NFLA Radioactive Waste Policy Briefing Number 80: Proposed Changes to the Environmental Permits at the Sellafield site in West Cumbria

Prepared for NFLA member authorities, November 2019

Proposed Changes to Sellafield's Environmental Permits

i. Overview of Policy Briefing

This edition of the NFLA Radioactive Waste Policy has been developed by the NFLA Secretariat to respond to an Environment Agency Draft Decision Document which would permit a change to the environmental permits for the Sellafield site. It has been developed for the NFLA by the NFLA Policy Advisor Pete Roche and the independent marine radioactivity consultant Tim Deere-Jones. The response has the full support of the groups Cumbrians Opposed to a Radioactive Environment (CORE) and West Cumbria and North Lakes Friends of the Earth group.

The first part of this response provides a model response to this consultation, while the second part brings in additional information over specific concerns around the discharges in relation to its impact on the marine environment.

1. Introduction

In October 2018, Sellafield Ltd applied for a number of changes to its environmental permit. The permit sets limits on the total amount of radioactive waste Sellafield is allowed to discharge into the environment "to ensure that any radiation exposure of people that results is small and well below statutory limits". The new limits applied for were mainly to reflect changes in Sellafield's operations. The application included a 2-phase approach. Phase 1 of the site limit reductions was intended to be introduced after THORP had closed, but before Magnox reprocessing had ended. Phase 2 was to be implemented when Magnox reprocessing ended.

In December 2018, the NFLA submitted a detailed response to the Environment Agency (EA) on these proposed changes. This is available here:
https://www.nuclearpolicy.info/wp/wp-content/uploads/2019/01/Rad_Waste_Brfg_74_Sellafield_discharges.pdf

Sellafield Ltd has now amended the proposal for site limits following the consultation. This is mainly because the EA asked for further information on how it had derived the proposed site limits. In response, Sellafield Ltd amended its application to a single change in site limits rather than a 2-phase change. According to the EA, this offers further significant reductions in discharge limits compared with the original application. The new limits are proposed to come into effect before the end of Magnox reprocessing operations.

The EA has now published a draft decision document (See https://consult.environment-agency.gov.uk/cumbria-and-lancashire/sellafield-radioactive-substances-activities-rsa-p/) which it is consulting. The consultation closes on **1st December 2019**. Responses should be sent to the EA Nuclear Regulation Team – North (020 3025 5873) - nrg.north@environment-agency.gov.uk.

The document considers Sellafield Ltd's arrangements for using best available techniques (BAT) to prevent or minimise discharges of radioactive waste, identifying improvements and requests for more information, as necessary. Appendix Two of the draft decision document responds to the NFLA's December 2018 response.

2. The Agency Decision

The Environment Agency says all of the relevant proposed aqueous limits are broadly consistent with the 2020 expected outcomes in the UK Strategy for Radioactive Discharges (UKSRS)[1], taking into account that headroom is required between expected discharges and limits.

The Environment Agency is going to allow the permit to include upper and lower site discharge limits at the values proposed by Sellafield Ltd. Around half of the upper tier limits will come into effect when the permit change is issued and last until one of two important milestones has been achieved - the end of Magnox reprocessing or the commissioning of the retrievals ventilation system incorporating high efficiency particulate air (HEPA) filtration in the Magnox Swarf Storage Silos (MSSS) ventilation stack.

Once the lower site limit is in force, the upper site limit will only apply where the EA has agreed that Sellafield Ltd has submitted an acceptable BAT case to move to the upper limit for a certain time so that it can complete certain tasks. In other words, Sellafield Ltd would be allowed to increase certain discharges for a certain length of time, in order to carry out a particular decommissioning task, provided it has submitted an acceptable BAT case.

