P-05-785 Suspend Marine Licence 1245ML –
Correspondence from Petitioner to Committee, 13.03.18

Dear Committee Chairman and Clerking Team:

As stated in my email of last week, the Campaign has been working on a further briefing in respect of the Radiological Surveys carried out by Gamma Spec' Analysis. Please find that Briefing attached to this email.

This Briefing addresses further issues relating to the three previous radiological surveys (2009, 2013 & 2017) but does NOT address issues relating to the Gamma Spec' Raw Data.

With regard to our issues regarding access to the Raw Gamma Spec' Data, I can inform you that the Campaign is about to undertake a final attempt to persuade CEFAS to help us to translate their preferred in house software into a format which is accessible to our analytical consultants. I apologise for the lack of progress in this area to date.

The Campaign would be most grateful if this message and its attachment could be distributed to the members of the Senedd Petitions Committee and if receipt of this message and its attachment could be confirmed.

With apologies to all concerned for this delay

Yours Sincerely
Tim Deere-Jones (for Postpone the Dump of Hinkley Radioactive Mud at the Cardiff Grounds "Disposal" site)

Briefing Paper from:

Postpone the Dump of radioactive Sediments at Cardiff Grounds

to Senedd Petitions Committee

Do the CEFAS Radiological Analysis Reports provide full data on the radio nuclides present in Hinkley sediments?

Submitted Monday March 12 2018

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Contents:

Summary Conclusions:

Section 1:

This Briefing supplements an earlier submission which discussed aspects of the CEFAS radiological surveys (2009, 2013, 2017) commissioned by the nuclear industry (EDF) and / or NRW.

Following CEFAS / EDF / NRW evidence given at Senedd Petitions Committee hearings, the Campaign requested (and has been granted) access to the Gamma Spectrometry Raw Data. To date it has not proved possible to overcome "conflicts" between the CEFAS software and that employed by the Campaign's independent radiological analysts, although efforts continue to reconcile the relevant softwares.

However, additional (limited) data made available has been reviewed by the Campaign and the results of that review are set out in the following pages of this Briefing.

Sections 2 &3:

EDF and CEFAS have proposed that the Gamma Spectrometry analysis has identified and quantified ALL radionuclides present in the Hinkley sediments.

However, the Campaign reports that it is universally understood that a number of radio nuclides DO NOT emit gamma rays, or do so only at very low levels, and that these radio nuclides cannot be identified, or quantified directly, by Gamma Spectrometry and must be identified and quantified by other means.

This is demonstrated by the fact that, although CEFAS could not identify or quantify the Plutonium content of the Hinkley sediments by Gamma Spectrometry, they knew from other sources that Plutonium was present in those sediments, and indeed have "estimated" that concentrations of Plutonium in the sediments are greater than the Americium 241 that their surveys did "positively" identify.

Sections 4&5:

The Campaign notes that Gamma Spectrometry did not, and could not, identify the presence or concentrations of Plutonium in the Hinkley sediments.

The Campaign draws attention to the fact that CEFAS were compelled to use the "derived estimate" process to conclude that average Plutonium content of the Hinkley sediments for all 3 surveys exceeded all of the "positive" findings for Americium 241 recorded by Gamma Spectrometry. The Campaign concludes that this fact alone is evidence that Gamma Spectrometry cannot and has not identified ALL of the radio nuclides present in the sediments.

The Campaign offers examples of a number of radio nuclides (all of which are known to have been present in the Hinkley liquid effluents) and universally known to be incapable of either identification or quantification by the use of Gamma Spectrometry.

Sections 6&7:
The Campaign notes that Gamma Spectrometry “counting” times deployed during the CEFAS analysis are reported as approximately 15 hour duration.

The Campaign references recent scientific studies which advise that research demonstrates that, for maximum efficiency of ID and quantification of lower level rates of radio activity concentration, count times exceeding 24 hours and up to 72 hours provide a far greater degree of identification and quantification accuracy.

The Campaign notes that the “less than” quantifications reported by the CEFAS surveys have generated confusing and contradictory outcomes which DO NOT clarify the understanding of radioactivity concentrations and presence in the sediments.

