Isle of Man Government
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DEPARTMENT OF ENVIRONMENT, FOOD AND AGRICULTURE

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GOVERNMENT LABORATORY

RADIOACTIVITY MONITORING ON THE ISLE OF MAN 2013

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1. INTRODUCTION

The Isle of Man Government carries out its own independent monitoring of environmental radioactivity on the Island [(1)]. The main objective of the monitoring is to provide public reassurance that levels of environmental radioactivity are below internationally accepted limits for public safety. This annual report details the results of the monitoring of radioactivity levels in foodstuffs and the general environment, for the year 2013.

Environmental radioactivity arises from a variety of sources, mostly natural, however some arises through releases from the global nuclear industry, whether by deliberate discharge (licensed or otherwise) or accidental release, including disasters such as Chernobyl. The radioactivity testing capability in the Government Laboratory was established following Chernobyl, however as that contamination reduced towards the trace levels remaining today, attention was drawn to Sellafield, the primary non-natural source of radioactive environmental contamination reaching the Isle of Man in recent years. The monitoring is not exclusive, however, and it is notable that traces of fallout from the Fukushima disaster in Japan in 2011 were detected here some weeks after the event, as recorded in the Annual Report for that year.

Laxev Harbour at low tide

Sellafield is the centre of Britain's nuclear industry, located on the Cumbrian coast only some 32 miles from the Isle of Man. The principal commercial activity at Sellafield is the reprocessing of spent nuclear fuel, which gives rise to different forms of gaseous and liquid radioactive waste. Although most of these materials are stored on site, the reprocessing operations mean that gaseous wastes are vented to the atmosphere and some low-level radioactive effluent is discharged into the Irish Sea. Authorised radioactive discharges from Sellafield make a very small addition to the public radiation exposure from the natural background radioactivity level on the Island. The proximity of Sellafield to the Isle of Man does mean that there is public concern about both the authorised waste discharges and operational safety at the nuclear site [(2)].

Nuclear safety and security at Sellafield is regulated by the UK Office for Nuclear Regulation (ONR). In November 2013, the ONR reported on the potential dangers from Sellafield's stored nuclear wastes and the necessary work required of the site operator 'Sellafield Limited', to improve safety and security standards. The ONR have prioritised the legacy wastes contained in storage ponds and silos for enhanced regulatory attention. Sellafield contains substantial volumes of nuclear waste which must be removed from existing waste stores and converted into a safer solid form. Continuing work to reduce nuclear hazards at Sellafield is likely to remain a UK national priority for the foreseeable future.

2. MONITORING OF FOODSTUFFS: 2013

Most foods contain trace amounts of naturally occurring radioisotopes. Some foods also contain traces of artificial radioisotopes. The presence of artificial radioisotopes in foods may be as a result of the waste discharges of the nuclear industry, or from fallout from nuclear accidents, or from past atmospheric testing of atomic weapons.

2.1 MILK

Manx milk was monitored on a monthly basis during the year 2013. Samples were obtained from four representative farms and also monthly from the Central Creamery. Table 1 shows the results of gamma spectrometric analysis of whole milk.
In the recent past the only artificial gamma-emitter detected was Caesium-137. During 2013 there was no detectable Cs-137 at the detection limit of 0.10 $Bq.L^{-1.}$

The trace of radiocaesium found in milk in earlier years was due to residual Chernobyl fallout [(1)]. The Caesium-137 concentrations were extremely small in comparison with the European Community (E.C.) recommended maximum permitted level for Cs-137 in milk for consumption by infants which is 400 $Bq.L^{-1}$. The artificial beta-emitter Strontium-90 has also been present at low concentration in milk since the 1950's atmospheric testing of atomic weapons. Analysis of Manx milk in previous years has found a fairly uniform concentration of less than 0.1 $Bq.L^{-1}$[(1)]. The EC maximum permitted level for Sr-90 in milk for consumption by infants is 75 $Bq.L^{-1}$.