3. Discharge Reductions

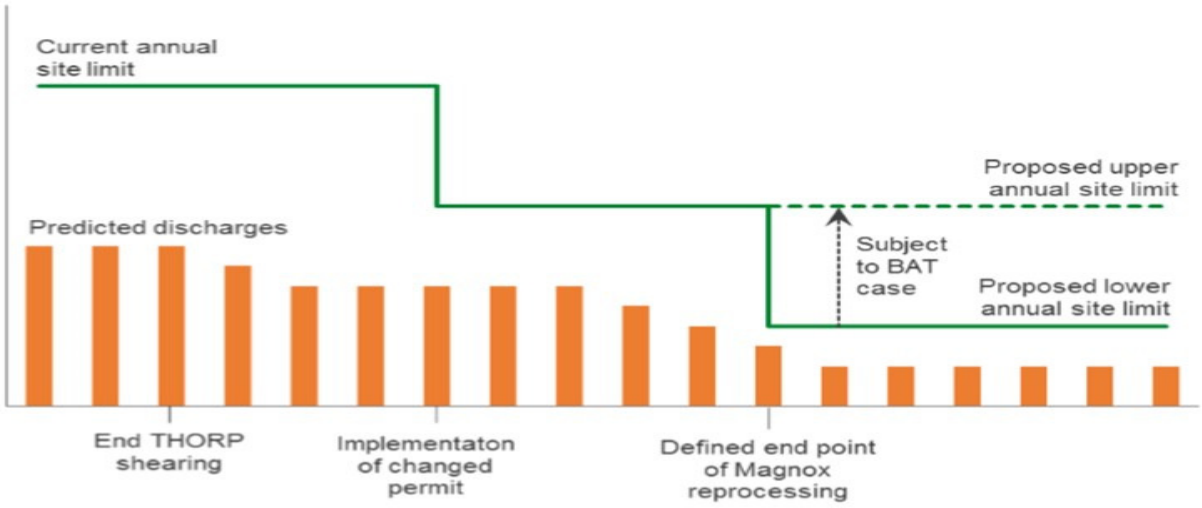
On gaseous discharges the draft decision document discusses high efficiency particulate air (HEPA) filtration to minimise radioactive discharges associated with particulate matter. It says since 2016 the Separation Area Ventilation (SAV) plant has diverted gaseous discharges from the Magnox reprocessing plant and other facilities to a new discharge stack with additional HEPA filtration abatement plant. And a significant future development is the installation of HEPA filtration at the Magnox Swarf Storage Silos (MSSS) plant. (There is no indication of the timescale for this).

On aqueous discharges, the document lists the major waste treatment plants operating on the site. It says when reprocessing ends, Sellafield Ltd aims to maximise the use of existing treatment facilities by, for instance, diverting effluent streams from the segregated effluent treatment plant (SETP) to the Enhanced Actinide Removal Plant (EARP) to improve abatement levels before they are discharged into the sea.

While such improvements are to be welcomed, it is not clear from the document whether superior abatement techniques have been rejected, or what research is going on so that discharges to the sea can be further reduced.

4. Upper and Lower Limits

The upper and lower site limits and requirement for BAT cases is illustrated below:



[1] UK Strategy for Radioactive Discharges, DECC et al July 2009
https://www2.gov.scot/Resource/Doc/280203/0084414.pdf

The EA is also proposing to agree to remove site discharge limits where discharges have fallen below significant levels and do not meet the criteria for setting a limit. All remaining site limits are significantly reduced, apart from 3 upper tier limits.

Aerial Discharges Bq	Actual Discharges during 2018[2]	Annual Limit[3]	New Upper Limit	Earlier Proposal Phase 2 Upper	New Lower Limit	Earlier Proposal Phase 2 Lower
Tritium	9.02E+13	1.10E+15	3.70E+14	5.50E+14	1.70E+14	2.20E+14
Carbon-14	4.27E+11	3.30E+12	2.30E+12	2.31E+12	3.60E+11	1.65E+12
Krypton-85	6.47E+16	4.40E+17	7.00E+10	Limit to be removed after end of Magnox reprocessing	Limit to be removed after end of Magnox repro-cessing	Limit to be removed after end of Magnox repro-cessing
Strontium-90	1.34E+07	7.10E+08	5.0E+08	4.97E+08	7.41E+07	4.97E+08
Ruthenium-106	4.94E+08	2.30E+10	1.8E+10	1.96E+10	2.8E+09	1.96E+10
Antimony-125	1.33E+09	3.00E+10	3.0E+10	Limit to be removed after end of Magnox reprocessing	Limit to be removed after end of Magnox repro-cessing	Limit to be removed after end of Magnox repro-cessing
Iodine-129	1.02E+10	7.00E+10	4.2E+10	4.2E+10	1.3E+10	1.8E+10
Iodine-131	3.94E+08	3.70E+10	Limit Removed	Limit Removed	Limit Removed	Limit Removed
Caesium-137	5.11E+07	5.80E+09	4.8E+09	4.8E+09	4.1E+08	4.8E+09
Radon-222	Nil	5.00E+11				
Plutonium alpha	2.86E+07	1.90E+08	1.3E+08	1.33E+08	7.2E+07	1.33E+08
Plutonium-241	2.31E+08	3.00E+09	Limit Removed	Limit Removed	Limit Removed	Limit Removed
Americium-241 and curium-242	1.57E+07	1.20E+08	8.4E+07	8.4E+07	5.0E+07	8.4E+07
alpha	1.04E+08	8.80E+08	6.6E+08	6.6E+08	3.2E+08	4.4E+08
beta	6.26E+08	4.20E+10	3.2E+10	3.15E+10	5.1E+09	2.1E+10

