Centre for Environment Fisheries & Aquaculture Science

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Radiological assessment of sediment samples collected by Fugro Alluvial Offshore Limited at Hinkley Point C Power Station, Somerset (2009)

(Cefas contact C7458HINK2)

Kins Leonard
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RADIOLOGICAL ASSESSMENT OF SEDIMENT SAMPLES AT HINKLEY POINT C POWER STATION, SOMERSET (2009)

SUMMARY

In 2009, Fugro Alluvial Offshore Limited collected sediment samples (surface and sub-surface) from various locations, at the proposed Hinkley Point C Power Station. The radioanalysis of these samples, by gamma-ray spectrometry, was sub-contracted to Cefas (under Cefas contract C3630). This report provides a radiological assessment of the 2009 radioanalysis results, as requested by Natural Resources Wales (dated 22nd January 2018), which includes data from surface and sub-surface sediment samples at each of the sampling locations.

Using the conservative generic radiological assessment procedure developed by the IAEA, to convert radionuclide concentrations in dumped material into radiation doses due to dumping, the derived total doses (using the 2009 analytical data) to individual members of the crew and public were 5.6 µSv/year and 1.9 µSv/year, respectively. The total collective dose was 0.044 manSv/year in 2009. The values for individual members of the crew and public, and the collective dose, were within the *de minimis* criteria of 10 µSv/year (individual doses) and 1 manSv/year (collective dose), respectively.

Therefore, from radiological considerations, there is no objection to this material being dredged and dumped.

METHODOLOGY AND ASSESSMENT DETAILS

In 2009, Fugro Alluvial Offshore Limited collected sediment samples from various locations, at the proposed Hinkley Point C Power Station. Surface and sub-surface sediment samples were collected (using a 6 m vibro-corer) at each of five sampling locations (depths of samples are provided in Table 1. Sediment samples were taken at the planned two Hinkley Point C intake locations (samples identifiers "VC", from the outfall location, and samples identifiers "VCJ", from further inshore at the planned jetty location, Table 1). The radioanalysis of these samples, by gamma-ray spectrometry, was sub-contracted to Cefas (under Cefas contract C3630). The sediment samples were received at the Cefas laboratory in November 2009. Cartographic information (i.e. map or specific site locations) were not provided to Cefas (only sample identifies as provided in Table 1). Following freeze-drying and homogenisation, radionuclide assay at the Cefas Lowestoft Laboratory was achieved by gamma-ray spectrometry on a high purity Ge detector.

Gamma-emitting radionuclides commonly emit gamma rays in the energy range, typically 60keV to 2MeV, corresponding to the typical energy levels in nuclei with reasonably long half-lives. Gamma-ray spectrometry is an analytical method that allows the identification and quantification of gamma-emitting radionuclides. The measurement gives a spectrum of lines, (i.e. many photons emitted at discrete energies). the amplitude of which is proportional to the activity concentration of the radionuclide.

In layman's terms, this means all potential gamma-emitting radionuclides (both naturally-occurring and artificial) in a sample, in the energy range (i.e. 60keV to 2MeV), are simultaneously scanned to identify and determine their activity concentrations. For the purposes of radiological assessment, under *de minimis* criteria, only selected gamma-emitting radionuclides (both naturally-occurring and artificial) are reported. This includes those radionuclides that are positively detected, or those that are reported below the detection limit (< value) but contribute to dose at the limit of detection; consistent with the developed methodology to assess dose in relation to disposal at sea under the London Convention 1972 (McCubbin and Vivian 2006).

Activity concentrations of gamma-emitting radionuclides ^{226}Ra, ^{232}Th and ^{238}U are determined via the assay of ^{214}Pb, ^{228}Ac and ^{234}Th, respectively.

A copy of the results, submitted to Fugro Alluvial Offshore Limited in December 2009, is also provided in Table 1.

