

Nuclear Free Local Authorities

briefing



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Subject: Identification and discussion of some data “voids” in RPII’s “Assessment of Aquatic Radiation Pathways in Ireland: 2008”

This NFLA Policy Briefing is a written overview of a presentation provided to the NFLA Ireland meeting at Bray Town Hall on 16th October 2009 by Tim Deere-Jones, independent marine pollution consultant.

1. Introduction

The RPII report states that it “provides an assessment of aquatic radiation exposure pathways in Ireland” derived from man made radioactivity in the Irish Sea and states that these assessments were calculated from:

- a: Marine monitoring data gathered by the RPII in 2007
- b: The results of a “habits survey” undertaken on the northeast coast of Ireland.

The RPII Report and its calculations were carried out by CEFAS (Centre for Environment, Fisheries and Aquaculture Science). CEFAS is an executive agency of the UK Government. The RPII Report offers no explanation for the decision to contract out the work to an executive agency of a foreign government (which had already committed to an expansion of its Irish Sea based nuclear industry) rather than carry it out “in house”.

2. Marine radioactivity “experiment”

When discharges of man made radioactivity into the Irish Sea began in 1950, nothing was known about the behaviour of radioactivity in the marine environment. In 1958 the UK’s Atomic Energy Authority admitted that large amounts of radioactive waste were intentionally discharged into the Irish Sea in order to find out how it would behave and stated that “the aims of this experiment would have been defeated if the level of radioactivity had been kept to a minimum”.

3. Evolution of marine monitoring programme

During the 1960’s, the UK Government and Nuclear Industry began constructing a theoretical “model” for the behaviour of marine radioactivity in the Irish Sea. In summary this model argued that:

- a: water-soluble radioactive isotopes (such as Caesium) would dissolve in the water column, dilute and disperse as the water column moved.
- b: non-soluble radioactive isotopes (such as Plutonium or Americium) would not mix or dissolve and would remain stable on the seabed, adjacent to the point of discharge. close to the end of the pipeline.

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During the 1960's, the UK Government and Nuclear Industry began to construct a Marine Radioactivity Monitoring Programme based on their theoretical model. This programme measured radioactivity in marine animals and plants, water and sediments. In the context of the "theoretical model" it was natural that the Marine Radioactivity Monitoring Programme should focus particularly on point sources of discharges (sea pipelines) with a particular concentration on the Sellafield site, but also investigating environments around the sea discharge pipelines of all other nuclear sites.

4. Marine Radioactivity: evolving data base during 1970s & '80s

Academic research

During the 1970's and 80's independent academic scientific research began to provide revolutionary new data about the behaviour of marine pollutants including radioactivity. Organisations such as the UK's Institute of Oceanographic Sciences and the US Woods Hole Oceanographic Institute demonstrated that pollutants such as the non-soluble radioactive isotopes would

- a: become ADSORBED (attached to the outer surface of) marine fine sediment particles suspended in the water column;
- b: that the contaminated fine sediments could be subjected to long-term transport in the water column;
- c: that following such transport, the contaminated fine sediments were likely to be eventually deposited in "low energy environments" such as bays and estuaries and inter tidal areas, where radioactivity could re-concentrate to relatively high concentrations.

The findings of the independent academic bodies were supported by the outcome of research studies carried out by a number of campaigning research groups.

5. Other Independent Research

In 1986, the independent group RSPW (Radiation Survey for the People of Wigtownshire) conducted a study of the Cree Estuary in S.W. Scotland, about 100 miles of coastline from the Sellafield pipelines.

The UK Government had established one of its "distant" marine radioactivity monitoring sites at a village called Garlieston, a relatively stony bottomed harbour situated at the mouth of the Cree estuary. Monitoring results from Garlieston represent the data inputs for about 120 miles of South West Scotland's coast.

The RSPW study compared the results of the Garlieston monitoring (now carried out by CEFAS) against those of their own sampling and analysis of fine sediments taken from the very extensive mud flats of the upper reaches of the Cree estuary.