TABLE 1: RADIOACTIVITY IN MILK (2013 and 2012 + 2011)

Whole Milk from the Central Creamery	2013	2012	2011
	Caesium-137 Becquerels per litre		
January	< 0.10	< 0.10	< 0.10
February	< 0.10	< 0.10	< 0.10
March	< 0.10	< 0.10	< 0.10
April	< 0.10	< 0.10	< 0.10
May	< 0.10	< 0.10	< 0.10
June	< 0.10	< 0.10	< 0.10
July	< 0.10	< 0.10	< 0.10
August	< 0.10	< 0.10	< 0.10
September	< 0.10	< 0.10	< 0.10
October	< 0.10	< 0.10	< 0.10
November	< 0.10	< 0.10	< 0.10
December	< 0.10	< 0.10	< 0.10

2.2 MEAT PRODUCTS

Samples of Manx lamb, beef and pork were collected from various shops from May to September 2013 (Table 2). A trace amount of radiocaesium detected in the samples of lamb can be attributed to residual Chernobyl fallout. The maximum legally permitted radiocaesium concentration in sheep meat is 1000 $Bq.kg^{-1}$. All samples of Manx lamb therefore contained less than 1% of the legally permitted maximum. Analysis of samples of beef and pork found no significant level of artificial radioactivity. The EC recommended maximum permitted level for radiocaesium in major foodstuffs (including lamb, beef and pork) is 1250 $Bq.kg^{-1}$.

TABLE 2 : RADIOACTIVITY IN MEAT PRODUCTS (2013)

Sample	Sampling Date	Origin	Cs-137	Cs-134
			$Bq.kg^{-1}$(fresh weight)	
Lamb	May	Manx	< 0.7	< 0.7
Lamb	May	Manx	0.8	< 0.8
Lamb (shank)	May	Manx	< 0.9	< 0.9
Lamb (shoulder)	August	Manx	0.8	< 0.7
Lamb (brisket)	August	Manx	< 0.5	< 0.4
Lamb (shoulder)	August	Manx	3.1	< 0.6
Beef (sausage)	September	Manx	< 0.6	< 0.5
Beef (sausage)	September	Manx	< 0.7	< 0.6
Pork (sausage)	September	Manx	< 0.6	< 0.5
Pork (sausage)	September	Manx	< 0.6	< 0.5

2.3 LOCAL FOODS

A wide range of locally produced foods have been analysed in previous years [(1)]. During the year 2013, samples of Manx grown Cabbage, and Gooseberries were analysed by gamma spectrometry and no artificial radioactivity was detected (Cs-137 less than 1.2 $Bq.kg^{-1}$ fresh wt.) Three samples of Manx honey were also analysed for traces of artificial radioactivity and the Caesium-137 content was determined as: < 0.3 $Bq.kg^{-1}$ and < 0.5 $Bq.kg^{-1}$ and 0.7 $Bq.kg^{-1}$ (fresh wt.).Wild foods such as heather honey and hedgerow berries collected from hill land can sometimes contain a trace of radiocaesium attributable to Chernobyl fallout [(4)]. These trace amounts of radiocaesium in locally produced honey present no radiological hazard to consumers of the product.

2.4 FISH AND SHELLFISH

Caesium-137 was detected at very low concentration in almost all of the seafood samples tested during the year 2013 (Table 3). The EC recommended maximum permitted level for Caesium-137 in fish and shellfish is 1250 $Bq.kg^{-1}$.
Analysis for total beta activity also indicated a low level of artificial radioactivity in local seafood.
Although discharges of radioactive effluent from Sellafield into the Irish Sea are well below the peak levels of the mid-1970's, from 1994 onwards there have been significantly increased discharges of the radioisotope, Technetium-99. For the past eighteen years Technetium-99 has been the principal contaminant in lobsters caught in Manx coastal waters.
Our monitoring results (Table 4) show that Tc-99 concentrations in locally caught lobsters averaged 30 $Bq.kg^{-1}$ during the year 2013, which is not significantly different from the 26 $Bq.kg^{-1}$ found the previous year. Technetium-99 concentrations in lobster meat have been on a downward trend over the period from1998, reflecting a cut in the actual quantities of Tc-99 waste discharged from Sellafield.