(Blue shading indicates the trigger for a switch to the lower limit is the end of Magnox Reprocessing. Yellow indicated the trigger is the operation of the HEPA filters on the Magnox Swarf Storage Silo) Emissions of Ruthenium-106 are mainly associated with the Vitrification Plant.

In almost every case with gaseous discharges the new upper and lower limits proposed are lower than those proposed for the phase two upper and lower limits in the earlier application. For the NFLA, it is pleasing to see lower levels and this is acknowledged.

[2] Number from RIFE 24
[3] RIFE 24

However, in almost every case (Tritium, Strontium-90, Ruthenium-106, iodine-129, caesium-137, plutonium-alpha, americium-24 and curium-242, alpha and beta) the new lower limit would allow discharges to continue at the current level or even increase because of the headroom allowed.

Liquid Discharges Bq	Actual Discharges during 2018	Annual Limit	New Upper Limit	Earlier Proposed Phase 2 Upper	New Lower Limit	Earlier Proposed Phase 2 Lower
Tritium	1.27E+15	1.80E+16	3.0E+15	7.2E+15	7.0E+14	1.44E+15
Carbon-14	2.93E+12	2.10E+13	1.3E+13	1.05E+13	5.1E+12	8.40E+12
Cobal-60	2.01E+10	3.60E+12	3.6E+12	3.6E+12	2.5E+12	3.6E+12
Strontium-90	1.28E+12	4.50E+13	3.2E+13	3.15E+13	1.4E+13	2.25E+13
Zirconium-95& Niobium-95	5.74E+10	2.80E+12	Limit Removed	Limit Removed	Limit Removed	Limit Removed
Technetium-99	9.31E+11	1.00E+13	7.5E+12	8.00E+12	4.5E+12	6.00E+12
Ruthenium-106	5.4E+11	5.10E+13	1.0E+13	1.53E+13	3.1E+12	1.02E+13
Iodine-129	3.00E+11	2.00E+12	8.0E+11	8.0E+11	3.2E+11	4.0E+11
Caesium-134	3.67E+10	1.60E+12	Limit Removed	Limit Removed	Limit Removed	Limit Removed
Caesium-137	4.36E+12	3.40E+13	2.4E+13	2.28E+13	1.7E+13	1.7E+13
Cerium-144	9.32E+10	4.00E+12	Limit Removed	Limit Removed	Limit Removed	Limit Removed
Neptunium-237	4.65E+10	7.30E+11	Limit Removed	Limit Removed	Limit Removed	Limit Removed
Plutonium-alpha	1.39E+11	7.00E+11	5.0E+11	6.3E+11	2.9E+11	4.2E+11
Plutonium-241	1.88E+12	2.50E+13	1.8E+13	1.75E+13	6.0E+12	7.5E+12
Americium-241	1.94E+10	3.00E+11	2.2E+11	2.4E+11	1.4E+11	1.5E+11
Curium-243&244	1.47E+09	5.00E+10	Limit Removed	Limit Removed	Limit Removed	Limit Removed
Alpha	1.62E+11	9.00E+11	6.0E+11	7.2E+11	3.4E+11	4.5E+11
Beta	1.04E+13	1.80E+14	1.2E+14	1.26E+14	6.2E+13	8.1E+13

The trigger for moving from the upper limit to the lower one for those radionuclides shaded in blue will be closure of the Magnox reprocessing plant. All others will start on the lower limit.

As with the gaseous emissions in many cases with liquid discharges the new upper and lower limits proposed are lower than those proposed for the phase two upper and lower limits in the earlier application. Again, it is pleasing to see lower levels proposed and this is acknowledged.

However, in almost every case (the notable exception being tritium) the new lower limit would allow discharges to continue at the current level or even increase because of the headroom allowed.

5. Large Headroom

In response to our expressions of concern in 2018 about the large headroom the EA points out that Sellafield Ltd has now proposed new values for site limits. “The majority of these represent a large reduction from those in place in the current permit. Notably, there are significant reductions in the lower site limits for gaseous carbon-14 and strontium-90.”