RSPW's work (carried out in 1986) showed that the Upper Cree sediments held 715 Bq/Kg of the Sellafield originating isotope Americium 241, while the "official" monitoring site at Garlieston held only 40.5 Bq/Kg of Americium 241.

This represents an 18 fold re-concentration of Americium (Am) 241 in the upper estuary fine sediments relative to those in the official site at the mouth of the estuary. The RSPW study recorded a similar pattern for Caesium (Cs) and the Plutoniums (Pu).

In the same year, another campaigning research group, the Irish Sea Project (ISP), sampled the Teifi estuary in southwest Wales, an area with no official monitoring sites. The ISP work sampled three estuarine sites (mouth of estuary, mid estuary and upper estuary) and demonstrated that Sellafield derived Am and Cs concentrations were elevated in upper estuary fine sediments relative to those at other sites.

Both of these independent studies proved that the new academic data was correct and that the official postulated models of behaviour for man made marine radioactivity were wrong.

Water-soluble isotopes may temporarily dilute and disperse but plainly CAN and DO re-concentrate at sites distant from discharge.

Non-soluble isotopes DO NOT remain bound to sediments at the end of pipelines. Non-soluble isotopes are transported over distance and re-concentrate in certain environments, especially fine sediment (silt or mud) deposits in mud flats and salt marshes in estuaries and bays.

6. Government and Industry response to the new data

In response to this new data, the UK's marine radioactivity monitoring programme was barely modified. While the bulk of the effort continued to focus on point source environments adjacent to pipelines there was some small increase in the monitoring of sites distant from point sources.

However, it is particularly noteworthy that these "distant" sites poorly reflect the new understanding that fine sediment deposits were the crucial environments where radioactivity concentrations reached their peak.

7. RPII Annual coastal monitoring programme

Although the annual monitoring programmes conducted by the RPII used 8 coastal sediment monitoring points in the years up to 2006 it is evident that none of the sediments monitored were representative of Ireland's Irish Sea coast mostly fine sediment environments (upper reaches of estuaries, fine sediment coastal bays etc).

Therefore, as explained above, the RPII coastal monitoring up to 2006 was not able to identify peak levels of radioactivity in the Irish coastal sediments and can not generate an accurate record of peak, average or mean concentrations.

The failure to generate accurate data on concentrations of environmental radioactivity plainly militates against the calculation of accurate doses of the radioactivity received by Irish coastal population groups.

It is particularly noteworthy that the RPII 2007 monitoring report (RPII-08-02) on which the dose rates estimates were based, did not analyse ANY coastal sediment samples.

8. Americium 241 (Am 241)

The isotope Am 241 is both an alpha and beta emitter, generally considered to be 2.5 times more radiotoxic to humans than the Plutoniums (Pu). Like the Pu, it accumulates (by adsorption to the outer surfaces of particles) in fine sediment environments and has now been shown to be readily available for transport when attached to fine sediment particles suspended in marine water columns.

Although Am 241 is, and has been, discharged to sea directly through sea discharge pipelines it is widely understood that the vast majority of Americium now in the marine environment has appeared as a result of the decay of Pu 241. For many years Pu 241 was considered to be of relatively low radiotoxic significance and the volumes discharged from the Sellafield site were not measured or recorded.

However by the mid to late 1980's it was understood that, as a result of the decay of the very large amounts of Pu 241, production of Am 241 would continue for many years, reaching peak concentrations by the end of the 21st Century, when it has been estimated that Am 241 production would reach levels of about 48 T bq per annum.

As a result of this information strict limits have been placed on the discharge of both Pu 241 and Am 241. By 2008 the legal limit on discharges of Am 241 from the Sellafield sea pipelines had been restricted to 0.3 Tbj per annum. On this basis it can be calculated that the end-of-century annual production of Am 241 in the Irish Sea, as a result of historically discharged Pu 241, will be equivalent to the annual Am 241 output of 144 Sellafields.