Section 8:
The Campaign notes that, despite ample reported evidence that the liquid radioactive effluents discharged from UK Nuclear Power Stations can contain scores of discrete“radioactive particles” (lime scale etc) carrying “substantial amounts” of fission products and trans-uranics (Plutonium, Americium, Curium, etc.), there is no evidence that the CEFAS surveys have attempted to search for, identify and isolate such particles in the Hinkley sediments.

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More detailed reporting of the above issues is contained within the numbered sections appearing in the following pages.

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9: Final Conclusion:
On the basis of the issues summarized within this Briefing, the Campaign concludes that the radio-analytical work carried out to date has not been able to identify, or quantify, the totality of the Hinkley derived radio nuclides contained within the sediments proposed for dumping at the Cardiff Grounds dispersal site.

The Campaign further concludes that the Welsh Government and the NRW have failed the populations of the Welsh coastal zone and may have breached their human rights.

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1: Introduction:
Having reviewed 3 discrete radiological surveys (2009, 2013 and 2017) commissioned and paid for by EDF, and carried out by the UK Government’s CEFAS laboratory, the Campaign remains deeply concerned about the low level, and the low standard of data presented in support of the EDF, NRW and Welsh Government claim that the radioactivity associated with the sediments presents NO environmental or public health risk.

The Campaign concluded that the 3 surveys had **"failed to provide sufficient, coherent, conclusive and precise scientific data for the assessment of radiological impacts to the inhabitants and users / stakeholders of the south Wales inshore waters and coastal zone"**

Subsequent EDF, CEFAS and NRW evidence to the Senedd Petitions Committee have not modified the Campaign's concerns

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Following the evidence from CEFAS, EDF and NRW, the Campaign requested access to the RAW DATA produced by the CEFAS Gamma Spectrometry analysis, and CEFAS forwarded us the material in question. However, the "raw data" that CEFAS has provided is presented in a format (Canberra Genie analytical) that cannot be read by the Campaign's independent radiological analytical experts, who do not use that format. We have been in further contact with CEFAS who find themselves unable to assist further.

We have been in contact with specialists from the "Canberra" company who have offered additional information, but to data that information has NOT been sufficient to clarify a way forward for our analytical expert to access the CEFAS data. The Campaign, and our analyst, continue, as a matter of priority to seek a way to untangle this problem, but as of today we have no end date for this work.

However, ongoing scrutiny of data from other relevant CEFAS sources has revealed further information of high relevance to the EDF claim that Gamma Spectrometry can describe the TOTALITY of radio nuclide concentrations in the Hinkley sediments information.

This additional information is now shown (in the following paragraphs) to directly contradict claims made by EDF, that the Gamma Spectrometry analysis carried out by CEFAS has revealed precise data on ALL of the radio nuclides expected to be present in the Hinkley sediments.

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2: EDF and CEFAS reporting (to date) on the radioactivity in Hinkley dredge/dump sediment

a: CEFAS reporting of sediment radiological analysis (2009, 2013 & 2017) conducted on the material proposed for dumping at Cardiff Grounds has reported the presence of only 3 of the 50+ man-made radio nuclides discharged to sea from the historic reactors at Hinkley Point

b: The Campaign has consistently expressed concern that many man-made radio nuclides, other than the Americium 241, Cesium 137 and Cobalt 60 identified by the surveys, might be present in the sediments subjected to the testing regime.

However, EDF have insisted that ALL radio nuclides present in the Hinkley sediments have been tested for, and identified, as set out (in the extract of transcript of the 5th Dec 2017 meeting of the Petitions Committee) below:

Neil McEvoy AM: Yes. Just following on from what the witness said earlier, the first question is: how many radionuclides were tested for?