Again for the NFLA, it is pleasing to see significant reductions and this is acknowledged.

Part of the explanation for the need for headroom appears to be based on the uncertainties in the Sellafield Overall Effluent Strategy Model (OESM). The limits are set according to the EA's guidance on setting limits and levels on discharges of gaseous and liquid radioactive waste from nuclear licensed sites in England and Wales.[4] EA emphasises that "*Sellafield Ltd is continually required to apply the best available techniques*".

This suggests to us that opportunities for consultation during the BAT decision-making process should be maximised.

6. Best Available Techniques

According to the EA BAT means "the available techniques which are the best for preventing or minimising emissions and impacts on the environment …Techniques include both the technology used and the way your installation is designed, built, maintained, operated and decommissioned."

The EA website indicates that alternative techniques which won't provide equivalent environmental protection, can be proposed if a case can be justified on cost benefit grounds with cost benefit analysis used to support the proposed alternative technique.

In the NFLA's view a sustainable decommissioning policy must be based on a clear set of environmental principles, in particular: the polluter pays principle, the concentration and containment principle and the proximity principle. What is important is that the full benefit in terms of reduced emissions to the environment are realised as a result of the closure of THORP followed by Magnox Reprocessing. Decommissioning should not be used as an excuse for increasing discharges into the environment. This means that decommissioning should use the Best Practicable Environmental Option. (BPEO) which, according to the Twelfth Report of the Royal Commission on Environmental Pollution (RCEP) (1988) should be *"the outcome of a systematic consultative and decision-making procedure which emphasises the protection and conservation of the environment across land, air and water."*

The crucial phrase here is "systematic consultative … procedure".

The EA says (in response to our previous submissions) that according to the UKSRD BAT is broadly equivalent to a combination of best practicable means (BPM) and best practicable environmental option (BPEO).

EA also says it is for the operators to determine how consultative they want to be in making their decisions. Given that the operator is Sellafield Ltd which is a subsidiary of the Nuclear Decommissioning Authority – a Government agency, it is our view that the EA should encourage Sellafield Ltd to maximise consultation opportunities when deciding on Best Available Techniques.

The EA's Draft Decision Document says BAT:

"…takes account of factors such as the availability and cost of relevant measures, operator safety, and the benefits of reduced discharges and disposals. If the operator is using BAT, radiation risks to members of the public will be as low as reasonably achievable, and the environment will be adequately protected."

In NFLA's view there should be a wider discussion about the balance between the benefits of reduced discharges to the environment and the costs and available technology for implementing such reductions.

The decision document states that:

"Government policy on radioactive discharges states that unnecessarily introducing radioactivity into the environment is undesirable, even at levels where doses to humans and other species are low and, on the basis of current knowledge, are unlikely to cause harm."

[4] https://www.gov.uk/government/publications/discharge-of-radioactive-waste-from-nuclear-sites-setting-limits

The EA says it has decided that Sellafield Ltd should evaluate strategic options for ceasing sea pipeline discharges (and pipeline remediation). It concludes:

"Overall, we consider that Sellafield Ltd applies BAT to minimise gaseous and aqueous waste discharges and it continues to make good progress towards achieving the 2020 and 2030 expected outcomes of the UKSRD [UK Strategy on Radioactive Discharges]. However, we continue to see a small but persistent number of events associated with managing gaseous and aqueous waste, which leads to us taking enforcement action to prevent repeat events. Some events are associated with ageing infrastructure."

Without any further information on how Sellafield is applying BAT to the various processes it is impossible to give a fully considered view on the proposed discharge limits. With regard to solid radioactive waste disposal routes, the EA has decided that Sellafield Ltd must regularly review its BAT assessments for disposing of low-level waste (LLW) and very low-level waste (VLLW). It should specify the current BAT assessment in a summary document that it submits to us when it is updated.

It is not clear from the summary document that a similar arrangement will be in place for gaseous and liquid discharges. It is our view that all BAT assessments should be regularly reviewed and subjected to public consultation.

Section 6 of the draft decision document talks about allowing High Hazard Risk Reduction (HHRR) work at Sellafield to be carried out in a timely way. The EA says:

"While we want to make sure that BAT is used to protect people and the environment, we do not want to stop or delay that work. We are mindful of not constraining clean-up, and recognise this in our limit setting guidance".