The low concentrations of Tc-99 found in 2013 are due to the fact that in 2003 BNFL began to re-route certain liquid wastes streams for on-land storage and also imposed a moratorium on Tc-99 discharges into the Irish Sea, pending plant-scale trials to evaluate a new technology to remove Tc-99 from liquid waste prior to discharge.
In April 2004, BNFL announced that it had received approval from the nuclear regulatory authorities [(5)] to use a new technology at Sellafield's waste treatment plants to cut by 90 % the existing discharges of Tc-99 into the Irish Sea. The new treatment process was developed to remove Tc-99 from a substantial volume of historic waste stored in tanks, and thereby allow for alternative on-land disposal of a solidified waste product.

Since 1998 the fall in Tc-99 concentrations in lobster meat has been slow and erratic due to several factors, including: the irregular pattern of Technetium discharges from Sellafield, the time-lag for dispersion of Tc-99 throughout the Irish Sea, and the natural variability to be expected when sampling lobsters. At present Tc-99 levels in locally caught lobsters are similar to the concentrations found prior to Sellafield's EARP waste treatment plant commencing operations in 1994. The trace amount of Technetium-99 in locally caught lobsters is likely to be the result of some remobilisation of the Tc-99 trapped on seabed sediments closer to Sellafield.

During 2013, concentrations of Tc-99 in lobsters caught off the Isle of Man remained lower than the levels of around 140 $Bq.kg^{-1}$ reportedly found in lobsters caught off the Cumbrian coast [(6)] Technetium-99 concentrations are now much reduced from the peak level of 418 $Bq.kg^{-1}$ found in February 1998. The presence of these low levels of Technetium-99 will result in only a very small radiation exposure to people who eat lobster on a regular basis.

TABLE 3: ARTIFICIAL BETA/GAMMA RADIOACTIVITY IN SEAFOOD LANDED ON THE ISLE OF MAN

Sample	Sampling Date	Location (2013)	Total Beta *	Cs-137	Cs-134	Co-60
				Concentration $Bq.kg^{-1}$(wet)		
Plaice	April	A	82	0.8	< 0.3	< 0.4
	June	A	88	0.6	< 0.2	< 0.3
	September	A	112	0.8	< 0.3	< 0.4
Cod	April	A	107	1.5	< 0.2	< 0.3
	June	A	100	0.8	< 0.2	< 0.3
	September	A	122	2.2	< 0.3	< 0.4
Haddock	April	A	107	0.6	< 0.2	< 0.3
	June	A	105	0.5	< 0.2	< 0.3
Hake	April	A	109	1.4	< 0.3	<0.4
	June	A	109	1.4	< 0.3	< 0.4
Lemon Sole	April	A	95	0.7	< 0.3	< 0.4
	April	A	95	1.2	< 0.2	< 0.3
	September	A	82	0.4	< 0.2	< 0.3
Torbay Sole	April	A	83	0.7	< 0.2	< 0.3
Dover Sole	September	A	108	2.0	< 0.3	< 0.4
Mackerel	June	A	105	0.5	< 0.3	< 0.4
	September	A	114	0.8	< 0.4	< 0.5
Brill	April	A	88	1.4	< 0.2	< 0.2
Pollock	September	A	101	3.9	< 0.3	< 0.4
Gurnard	April	A	105	2.1	< 0.4	< 0.5
	June	A	103	3.0	< 0.3	< 0.4
	September	A	79	1.1	< 0.2	< 0.2
Wrasse	September	A	113	1.7	< 0.2	< 0.3
Monkfish	June	A	108	1.2	< 0.2	< 0.2
Skate	June	A	96	2.5	< 0.3	< 0.4
Prawns	April	A	92	0.7	< 0.3	< 0.3
Scallops	April	A	102	0.3	< 0.3	< 0.4
	May	A	104	0.3	< 0.2	< 0.3
	June	A	78	< 0.2	< 0.2	< 0.2
	September	A	97	0.2	< 0.4	< 0.3
Queen Scallops	April	A	93	0.4	< 0.2	< 0.3
	June	A	71	0.4	< 0.3	< 0.4
	September	A	96	< 0.3	< 0.3	< 0.4
Crab	January	A	60	< 0.4	< 0.4	< 0.5
Lobster	January	A	79	0.3	< 0.3	< 0.4
	May	A	88	< 0.4	< 0.3	< 0.4
	June	A	71	< 0.6	< 0.5	< 0.7
	September	A	88	0.2	< 0.2	< 0.3
Location	A: IOM coastal waters					