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Peter Bryant 10:13:22

Perhaps I'll answer that one. So, basically the testing was done by CEFAS. They would have used something called high-purity germanium detection. It sounds very complicated, but in essence each radionuclide normally emits a gamma ray, which is a byproduct of alpha and beta decay. That's always at a specific energy, and that energy is like a signature that says, 'This particular radionuclide has emitted an emission of radioactivity.' So, the high-purity germanium detection system looks across all the energy range, really, so wherever there's a peak that corresponds to a particular radionuclide. *So, you detect actually what's present, and so it will detect way above 50 plus different types of radionuclides that occur in the environment*. So, it is very much looking for the signature of radionuclide: rather than just going, 'I'm going to target these three or four'; it goes, 'I look across the entire range of energies and I detect exactly what's present.' 147

Neil McEvoy AM 10:14:20
So, in effect, all the man-made radionuclides were tested for through that process.
Peter Bryant 10:14:27

Yes

My emphasis in italics

The statement made by Peter Bryant of EDF confirms the EDF assertion that **ALL** man-made radio nuclides *("exactly what's present")* had been tested for and that **ALL** radio nuclides present had been detected. Thus we may assume that it is EDF's position that the reporting of the 3 named man made radio nuclides (Americium, Cesium and Cobalt) confirmed that these were the **ONLY** man made radio nuclides detected, and hence the only man made radio nuclides present.

NB: This statement was a response to both the direct question from Neil McEvoy AM and previous evidence and written submissions from the Campaign

The Campaign rejects the NRW / EDF / CEFAS implied claim that **all** man-made radio nuclides present in the mud can be detected by the Gamma Spectroscopy, because it is the fact that a number of radio nuclides do not emit gamma rays (or do so in very small percentage of their decays) and therefore **cannot be identified or quantified** directly by gamma spectroscopy.

Non gamma emitters consist of a range of radio nuclides including a number of alpha and beta emitting Plutonium isotopes, Tritium (H_3) and organically bound Tritium *(Tritium bound to organic particles achieves high levels of bio- concentration in the marine environment and generates elevated doses to seafood consumers),* Strontium 90, Carbon 14, Phosphorus 32 and a number of others. These radio nuclides must be analysed by other means such as radiochemistry, alpha analysis or liquid scintillation counting for extremely low-energy beta emitters.

Proof of the inability of Gamma spectrometry to detect non gamma emitting, alpha emitters is evidenced by statements in the relevant CEFAS radiological survey reports (see below):

The 2013 & 2017 CEFAS survey reports states that *"In addition to the nuclides detected by gamma spectrometry, sediments are also known to contain activities of Pu (Plutonium) radionuclides.* ***The Am 241 data were used to derive estimates for the radio nuclides Pu 239, Pu 240 and Pu 241****, assuming their activity was proportional to the ratio in the time integrated Sellafield discharges"*

Ref: "CEFAS BEEMS Technical Report TR444, HPC intake and outfall location pre-dredge sediment sample analysis results. Page 30 of 36".

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3: CEFAS Plutonium estimates

It is evident from the statement reproduced in the preceding paragraph (above) that Plutonium isotopes **could not be, and were not, detected by Gamma spectrometry** and in order to obtain some form of quantification it was necessary to undertake extrapolated **"estimations"** from the available Americium 241 data.

The three surveys in question gave **no measured (or analysed)** quantification for the plutonium isotopes Pu 238, Pu 239, Pu 240 and Pu 241 as can be seen from the Tables entitled *"Radioactivity in Sediment dredged from Hinkley Point C"* presented in each of the 3 Radiological surveys.

The absence of empirical data on alpha emitters is somewhat surprising since the alpha emitting Plutonium isotopes are understood to be a major potential health risk if ingested or inhaled, and their presence in the Hinkley marine environment is explicitly, and regularly, referenced in the annual RIFE monitoring reports. However, since none of the relevant CEFAS reports provided details of the outcomes of the CEFAS Plutonium "estimates", in February 2018, the Campaign contacted CEFAS and requested details of those Plutonium estimates.

NB: RIFE Reports are annual Radioactivity In Food and the Environment Reports, generated by UK Regulatory Agencies including the Environment Agency, SEPA and the Food Standards Agency

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4: The CEFAS reply to Campaign query concerning Plutonium estimates

"We can confirm that the data for Pu-238, Pu-239+240 and Pu-241 are derived estimates (i.e. calculated from Am-241 concentration measurements). Moreover, given the Am-241 data are mostly reported as less than values, the plutonium nuclide data are very conservatively estimated values (in line with the tiered approach of the radiological assessment methodology and in line with the IAEA guidelines).