9. RPII's response to the Am 241 issue

As explained above, the RPII annual coastal monitoring programme doesn't investigate coastal fine sediment deposits. It is also the case that the RPII annual coastal monitoring programme does not analyse coastal fine sediments for Am 241.

Therefore the RPII are unable to provide any effective database against which to monitor future Am 241 delivery and its impact on Irish Sea coastal fine sediments. The RPII is gathering no effective data on the current and ongoing delivery of Am 241 and can make no assessment of rising Am 241 input into dose rate studies.

10. Sea to Land Transfer of marine radioactivity.

It has been demonstrated that man made radioactivity can be transferred from the sea to the land by a number of mechanisms.

In 1990 a winter storm overwhelmed sea defences on the North Wales coast and deposited hundreds of tonnes of marine sediment into the coastal town of Towyn. Samples of this sediment taken from streets, homes and gardens of Towyn contained high concentrations of Cs, Am and Pu.

However, the most significant mechanisms of sea to land transfer involve the production and inland penetration of sea spray and marine aerosols. Studies have shown that concentrations of man made radioactivity become "enriched" in breaking wave environments at sea and in the surf line as a result of processes known as "foam flotation" and "bubble scavenging". Bubbles forced beneath the surface scavenge, and re-concentrate particles and pollutants from the water column. When these bubbles return to the surface and burst the re-concentrated pollutants are released into the air contained in spray, jet drops and aerosols and are available for inland penetration on onshore winds.

Experiments in unenclosed "open coast" environments have shown that under such conditions Am 241 can be enriched in aerosols (relative to levels in the water column) by a factor of at least 583, Pu by a factor of at least 347.

The behaviour of such enriched aerosol and spray is very poorly understood. Monitoring of the phenomenon has proved very difficult and to date the various technologies used in attempts to investigate the amount of radioactivity passing across the shoreline are consensually agreed to be particularly useless for calculating the absolute quantity of radioactivity involved.

Although it is understood that the magnitude of the mechanism is closely linked to the strength and "fetch" of the wind, and the size and "fetch" of the waves, the size, height and coherence of spray/aerosol fronts as they move over the shoreline and penetrate inland remains virtually unknown.

RPII have not carried out any studies of spray/aerosol sea to land transfer of radioactivity in Irish coastal environments where the factors of large fetch, high winds and rough sea operate over an un-enclosed "open" coast.

11. Sea to Land Transfer impacts on terrestrial foodstuffs

Various non-government and non-industry groups have investigated the phenomenon of sea to land transfer and its radiological impacts.

In 1986 the Irish Sea Project built on their study of Am 241 and Cs in the Teifi Estuary in S.W.Wales by measuring the concentration of Sellafield derived Cs in terrestrial lichens (growing in trees) up to 10 miles inland. This study demonstrated that concentrations of Sellafield derived Cs declined with distance from the sea but were still detectable at the 10 mile point.

Following this (and the other ISP work) the local authority (Dyfed County Council) commissioned it's own survey (RADMID), the results of which broadly confirmed the ISP work, detected Sellafield sea derived Caesium in pasture grasses 10km from the sea and demonstrated that Sellafield sea derived radioactivity must be entering the dairy and meat stock food webs.

In 1987 the UK government carried out a Diet Study to examine the doses of 7 radioactive isotopes discharged from the 4 Hinkley nuclear reactors (located on the Bristol Channel coast) received by people living around the reactors and eating locally produced terrestrial foods.

A "control group" of locally produced terrestrial food consumers was identified at Kingsbridge located on the shores of the upper reaches of an extensive estuarine system in south Devon. This group was selected because it was considered to be distant from any point sources of radioactivity.

The outcome of the study delighted the nuclear industry, because it demonstrated that the dietary dose received by the group living around the 4 Hinkley reactors (14.2 microSv) was lower than that received by the Kingsbridge control group (16.0 microSv).