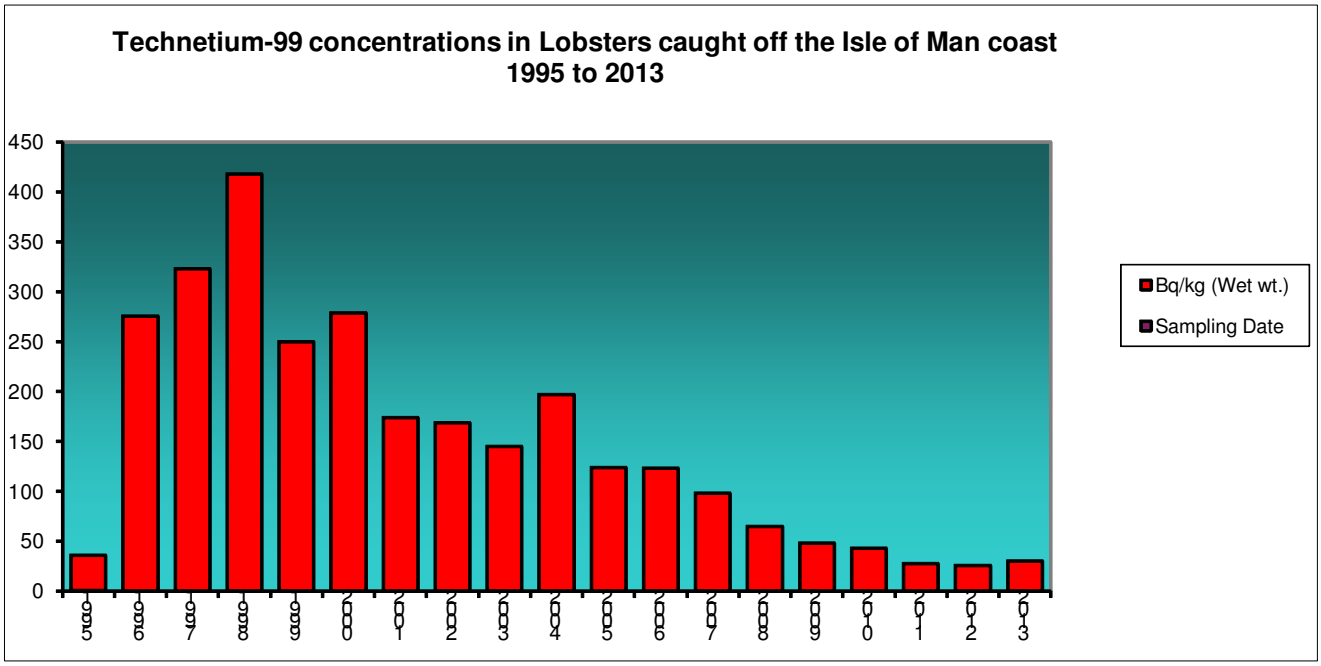
* Total Beta values include naturally occurring radioactivity.

TABLE 4: ACTIVITY CONCENTRATION OF TECHNETIUM-99 IN SEAFOOD LANDED ON THE ISLE OF MAN

Sample	Sampling Date	Tc-99 Concentration $Bq.kg^{-1}$ (wet)
Lobster	January 2013	28
Lobster	May 2013	27
Lobster	June 2013	49
Lobster	September 2013	17

The EC recommended maximum permitted level for Tc-99 in seafood is 1250 $Bq.kg^{-1}$, this is the lowest applicable Tc-99 limit under any circumstance and would be applied during any future radiological emergency.

Tc-99 analysis was performed by chemical separation on TEVA resin and Liquid scintillation counting. A recovery check was made using Tc-95m and gamma counting. Standards were supplied by the UK National Physical Laboratory.



3. ENVIRONMENTAL MONITORING: 2013

Under normal circumstances natural background radiation is the major contributor to public radiation exposure. In comparison any environmental contamination by artificial radioisotopes should be of little significance.