We can also confirm that the plutonium values are not given in the analytical results table (because the tables only contain measured values). The estimated plutonium values are included in the radiological assessment and reproduced in the Figure of dose to individual members of crew and the public. The conservatively estimated "average" activity concentration values for each Plutonium from the assessment are as follows (as specific activity (Bq/kg, dry weight);

2009	**2013**	**2017**
Pu 238 (estimated)	Pu-238 (estimated)	Pu-238 (estimated)
0.076029 **[0.07 Bq/Kg]**	0.135394 **[0.13 Bq/kg]**	0.115984 **[0.11 Bq/Kg]**
Pu-239+240 (estimated)	Pu-239+240 (estimated)	Pu-23+240 (estimated)
0.461494 **[0.46 Bq/Kg]**	0.821839 **[0.82 Bq/Kg]**	0.704023 **[0.70 Bq/Kg]**
Pu-241 (estimated)	Pu-241 (estimated)	Pu-241 (estimated)
4.098069 **[4.09 Bq/kg]**	7.297931 **[7.29 Bq/Kg]**	6.251724 **[6.25 Bq/Kg]**
total average for 4 Pu's	**total av': 4 Pu's**	**total av': 4 Pu's**
4.62 Bqs/Kg	**8.24 Bqs/Kg**	**7.06Bqs/Kg**
(my insertion)	*(my insertion)*	*(my insertion)*

CEFAS also state that "If the resultant dose was not considered to be *de minimis* (in this tiered assessment approach) then plutonium radio nuclides would be analysed by chemistry methods **(which have significantly lower detection limits than gamma-ray spectrometry)** to establish measured values - and the assessment would be repeated" (my emphasis).

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5: Campaign's response to CEFAS reply

The Campaign takes issue with a number of the CEFAS statements.

The Campaign warns that "derived estimates" should **NOT be considered as if they were empirical observations.**

The Campaign notes that the **average** concentrations of total Plutonium nuclides, indentified by the CEFAS "derived estimates" process, **far exceed the maximum positive concentrations of Americium 241** recorded in any of the three Gamma Spectrometry surveys carried out by CEFAS, thus the Pu concentrations are far more significant than the Am concentrations…. yet no attempt has been made to record them by empirical measurement and the information that is available is the result of **"estimations"** only.

The CEFAS radiological analysis reports on the Hinkley sediments, produced in support of the dredge and dump proposal clearly states that the Hinkley "*Am 241 data were used to derive estimates for Pu 239, Pu 240 and Pu 241, assuming that their activity was proportional to the ratio in the time-integrated Sellafield discharges".*

It is inferred from this statement that the CEFAS estimates of Plutonium in the Hinkley sediments are derived from assumptions that Americium / Plutonium activity "was proportional to the ratio in the time integrated Sellafield discharges".

However, annual RIFE Reports consistently state that the radio nuclides in the Hinkley marine environment are derived from multiple sources of both local (Hinkley, Oldbury and Berkely nuclear power stations) and more distant sources outside the Bristol Channel including Sellafield, weapons testing and Chernobyl. ***Ref: RIFE 22: 2016.pps 122 - 124***

The historical Hinkley A (Magnox) and Hinkley B (AGR) stations both discharged low levels of Plutonium nuclides and Americium-241 in liquid nuclear waste effluents released to sea over 50+ years. Lists of the constituent nuclides in the proposed Hinkley C liquid radioactive waste discharges also reference Plutonium nuclides and Americium-241 and also imply the presence of alpha emitting Curium (Cm-244, Cm-245 and Cm-248)

Given the long half-lives of Plutonium, Americium and Curium nuclides it is inevitable that a percentage of that Plutonium, Americium and other alpha emitters **discharged from the Hinkley A and B sites** will still be present in the sediments proposed for the dredge and dump scheme.

Thus, from the evidence of the official monitoring agencies, plutonium, and indeed other alpha emitters, in the Hinkley region are demonstrably derived from multiple sources. Therefore, the CEFAS proposition, that Plutonium concentrations in the Hinkley sediments can be calculated from "measured Americium data" on the basis of time integrated Sellafield discharges only, is flawed.

The issue is further complicated by the fact that the largely beta emitting Plutonium-241, with a half-life of only 14 years, decays to produce the alpha emitting Americium-241. Since the Hinkley A, Hinkley B, Oldbury and Berkeley reactors all discharged Plutonium-241 **and** Americium-241, it is evident that attempts to calculate total Plutonium levels on the assumption that "*Am 241 data ……was proportional to the ratio in the time-integrated Sellafield discharges"* are mis-directed and lacking in rigour.

