield environment.

Figure 4 presents averaged data for C-14 in cod (*Gadus morhua*) and plaice (*Pleuronectes platessa*) sampled from near Sellafield. Concentrations increased in 1994 by about a factor of 2 compared with pre-existing levels. The higher levels of discharges (about a factor of 4) had probably not continued long enough in 1994 for their full effect on fish uptake to be observed.

For Sr-90, (Figure 5), discharges increased from pre-existing levels in 1993 because of changes in operation of the Sellafield site ion-exchange effluent plant, SIXEP, as well as in 1994 because of disposals of decay-stored liquors. An increase in concentrations of Sr-90 in fish, however, was not observed until 1994, indicating a slower rate of uptake than for C-14.

Rates of discharge of Tc-99 (Figure 6) changed rapidly in 1994 due to processing of decay-stored liquors, and discharges are plotted on a monthly basis. Quarterly data for concentrations observed in lobsters (*Homarus gammarus*) near Sellafield are illustrated, again because of radiological significance, and for the seaweed *Fucus vesiculosus* because of its strong uptake of Tc-99 and indicator potential. This seaweed is not eaten but it can be used as a fertiliser. Near Sellafield, the effects of the period of release of Tc-99 in March/April 1994, whilst observed in both species, were not as significant as for the period of September/October 1994. This could have been due to hydrographic factors, because both releases were observed in a more additive fashion in *Fucus* at St Bees, 10km north of Sellafield.

RADIOLOGICAL SIGNIFICANCE

Changes in plant operations at Sellafield have resulted in decreases in discharges of some radionuclides (mainly the actinides, radiocaesium and Ru-106) and increases in others (C-14, Sr-90 and Tc-99). Assessments of doses to potential critical groups, however, have shown continuing reductions (2). The critical group near Sellafield of high-rate fish and shellfish consumers received 0.08 mSv in 1994 compared with 0.10 mSv in 1993 (and higher doses in previous years) using ICRP-60 data. This confirms the minor radiological significance of those nuclides whose discharges have increased. Nevertheless, careful surveillance is continuing to ensure that this remains the case under the developing operational conditions.

REFERENCES

1. Smith, B.D., *et al.*. Proc. Reg. Cong. IRPA, Portsmouth, 233-238 (1994).
2. Camplin, W.C. Aquat. Environ. Monit. Rep. 45, MAFF, Lowestoft (1995).

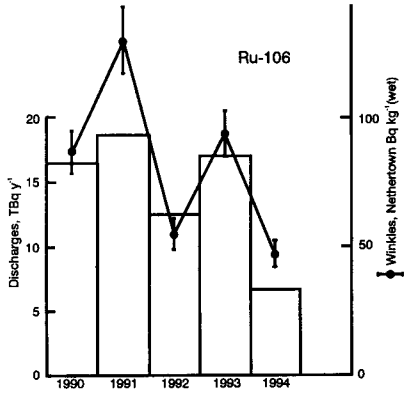
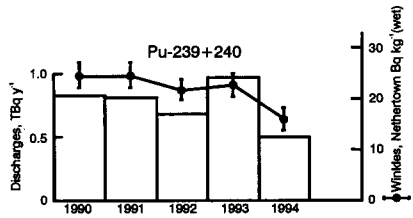


Figure 1.



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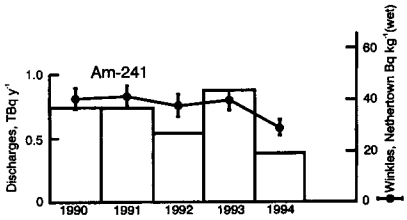

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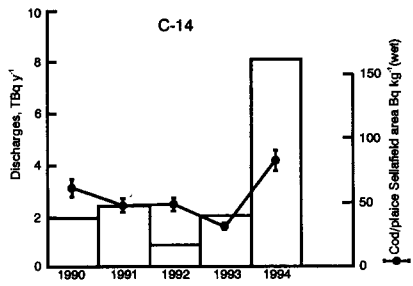

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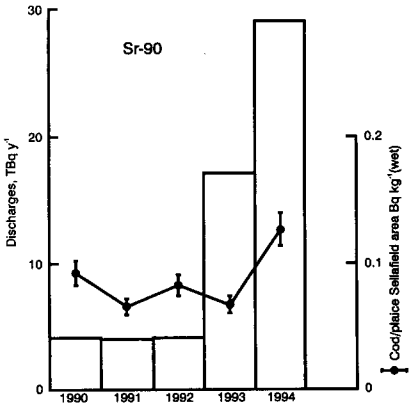

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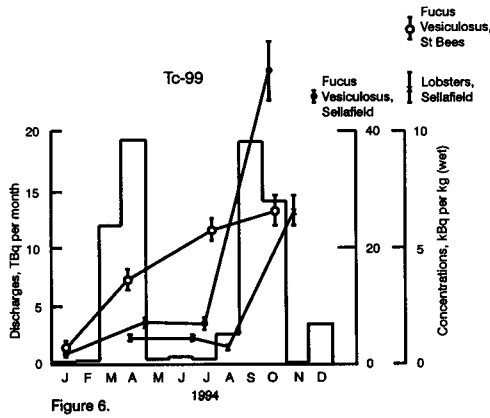

Figure 6.