Section 6 also highlights "uncertainties associated with the discharge predictions for each radionuclide in both aqueous and gaseous discharges." These uncertainties are often related "to future legacy ponds and silos retrievals projects [affecting] the amount of headroom Sellafield Ltd has proposed above projected discharge levels, particularly for upper tier limits."

The NFLA argues that if as a society we are being asked to balance hazard risk reduction against the use of BAT for reducing radioactive emissions to the environment, then the public should be regularly consulted as the programme of work at Sellafield is developed. It is also worth considering that the BAT for a particular waste management process could be improving all the time through research and development.

We acknowledge the proposal to remove the upper discharge limit for many radionuclides when Magnox reprocessing has ended or the Magnox Swarf Storage Silo HEPA filters have been installed.

Sellafield Ltd will have to apply to move from lower to upper limits for a specified radionuclide(s) for a certain time period to carry out a specified task or programme of work. An application will have to be supported by an adequate demonstration that the work uses best available techniques. We believe that there should be further public consultation on such applications.

7. Radiation doses

The total doses from future discharges according to the EA are108 and 59μSv/y (2017 habits data) for the upper and lower site limits respectively. Total doses from past and future discharges and direct radiation were between 130 and 530μSv/y for upper permit limits and between 100 and 480μSv/y for the lower permit limits. The EA says all of these are below the dose limit for members of the public of 1,000μSv/y.

The UK Strategy for Radioactive Discharges published in 2002 included a Strategy Target "…of a local critical group of the general public being exposed to an estimated mean dose of no more than 0.02mSv [20μSv] a year as a result of authorised radioactive discharges made from 2020 onwards".

It is disappointing that this target is no longer even an aspiration. The NFLA believes it should be re-introduced. We note that this 20 µSv has been replaced in the Government's 2009 "Statutory Guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment" (See para 22 and footnote 17)

8. Conclusions

The NFLA's overall views on the EA's Draft Decision Document are as follows:

- Reductions in site discharge limits in the decision document compared with existing limits and the limits proposed in the earlier proposals are acknowledged as a positive development.
- We note though that Sellafield Ltd could be allowed to increase certain discharges for a certain length of time, in order to carry out a particular decommissioning task, provided it has submitted an acceptable BAT case.
- The EA emphasises that "Sellafield Ltd is continually required to apply the best available techniques", but it is not clear from the document whether any superior abatement techniques have been rejected on, for example, cost benefit grounds, or what research is going on so that discharges to the sea can be further reduced.
- The NFLA argues that, if as a society we are being asked to balance hazard risk reduction against the use of BAT for reducing radioactive emissions to the environment, then the public should be regularly consulted as the programme of work at Sellafield is developed. BAT for any one particular waste management process could be improving all the time through research and development.

9. Specific NFLA Responses to the Consultation Questions

Q1. Do you understand the proposed structure of discharge limits and levels, and how it is intended to control discharges at the site? Does the new structure (site upper and lower limits, quarterly notification levels, annual plant notification levels and monthly triggers) raise any concerns for you? If so, what are those concerns?

As indicated our main concern is the lack of any proposed consultation during the BAT decision-making process. We believe the EA should encourage Sellafield Ltd to maximise public consultation opportunities. We also raise additional issues from Tim Deere-Jones noted in Appendix 1 below which we also ask you to consider.

Q2. Do the values of the proposed site (upper and lower limits), quarterly notification levels and annual plant notification levels raise any concerns for you? If so, what are those concerns?

Without more information about the BAT decision-making process it is impossible to give a view on whether we think the proposed limits are reasonable. We would need to know if any alternative superior abatement technologies or techniques have been rejected and on what grounds. Please also consider the additional issues on marine radioactivity issues noted in Appendix 1.

Q3. Are you satisfied that the varied Sellafield permit aligns with government policy and guidance, in particular the UK strategy for radioactive discharges? If not, what are your concerns?

In our view government should re-introduce the 2002 Strategy Target "…of a local critical group of the general public being exposed to an estimated mean dose of no more than 0.02mSv [20µSv] a year as a result of authorised radioactive discharges made from 2020 onwards".

No further comment.

Appendix 1

Additional comments on the draft decision document in relation to marine radioactivity impacts from independent marine radioactivity consultant Tim Deere-Jones

Sellafield Consultation: Marine Issues:

This Consultation Submission Appendix has been provided to the NFLA by Tim Deere-Jones, and we would like to include it in addition to our core response above. It addresses issues related to proposed revisions of the limits imposed on discharges of aqueous radioactive wastes to the marine environment.