For this reason, the Campaign has little confidence in the accuracy of CEFAS "estimates" of Plutonium (and other alpha emitters) since they are stated to be based only on the proportionality of Americium-241 in Sellafield related time integrated discharges and take no account of either Bristol Channel sourced Americium-241 (Hinkley A and B, Oldbury, Berkeley) or Bristol Channel sourced Plutonium-241.

Had Alpha analysis been deployed on the Hinkley sediments proposed for disposal at the Cardiff grounds site, the precise concentrations of alpha emitters in the sediments could have been quantified.

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6: Gamma spectrometry "Counting Times"

The Campaign has analysed scientific papers undertaking research and review of the methodology of Gamma spectrometry. From these papers the Campaign concludes that because such decay occurs randomly through time, the measurement of decay "events" detected over a given time period is never exact but represents an average value and that longer "counting" periods will provide more reliable results. In that context the Campaign understands that a certain amount of unreliability may be expected when results are presented, especially if the counting times are relatively short.

Data presented to the Campaign by CEFAS (machine "translations" of the raw Gamma Spectrometry data) indicates that the CEFAS methodology "counted" the samples for approximately 15 hours or 55,000 seconds. However many papers reference much longer counting times for maximum statistical efficiency.

Recent papers have explained that the 55,000 seconds is now regarded as an **"optimal measurement counting time", and that the "optimal" standard is achieved by arriving at the best balance between financial costs and the effectiveness of the Spectrometry results.**

There is now a consensus that "Better average values can be obtained by acquiring data over longer time periods" and " for the analysis of environmental samples with low radioactivity, a relatively long counting time is required e.g. up to 1-2 days to obtain accurate and precise results".

Ref: UNSCEAR Report to the General Assembly. Annex B: Exposures from Natural Radiation Sources (2000)

Ref: IAEA-TECDOC-1401: "Quantifying Uncertainty in Nuclear Analytical Measurements", International Atomic Energy Authority, (2004)

Ref: Nuclear Forensic International Technical Working Group, Guidelines Task Group, high resolution gamma spectrometry general overview: INFL-GSOV (2013)

A 2016 paper references counting "for 86,400 seconds (24 hrs) for effective peak area statistics of above 0.1%"

REF: Joel et al' "Precision measurement of radioactivity in gamma rays spectrometry using two HPGe detectors comparison techniques: Application to the soil measurement": published online 2016 Dec 31. Doi: 10.1016/j.mex.2016.12.003

A 2017 paper explains that "Better average values can be obtained by acquiring data over longer time periods" and "for the analysis of environmental samples with low radioactivity, a relatively long counting time is required e.g. up to 1-2 days to obtain accurate and precise results."

This paper also provides detailed analysis of fourteen consecutive analytical measurements of selected "natural" radio nuclides under the influence of different time measurement and counting statistics using HPGe detectors (similar to those used by CEFAS) for time periods ranging from 5 minutes up to 72 hours.

This paper shows that only one radio nuclide (Pb-212, a radioactive isotope of Lead, a decay product of Uranium-235) was detected after 5 minutes counting, but the related error was greater than 20%, longer counting time demonstrably reduced the related error. After ten minutes counting the radio nuclides Bismuth-212 and Potassium-40 were detected but their related errors were 27% and 33% respectively, again longer counting times reduced the related error.

At the other end of the scale Uranium-235 and Radium-226 required a count of 3 hours before they were initially detected but appropriate statistical results were not achieved until 24 and 36 hours respectively.

Figure 1 of the 2017 paper reports (in graph form) the Relative Error (in terms of percentage) , related to Specific Activity (Bq/Kg) of nine radio nuclides over the fourteen set count times and confirms that, after approximately 36 hours counting, the Relative Error for all nine radio nuclides is approaching its minimum level and that, as also shown in Table 1, the lowest error is achieved after 72 hours (259,200 seconds).
REF: "Optimal Measurement Counting Time and Statistics in Gamma Spectrometry Analysis: The Time Balance" Joel et al': American Institute of Physics, Conf Proceedings 1792 100001 (2017); doi: 10.1063/1.4969040

On this basis, the Campaign concludes that greater accuracy of measurements of radioactivity concentrations in the Hinkley sediments would have been achieved if longer counting times had been used, and that longer counting times were not deployed in the interests of reducing costs to EDF and that this conclusion is supported by the scientific research and reviews reported above.