Table 1. Report of radioactivity in sediment from Hinkley Point C, 2009

Customer: Fugro Alluvial Offshore Ltd
Contract / Sub-contract No: C3630
Description of sample(s): Sediment core samples
Description of methods of analysis used: Radionuclide concentration by drying
Report authorised by: Dr Kins Leonard & Steph Cogan
The results follow and relate only to the samples as indicated

Type of analysis: Gamma Spectrometry
Date of receipt of sample(s): Nov-09
Date of analysis: Dec-09
Date: 18/12/09

Sampled date	Sample Lsn	Depth m[1]	VC No[2]	Am-241	%error	Co-60	%error	Cs-137	%error	K-40	%error	Ra-226	%error	Th-232	%error	U-238	%error
09/11/2009	1230	0.0 - 1.0	VCJ9	<0.67	*-	<0.40	*-	23.52	4.53%	673.0	3.92%	25.25	5.88%	29.71	5.64%	48.73	7.49%
09/11/2009	1231	4.35 - 4.42	VCJ9	<1.24	*-	<0.30	*-	<0.30	*-	580.0	3.88%	27.65	6.43%	33.29	5.19%	46.13	8.84%
09/11/2009	1232	0.0 - 1.0	VC17	<1.38	*-	<0.30	*-	36.73	4.37%	654.0	3.87%	24.46	6.22%	33.78	5.37%	43.98	8.11%
09/11/2009	1233	3.00 - 3.08	VC17	<0.62	*-	<0.30	*-	<0.30	*-	584.0	3.91%	71.25	5.40%	29.32	5.53%	71.23	6.19%
15/11/2009	1234	0.0 - 1.0	VC9	0.65	38.19%	<0.40	*-	26.27	4.48%	664.0	3.90%	22.43	6.17%	29.47	5.57%	39.46	7.80%
15/11/2009	1235	4.70 - 4.80	VC9	<0.54	*-	<0.30	*-	<0.30	*-	614.0	3.89%	30.30	5.64%	40.73	5.03%	41.25	6.67%
15/11/2009	1236	0.0 - 1.0	VC36	<0.42	*-	<0.50	*-	0.98	24.57%	370.0	4.16%	15.56	7.35%	22.36	7.19%	30.83	8.48%
15/11/2009	1237	1.94 - 2.16	VC36	<0.51	*-	<0.30	*-	<0.30	*-	480.0	3.93%	29.10	5.64%	27.32	5.43%	50.90	7.04%
17/11/2009	1238	0.0 - 1.0	VCJ20R	<1.37	*-	<0.30	*-	43.14	4.35%	674.0	3.87%	25.29	6.09%	33.10	5.36%	50.25	9.94%
17/11/2009	1239	3.00 - 4.12	VCJ20R	<0.63	*-	<0.40	*-	<0.30	*-	480.0	3.95%	73.57	5.39%	25.85	5.62%	68.56	6.34%

Comments: All results are expressed as Bq/kg dry
< indicates that the result is below the limit of detection of the counting equipment.
% error indicates 1 sigma Total uncertainty
* inapplicable when result is below detection limit.

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Table 2. Activity concentrations used to assess dose (*de minimis* criteria) in surface and sub-surface sediment from Hinkley Point C, 2009

	Specific activity (Bq/kg, dry weight)					
	^{60}Co	^{137}Cs	^{226}Ra (via ^{214}Pb)	^{232}Th (via ^{228}Ac)	^{238}U (via ^{234}Th)	^{241}Am
***Average**	**0.32**	**13**	**29**	**30**	**49**	**1**

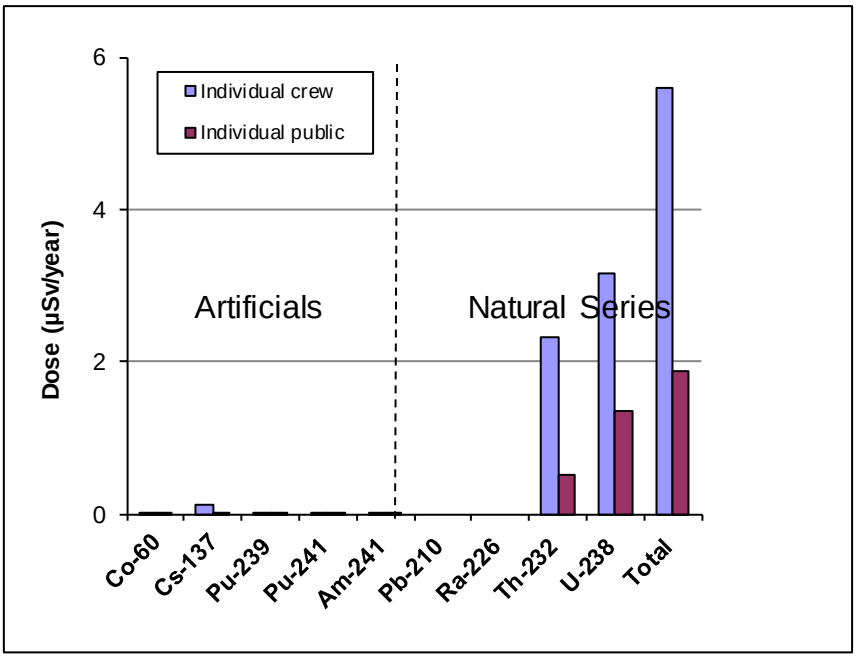
*Average determinations use < results as positively measured values to produce a conservative estimate