3.1 BACKGROUND RADIATION MEASUREMENTS

The Government Laboratory operates a three station Radioactivity Monitoring Network on the Isle of Man. The automatic radiation detectors continuously monitor background radioactivity levels on the Island.
The detectors are housed in remote monitoring cabinets located at Douglas, Ramsey and Snaefell mountain. The background gamma dose rate is measured at each location and additionally, the Ramsey station contains detectors to monitor alpha and beta particulate in air, and radioiodine. Monitoring can also be extended by collection of rainwater using Deposit gauges (BS 1747:1969).The purpose of the monitoring stations is to provide immediate information on radiation levels on the Island, in the event of an accident at Sellafield or any other nuclear site which could result in widespread radioactive contamination, such as occurred following the Chernobyl accident.

Whilst Sellafield is the largest nuclear site on the Irish Sea coastline, there are other licenced nuclear sites which are potential sources of accidental emissions. One of the smaller sites is the Low Level Waste Repository (LLWR) located near Drigg village in Cumbria. From an Isle of Man perspective it is unfortunate that the LLWR is only some 350 metres from the sea, and that the UK Environment Agency (EA) believe that it is likely to be destroyed by coastal erosion within hundreds to thousands of years. In relation to potential impacts on the Isle of Man, the EA has determined that any impacts on neighbouring countries will be insignificant, due to the distances involved and the dilution of any releases that occur in the air or sea. Nevertheless, the LLWR waste inventory does include some limited quantities of wastes presenting a long term hazard such as: high specific activity particles, items containing radium paint or plutonium and quantities of radioactive asbestos. In relation to such hazardous materials within the LLWR inventory, the Isle of Man Government would wish to see some practical mitigation measures being taken, to avoid radioactive contamination of the marine environment in the distant future.

3.2 SEAWEED AND HARBOUR SEDIMENTS

Seaweed was collected from the shore at Port Lewaigue, Laxey Harbour and Derbyhaven. Analysis for artificial gamma emitting nuclides found very low concentrations of Caesium-137 (Table 5).

Certain species of seaweed are known to bioaccumulate the beta-emitter, Technetium-99 to a significant extent. The uptake of Tc-99 from seawater by the brown wracks common to the Isle of Man coast, particularly **Fucus vesiculosus** has been widely reported [7]. Analysis of this species of seaweed collected from Port Lewaigue found 110 $Bq.kg^{-1}$ Tc-99 which shows a substantial reduction from the peak concentration of 3769 $Bq.kg^{-1}$ Tc-99 found in June 1997. The current levels are similar to the Tc-99 concentrations found in seaweed in the early 1980's [8] before increased inputs of Tc-99 due to commissioning of Sellafield's EARP waste cleanup facility. Present day concentrations of Tc-99 in seaweed do not present any radiological hazard to the general public using the Island's beaches, as the Tc-99 content of seaweed is far too low to give any measurable skin contact exposure, from handling seaweed.
Harbour sediment collected at low tide from five harbour areas contained low levels of radiocaesium and a smaller trace of Europium-155 (Table 6). The concentrations detected are certainly too low to constitute any hazard to people using these areas for recreation.

TABLE 5 : RADIOACTIVITY IN SEAWEED

Sample	Sampling (2013)		Total	Cs-137	Cs-134	Co-60	Tc-99
	Date	Location	Beta*	Concentration $Bq.kg^{-1}$(wet)			
Fucus vesiculosus(1)	4 March	Port Lewaigue	333	0.9	< 0.4	< 0.6	110
Fucus vesiculosus	17 July	Port Lewaigue	236	0.4	< 0.3	< 0.5	-
Ascophyllum nodosum(2)	17 July	Laxey Harbour	192	0.4	< 0.3	< 0.4	-
Fucus vesiculosus	29 July	Derbyhaven	179	0.5	< 0.3	< 0.4	-
Fucus vesiculosus	13 August	Port Lewaigue	187	0.6	< 0.3	< 0.5	
Fucus vesiculosus	16 Nov.	Port Lewaigue	240	0.7	< 0.3	< 0.4	-

Note: (1) Bladder wrack (a brown seaweed)
(2) Knotted wrack (olive green seaweed)
* Total beta values include naturally occurring radioactivity.