However, when analysed by this author, it was revealed that the whole study was deeply flawed. Although the diet sets were similar between both groups and most of the 7 isotopes were present in roughly equal concentrations, the excess dose delivered to the Kingsbridge group derived from the isotope Cobalt 60.

The source of the Cobalt 60 was discovered to be the Devonport nuclear submarine base 30 miles to the west of Kingsbridge and it was shown that the general movement of near surface sea currents had carried the Cobalt 60 30 miles downstream and into the Kingsbridge estuarine environment, from which it had transferred from the marine to the terrestrial environment and contaminated the locally grown foodstuffs.

It was also noted that the government had identified a Population Critical Group at Devonport and calculated that the dietary dose received by this group from the consumption of seafood alone was 12.0 microSv.

In a study published in the BMJ in 1991 an independent medical team compared Caesium (Cs) body burdens in patients from N.Uist (Western Isles of Scotland) to those in patients from the mainland of Scotland and investigated the source of Cs in the N.Uist patients.

The study demonstrated that islanders had excess body Cs compared to mainlanders. The dose source was excess dietary intake of Cs. Cs was identified in all types of island grown produce and environmental samples including both coastal and inland pasture grass. Island dairy, meat and fish products all had higher Cs concentrations than their mainland counterparts. Highest body burdens of Cs were found in those patients consuming the greatest dietary percentage of island produce. It was reported that the individual with the highest body burden "never ate fish". The average islander dietary dose of Cs alone was calculated at 13.7 microSv.

Analysis of the Cs indicated a clear Sellafield sea discharge component in most of the samples. **The study concluded that it was "important to note that an isotope discharged into the sea as waste, may return to land at considerable distance from the site of discharge and enter the human food chain"**

Table 1: Dietary dose rates

Some official Critical Groups (multiple isotopes)

Sellafield 1995 (seafood)	12.0 microSv
Springfields nuclear fuel factory 1995 (seafood)	6.0 microSv
Sizewell nuclear reactor 1991 (seafood & external)	5.0 microSv
Bradwell reactor 1985 (seafood & houseboat dwelling)	11.0 microSv
Devonport 1987 (seafood)	12.0 microSv

“Distant (un-recognised) Critical Groups”

Kingsbridge 1987 (local terrestrial foods)	16.3 microSv
N.Uist 1991 (island terrestrial foods: Cs only)	13.7 microSv

NB note the difference between dietary doses from seafood and those from terrestrial foods.

NB note that “distant” terrestrial diets contain dosage than those received by populations adjacent to “point sources” and nuclear installations.

Habits surveys of coastal populations identify the “pathways” of exposure to man made marine radioactivity. Assessment of doses delivered via those pathways identifies the Critical Group. In the UK CEFAS have identified seafood consumption, external (skin) exposure, and houseboat dwelling as significant pathways and Critical Groups whose dose rates are assessed annually.

In the RPII “Assessment of Aquatic Radiation Pathways In Ireland 2008”, CEFAS identify only the seafood consumption pathway Critical Group for dose rate assessment.

However, as the table above demonstrates, it is evident that on other coasts distant from point sources of discharge, sea to land transfer is shown to be occurring and to be responsible for significant dietary doses of man made radioactivity delivered via the terrestrial produce pathway. The doses received by these “Distant Critical groups”

This airborne radioactivity is evidently also available for inhalation and deposition in other coastal zone environments used by the inhabitants.

12. Summary – The major data voids in the RPII Dose Assessment report

- 1: No sampling and analysis of coastal fine sediments
- 2: No analysis of Americium or Plutonium in coastal fine sediment deposits (estuaries and bays)
- 3: No data on Americium arising in coastal fine sediments deposits (as a result of the Plutonium 241 decay)
- 4: No assessments of sea to land transfer over open coasts
- 5: No assessment of impact of sea to land transfer on terrestrial coastal zone local produce diet pathway
- 6: No assessment of inhalation pathway
- 7: No assessment of dose rates other than that from the seafood consumption pathway

Tim Deere-Jones, November 2009