Table 2 provides the average activity gamma-emitting concentrations from surface and sub-surface sediment samples, from the individual results (provided in Table 1). In addition to the radionuclides detected by gamma spectrometry, sediments are also known to contain activities of Pu radionuclides. The ^{241}Am data were used to derive estimates for ^{239,240}Pu and ^{241}Pu (for the radiological assessment), assuming their activity was proportional to the ratio in the time integrated Sellafield discharges. This approach is reasonable given that both radionuclides are highly particle-reactive, hence the fate following discharge is similar. The activity concentrations for ^{210}Pb was derived using data for ^{226}Ra and assuming secular equilibrium.

Under the London Convention, only materials with *de minimis* levels of radioactivity may be considered for dumping. Using the conservative generic radiological assessment procedure developed by the IAEA (IAEA, 2003) and Cefas (McCubbin, and Vivian 2006), to convert radionuclide concentrations in dumped material into radiation doses due to dumping, the derived total doses to individual members of the crew and public were 5.6 µSv/year and 1.9 µSv/year, respectively. The total collective dose was 0.044 manSv/year. The values for individual members of the crew and public, and the collective dose, were within the *de minimis* criteria of 10 µSv/year (individual doses) and 1 manSv/year (collective dose), respectively.

The dose estimates for individual crew/public (by nuclide), derived using the generic IAEA model, are shown in Figure 1.

Figure 1. Assessment of dose to individual members of crew and the public arising. (Doses were derived using average activities listed in Table 2).



Since the conservative generic radiological assessment procedure indicated that doses received were well below recommended limits, a subsequent more detailed case specific assessment was not necessary. All the derived total dose values were less than the *de minimis* criteria of 10 µSv/year and 1 manSv/year for individual and collective dose, respectively.

In 2013 and 2017, the derived (radiological) total doses to individual members of the crew and public were estimated at the proposed Hinkley Point C Power Station using surface sediment samples only. For both assessments, the values for individual members of the crew and public, and the collective dose, were within the *de minimis* criteria (Leonard *et al*., 2013; Leonard *et al*., 2017.)

Both reports in 2013 and 2017 concluded that since the conservative generic radiological assessment procedure indicated that doses received were below recommended limits, a subsequent more detailed case specific assessment was not necessary. The radiological assessment using 2009 data from surface and sub-surface sediment samples supports this view.

Therefore, from radiological considerations, there is no objection to this material being dredged and dumped.

References

IAEA (2003). Determining the suitability of materials for disposal at sea under the London Convention 1972: A radiological assessment procedure. TECDOC-1375, IAEA, Vienna.

Leonard, K.S., Smedley, P.A. and Cogan, S.M. (2017). Radiological Assessment of Dredging Application for Hinkley Point C Power Station, Somerset (2017). Cefas Environment Report RL 05/17

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McCubbin, D. and Vivian C. (2006). Dose assessments in relation to disposal at sea under the London Convention 1972: judging *de minimis* radioactivity. Environment Report RL 05/06.

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Head office
Centre for Environment, Fisheries & Aquaculture Science
Pakefield Road
Lowestoft
Suffolk
NR33 0HT
Tel: +44 (0) 1502 562244
Fax: +44 (0) 1502 513865

Weymouth office
Barrack Road
The Nothe
Weymouth
DT4 8UB

Tel: +44 (0) 1305 206600
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