TABLE 6: RADIOACTIVITY CONCENTRATIONS IN HARBOUR SEDIMENT

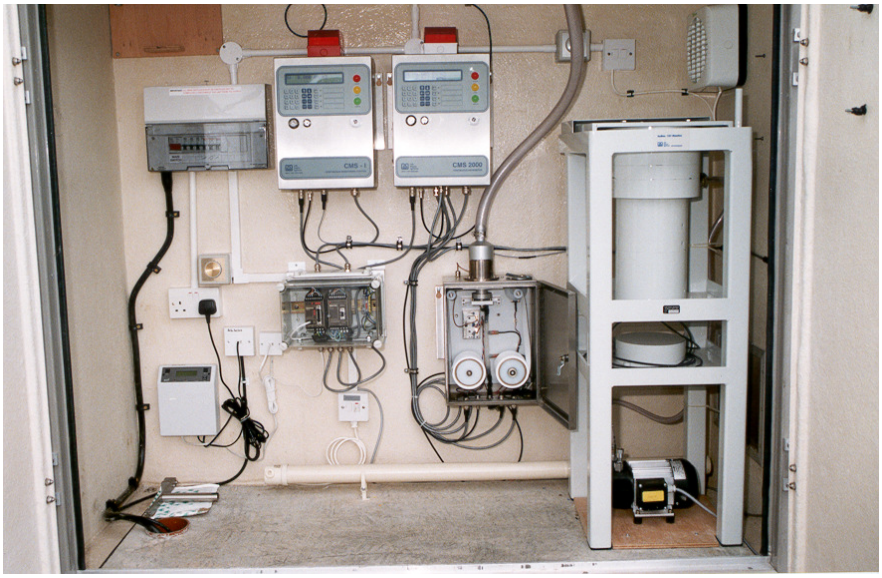
Sampling Location	Type	Date (2013)	Cs-137	Cs-134	Am-241	Eu-155
			$Bq.kg^{-1}$ (dry weight)			
Ramsey Harbour	muddy sand	13 September	4.3	< 1	< 2	1
Laxey Harbour	muddy sand	13 September	3.8	< 1	< 3	< 1
Douglas Harbour	not accessible #	----	n.a.	n.a.	n.a.	n.a.
Derbyhaven Harbour	muddy sand	13 September	4.4	< 1	< 3	< 1
Port St Mary Harbour	muddy sand	13 September	3.7	< 1	< 3	< 1
Peel Fenella Beach	muddy sand	13 September	3.7	< 1	< 3	< 1

Note: # sediments not exposed since construction of marina in 2001

4. ESTIMATES OF PUBLIC RADIATION EXPOSURE

The appropriate standard against which to judge the significance of inadvertent radiation exposure has been set by the International Commission on Radiological Protection (ICRP).

The I.C.R.P. recommends a principal dose limit for members of the public of one millisievert per year (1 mSv) from artificial sources, excluding medical procedures. Based on the results of monitoring Manx foodstuffs during the year 2013, the annual dose received by adults from artificial radioactivity in milk and seafood has been estimated [(1)] to total about 0.0025 mSv. The average dose to an adult from artificial radioactivity in food would therefore be less than 0.5% of the I.C.R.P. annual limit of 1 mSv, and for a high rate consumer of locally caught seafood, less than 2% of the I.C.R.P. limit.



Inside Ramsey Monitoring Station

5. CONCLUSIONS

1. Routine monitoring of Manx foodstuffs, including milk, and vegetables found no significant level of radioactivity in the majority of foods tested. Manx lamb sampled from shops during 2013 contained less than 1% of the legally permitted residual concentration of radiocaesium. No hazardous level of radioactivity was found in any of the foods.

2. Seafood landed on the Island during 2013 contained low levels of radioactivity associated with discharges from Sellafield. Technetium-99 still contaminates lobsters caught off the Manx coast; however, the Tc-99 concentrations have declined from a peak of around 400 $Bq.kg^{-1}$ in February 1998 to average 30 $Bq.kg^{-1}$ during 2013. These Tc-99 concentrations are lower than the levels found in lobsters caught off the Cumbrian coast. People who eat lobster on a regular basis will receive only a very small radiation exposure, which can have no measurable effect on health.

3. Background radiation levels on the Island were normal throughout the year. Radiation levels measured in harbour basins and on beaches were consistently low. Technetium-99 is found at low concentrations in seaweed collected from the shoreline, but does not constitute a hazard to people using beaches for recreation.

Appendix 1: References

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