In that context this Submission comments on:

- the EA's long term "justification" for the permitting of discharges of aqueous radioactive waste via the 2 km long "sea pipeline
- the removal of discharge limits on the aqueous discharge of a number of radionuclides
- the EA's failure to discuss the issue of "radioactive particles" discharged to sea in the so called liquid waste streams".

1. Justification for discharges to sea

The Environment Agency (EA) appears to have un-critically accepted the historical nuclear industry claim that radionuclides discharged to sea will dilute and disperse to such a degree that they will not present a health risk to humans, wildlife and the environment. This concept first appeared in the 1950's with the first discharges to sea from Windscale/Sellafield, and at a time when virtually nothing was known about the behaviour and fate of anthropogenic radioactivity discharged, in industrial" quantities, into enclosed sea areas like the Irish Sea.

EA staff will, no doubt, be well aware of John Dunster's (BNFL & UKAEA) famous 1958 speech to the UN explaining that "substantial amounts of radioactivity" had been discharged to the Irish Sea from the Sellafield site, in order observe how it would behave in the marine environment and that "the aims of this experiment would have been defeated if the level of radio-activity discharged had been kept to a minimum".

This Submission contends that the Dunster statement (made several years AFTER the commissioning of the Sellafield marine discharges) is a powerful indicator of the general lack of knowledge about the behaviour of man-made radioactivity in marine environments.

On page 37 (para 121) of the EA Decision, the Agency makes the following statement:
"Sellafield Ltd minimises the impact of its aqueous discharges by making sure that all discharges are made via the sea pipelines, factory sewer and the Calder interceptor sewer. Aqueous waste is segregated, with the more radioactive discharges being discharged to sea, 2km offshore via the sea pipelines. This means that all but a very small fraction of radioactive waste discharged to sea is subject to significant dispersion and dilution before impacting on people and the environment. Batch discharges are made via the sea pipelines at times, in a form and in a way that minimises the radiological effects on the environment and members of the public, mainly by considering tides. No other 'outlets' are approved for the discharge of aqueous radioactive waste. "

It is this Submission's contention that the EA statement is an "assertion" rather than a proven scientific fact, because the EA offers no evidence or scientific reference in support of the statement that "all but a very small fraction of radioactive waste discharged to sea is subject to significant dispersion and dilution before impacting on people and the environment."

This Submission further contends that while the EA seeks to reassure the reader that all radiological effects/impacts are "minimised" there is no discussion of, or reference to, any EMPIRICAL studies which have demonstrated the veracity of the claims embedded in the statement.

This submission contends that the publicly available documentations of UK marine sampling and analysis programmes (RIFE and AEMR Reports) do not carry data which supports the statement.

This Submission further contends that it is incumbent on the EA (in the context of their duties as "regulators" and environmental guardians) to provide that EMPIRICAL data, and requests that it does so in its response to this Consultation Submission.

While both the current RIFE reports produced by CEFAS on behalf of the EA and their predecessors, the Aquatic Environment Monitoring reports produced by FRL Lowestoft on behalf of the now defunct MAFF, contain tables listing "Principle discharges of liquid radioactive waste" from Sellafield and the other UK nuclear sites, no data is tabulated for the concentrations of radionuclides in seawater taken from the immediate vicinity of the Sellafield offshore outfall pipeline. (e.g.: RIFE-23: 2017 results & AEMR 29: 1990 results)

AEMR and RIFE reports did not measure and tabulate the outcomes of the analysis of seawater samples taken from the outflow end of waste discharge pipelines until the early 1990s (AEMR 45: 1994 observations), at first these observations were neither comprehensive nor detailed and often samples were analysed for only one, or very few, nuclides.

2. Evidence for re-concentration of radioactivity discharged to sea, once it has entered the marine environment

These weaknesses were improved upon in subsequent years with the introduction of the RIFE reports, which by 2003 were monitoring sea water samples from the vicinity of Nuclear Power Station (NPS) waste discharge "pipelines" for 5 discrete radionuclides, sometimes more. However, even as late as RIFE -23 (2017 observations) although such data was clearly presented and identified for the NPSs, there was no such presentation of analytical results for samples clearly identified as taken from the outfall end of the Sellafield waste discharge pipes.

Marine environmental monitoring outcomes of marine environmental samples, related to the Sellafield discharges, are presented in various tables in RIFE 23 (Tables 2:4 to Table 2:14). However, while the tables do report sampling of marine environmental media, none of the Tables 2:4 to 2:13 report any sea water analysis results. Table 2.14 reports no "end of pipeline results" for any sampling site, other than one nearby site up-stream and one nearby site downstream of the R.Ehen sewer. No samples are reported as taken from the marine environment close the outfall end of the Sellafield sea discharge pipelines.