The Campaign therefore has no faith in the accuracy or veracity of the claims put forward by EDF and apparently supported by the NRW (who have confirmed that they do not have any in-house marine environmental radioactivity expertise).

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7: Gamma spectrometry "Less than" results

The Campaign is also concerned by the "less than" results given in the tables of radioactivity in Hinkley sediments presented in the three CEFAS radiological analysis reports for the following reasons:

A: The Campaign notes the dis-continuity (*wide difference between*) between "less than" results for Americium-241 presented in the tables. For example, the 2013 results for 17 samples (Table 1) presents 14 of those results as "less thans" and 3 results as definitive positives.

The 14 "less than" results vary widely, ranging from "less than" 0.66 Bq/Kg to "less than" 1.71 Bq/Kg, with the maximum "less than" being more than twice as great than the minimum.

It should also be noted that of the three **positive** results presented in the 2013 table of Americium results (0.63 Bq/Kg, 0.97 Bq/Kg and 3.16 Bq/Kg), one (0.63) is lower than **all** of the presented "less thans" and the other is lower than 11 of the "less thans". Neither CEFAS nor EDF have offered an explanation for this dichotomy

Similar effects are noted for the tables for the 2009 and 2017 results.

B: The Campaign also notes the lack of continuity of Cobalt-60 "less thans" presented in the tables for the three surveys. For example, the 2013 results for 17 samples (Table 1) are all given as "less thans", but they range from "less than" 0.25 Bq/Kg to "less than" 0.49 Bq/Kg, with the maximum "less than" being nearly twice as great as the minimum "less than".

The Campaign concludes that these widely varying figures for "less thans", and the occasional "positives" which are smaller / lower than many of the "less thans", are a product of truncated count times and the wider relative errors associated with shorter counts.

In the context of the above, the Campaign concludes that the methodology used by CEFAS has generated confusing and contradictory outcomes. The Campaign therefore has little faith in the data produced for EDF by CEFAS using the relatively short counting times of around 15 hours compared to the frequently recommended, and much greater, extended counting times.

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8: "Radioactive Particles" Released from Nuclear Power Stations:

A study of the annual RIFE reports confirms the Campaign's concerns that there may be "particles" of relatively radioactive material (discharged from Bristol Channel nuclear power stations) in both the sedimentary environment of the south Wales coast **and** in those Hinkley sediments proposed for dredge and dumping off Cardiff Bay.

These are **not** the same type of Sellafield derived particles referred to in the submissions from Dr Chris Busby, rather they are radioactive particles like those found at the end of the discharge outfall of the Magnox nuclear power station at Chapelcross (southern Scotland) and identified by the authors of the RIFE Reports (Environment Agency, Food Standards Agency and Scottish Environmental protection Agency) as mostly "limescale" and believed to "originate from deposits within the pipeline".

In 2005, 95 such items were detected around the Chapelcross liquid waste outfall with radioactivity levels elevated above "background". Finds of similar particles had been reported from 1992 onwards. From the Campaign's brief review of the annual RIFE reports and their predecessors (the MAFF AEMRs) we conclude that the monitoring of "end of discharge outfalls" for "particles" is relatively uncommon at nuclear power stations as such activity is rarely reported elsewhere.

To date, despite our search of the available literature, the Campaign has NOT been able to find any reporting of such investigations at the Bristol Channel nuclear power stations (Hinkley A and B, Oldbury and Berkeley).