While the results and outcomes of seawater monitoring and radiological analysis at NPS sites are clearly presented in table form in the RIFE report, similar data for seawater are not given for Sellafield. Instead, a series of "Figures" (2.12 to 2.25) are provided. These "Figures" offer details of concentrations of individual nuclides in environmental media relative to the discharges from the Sellafield site. The source of the discharge data (which pipeline/discharge point) is not referenced in either the figures or the accompanying text. No detail is provided to clarify whether the given "concentrations" are derived from samples of water taken from the outfall or it's near vicinity or from pre-discharge measurements taken inside the Sellafield plant prior to discharge.

It is relevant to note that Figs 2.21 to 2.24 of RIFE-23 (results for 2017) clearly demonstrate that, in the case of the four nuclides, Cs 137, Pu 239/240, Co 60 and Am 241, "mud" in the Ravenglass estuary has accumulated greater concentrations of those nuclides than is reported for the Sellafield annual liquid discharges for the year.

Similarly, Figs2:12 through to 2.20 clearly demonstrate that, for most years, marine biota (shellfish, crustaceans, algae) have accumulated higher concentrations of measured radio nuclides than that contained in the annual discharge.

Readers of the RIFE report have little supporting data to fall back on, other than the Table A.2.2 "Principal discharges of liquid waste from nuclear establishments....." presented in RIFE reports.

However, this table does not provide a detailed analysis/discussion to explain how the quantification of Sellafield liquid discharge is achieved. There is no evidence that the data provided in Table A.2.2 has been acquired by sampling sea water from the seaward end of the Sellafield pipeline. In the absence of end-of-pipeline seawater samples from Sellafield it is difficult to comment on the

supposed, or assumed, dilution factors of liquid radioactive wastes once they have entered the marine environment.

In the context of the uncertainty discussed above, this Submission draws the EA's attention to the fact that despite the apparent lack of data about radioactivity concentrations in the water column near the OUTFALL of the 2 km long Sellafield liquid waste discharging sea pipelines, reports such as RIFE-23 do record the results of sea water sampling, at non-reprocessing, nuclear sites, close to pipeline outfalls and in conjunction with regional sediments.

For example, sampling and analysis of sea water taken from a site referenced as "pipeline" at the Hinkley Point nuclear complex (RIFE-23, [table 4.7.a.] p147) reports that the Cs 137 concentration in seawater from the "pipeline" site was less than 0.21 Bq/Kg, while in nearby intertidal sediment deposits (River Parrett estuary) the concentration was 19 Bq/Kg. This represents a re-concentration factor (from water to sediment) of 90.

At the same site, the "pipeline" seawater sample held "less than" 0.25 Bq/Kg of Co 60, while the River Parret estuary sediments held "less than" 0.88 Bq/Kg.... representing a possible 3.52 re-concentration factor.

Similarly, the Hinkley "pipeline" seawater held "less than" 0.31 Bq/Kg of Am 241, while the nearby River Parret estuary sediments led "less than" 0.93 Bq/kg .....representing a possible re-concentration factor of 2.97.

Clearly the intertidal and subtidal sediments in the Hinkley Point locality represent a significant sink of RE-CONCENTRATED Cs 137, Co 60 and Am 241, previously discharged at much lower concentrations from the "pipeline" and re-concentrated in marine sediments by a combination of factors.

Similarly, the Hinkley "pipeline" seawater held "less than" 6.2 Bq/Kg of OBT (Organically Bonded Tritium), while concentrations of OBT in local marine biota (shrimps) was reported to 34 Bq/Kg. This is a re-concentration factor of 5.5 achieved by biological (food web) accumulation.

Similar patterns of outcome can be observed at a number of the UK NPS sites (e.g.: Bradwell, Heysham, Chapelcross) where end of pipeline seawater sampling is regularly carried out and reported. There is no reason to doubt that broadly similar outcomes (in terms of the environmental re-concentration of many nuclides, initially diluted by discharge to the marine environment) will be occurring in the vicinity of the Sellafield site

Other mechanisms of re-concentration occur within the marine environment. It is now well attested that marine radioactivity transfers from the sea to the land under certain conditions and by specific mechanisms. Work by the UKAEA through late 1970s and 1980s clearly proved the sea to land transfer of 5 radionuclides (Cs 137, Am 241 and 3 forms of Pu). During the course of this work the various authors recorded a number of marine environmental mechanisms giving rise to re-concentration of previously diluted (post discharge) nuclides discharged from the Sellafield site.