A scientific paper submitted to the 2009 "Radioactive Particles in the Environment" Conference confirmed that "Radioactive particles and colloids are also released via effluents from reprocessing facilities **and civil reactors, and radioactive particles are identified in sediments in the close vicinity of radioactive waste dumped at sea."** *(my emphasis)*

The 2009 paper further reported that "Radioactive particles in the environment are heterogeneously distributed and can carry substantial amounts of refractory fission products, activation products and transuranics. Samples collected may not be representative and inert particles can be difficult to dissolve. For particle contaminated areas, the estimated inventories can therefore be underestimated" *(transuranics include Plutonium, Curium and Americium).*

The 2009 paper also noted that "Radioactive particles in the environment are defined as localised aggregates of radioactive atoms" that give rise to an inhomogeneous distribution of radionuclides significantly different from that of the matrix background (IAEA CRP, 2001). In water, "particles are defined as entities having diameters larger than 0.45 μm, which will settle due to gravity, while particles larger than 1 mm are referred to as fragments. Particles less than 10 μm are considered respiratory." i.e. easily inhaled.
Ref: "Radioactive Particles Released from Different Nuclear Sources", (pp3-13) Brit Salbu: Conference paper, from "Radioactive Particles in the Environment": 2009: editors DH Oughton & V. Kashparov. Nato Science for Peace & Security Series. Pub: Springer

The Campaign considers that there is a high probability that, during the 50+ year lifetime of liquid nuclear waste effluent discharges from the Hinkley Magnox and AGR reactors, radioactive particles, similar to those discharged from the Chapelcross site will have been discharged into the Hinkley marine and sedimentary environment.

As stated above, the Campaign has (to date) found no reporting of searches for "radioactive particles" in the sediments around the Hinkley outfalls, and certainly the CEFAS sediment sampling related to the dredge and dump proposal does not appear to have included any such investigation.

The absence of such work is a further reason why the Campaign does not believe that the investigations commissioned by EDF, supported by NRW and the Welsh Government, have provided sufficient information to justify the permitting of the dumping of radioactively contaminated sediments into the Cardiff Grounds dispersal site.

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9: Detailed Final Conclusion:

The Campaign concludes, on the basis of the information set out above, and the information set out in our previous Briefing, that the radiological surveys commissioned by EDF at the behest of NRW are inadequate to the task of providing appropriately detailed and specific information on the radioactivity content of the Hinkley sediments, and that this inevitably militates against the generation of precise and appropriate dose rates to both south Wales coastal zone populations and south Wales marine environment stakeholders.

The Campaign expects that EDF / NRW / CEFAS will respond to these concerns by stating that the methodology used is "normal procedure" and that the methodology is fully endorsed by the IAEA, the UK nuclear industry, the pro-nuclear Welsh and Westminster Governments, and their regulatory agencies and advisors (often staffed by personnel trained in the nuclear industry orthodoxy.)

However, the Campaign notes that there is no legal restriction on Welsh Government and NRW to take or recommend independent action in respect of such issues. While it may be expected that they should not do less than the standard protocols expect, there is no legal restriction on their ability to demand MORE than the normal protocols expect.

The Campaign notes that NRW, as the Welsh Government's environmental regulator and guardian, requested EDF to commission the 2017 survey, but did not request that the 2017 survey should be conducted with improved methodologies.
In the final analysis, as the Campaign's earlier briefing on this issue has pointed out, the methodology of the 2017 survey was actually of a lower standard because the samples taken were from lower depths (0-2 cms) and, as the Campaign had warned, this generated the lowest reported concentrations because it did not reflect the higher historical discharges from the Hinkley site which are found at greater depths (as the previous surveys had conclusively demonstrated).

The Campaign concludes that the NRW and the Welsh Government has failed in its duty to the people of the south Wales coastal zone and maritime stakeholders by not demanding that EDF commission the most thorough radiological in order to generate the most detailed information on radionuclide presence, radioactivity concentrations and accurate dose rate potentials.

The Campaign further concludes that the EDF/CEFAS claim that the radioactivity levels in the Hinkley sediments were "DE MINIMIS" cannot be justified by the evidence generated by the 2009, 2013 and 2017 surveys because they are incapable of generating any empirical data about the concentrations of non-gamma emitting radio nuclides in the 300,000 tonnes of Hinkley sediment proposed for dumping at the Cardiff Grounds dispersal site, and that any dose estimates arrived at on the basis of such incomplete data are likewise un-justified.

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Tim Deere-Jones *(Marine Radioactivity Research & Consultancy)* 12 March 2018

for **Postpone the Dump of Radioactive Sediments at Cardiff Grounds Campaign**