The UKAEA studies reported that micro-organisms on or near the sea surface can become enriched with actinides achieving concentration factors of between 260 and 26,000 for Pu 239/240.

Other studies report other mechanisms. Sedimentary accumulation operates very effectively through the marine environment and it is reported that the discharge of tritiated water to Plymouth Sound from the Devonport Nuclear Submarine base, resulted in the immediate dilution to activities of less than 10Bq/Kg in ambient water , "whereas corresponding activities of about 300 Bq.kg in sediment" were observed. (Distribution of Tritium in estuarine waters: the role of Organic matter" Journal of Environmental Radioactivity. Vol 100. Issue 10. October 2009. Pps 890-895. Turner. A. et al')

Additional studies have reported that marine aerosols generated by breaking waves in the surf zone were enriched (during the aerosol production process). The enrichment of sea spray and aerosols seldom exceeds an Enrichment factor (EF) of 2, while EFs for Pu 238 of 291 are reported, EFs of

347 for Pu239/240 and EFs of 583 are reported for Am241 ("Actinide Enrichment in Marine Aerosols" Nature 323. 6084. 11 Sep' 1986. Pps 141-143. Walker.M.I et al')

Clearly the proposition, long advanced by the nuclear industry and apparently accepted by the UK Environment Agency, that the end-fate of man-made radioactivity discharged to sea is DILUTION and DISPERSION, is not founded on the readily available scientific evidence.

This Submission invites and welcomes the Environment Agency's comments on these issues.

3. Removal of discharge limits on the aqueous discharge of a number of radionuclides.

The Environment Agency states that "We have also agreed to remove site discharge limits where discharges have fallen below significant levels and do not meet our criteria for setting a limit" (Executive summary: page 4: 4th para).

The Environment Agency reports that this strategy is to be adopted for the following radio-nuclides, Ce 144, Cm 243/244, Cs 134, Np 327 and Pu241.

This Submission contends that, in the case of the Sellafield discharges to sea, the proposed strategy is not appropriate for those listed radio-nuclides which are alpha emitters or which produce alpha emitting decay products.

This Submission reminds the Environment Agency that a number of the listed nuclides (and/or their daughter products are alpha emitters which decay by alpha emission, or generate alpha emitting decay products:

- Cm243: half-life of 29 years: transuranic alpha & beta emitter. Decay products include the alpha emitter Pu 239 and Am 243 (which itself decays to produce the alpha emitting Np239.
- Cm 244: half-life of 18 years: transuranic beta emitter. Decay product is the alpha emitting Pu 240 with a half-life of 6,561 years
- Np 237: half-life in excess of million years, alpha emitter: decay product = beta emitting protactinium 233.
- Pu 241: half-life of 14 years: beta emitter, decay product = long lived alpha emitting Am 241 (432 years).

This Submission reminds the Environment Agency that the Sellafield site discharges to the Irish Sea have, since 1952, included a relatively large volume (many TBq) of alpha emitters. Sellafield's discharges to sea also contained a significant volume of the short half-life, weak beta-emitting, Pu 241.

Pu241 had historically been considered unimportant in terms of human radio-biology and consequently discharged to sea in unlimited and unquantified amounts (though it has been "estimated" that, up to the end of 1982 approximately 550,000 curies may have been discharged through the Sellafield sea pipelines.

However, through the 1980s there was a growing realisation that Pu241's decay product was the alpha emitting Americium 241, and by the late 1980s limitations were being put on the discharge of Pu 241 because of concerns about the Irish Sea Am 241 "ingrowth" from Pu 241 decay.

In 1986 the First Report of the House of Commons Environment Committee (HMSO London) estimated that Am 241 production in the Irish Sea silts and sediments would peak towards the end of the 21st century with Pu 241 decay contributing approximately 1.3000 curies of Am 241 a year.

Am 241 is considered to be 2.5 times more hazardous to humans than the most active of the Plutonium nuclides. Am 241 accumulates in marine sediments and in marine biota, it is also particularly prone to sea to land transfer, during which process it's Enrichment Factor (well over an EF of 500) is the highest yet observed in marine aerosols.

Clearly, it is accepted that Am 241 “ingrowth” has been, and remains, a matter of considerable concern. However, this is due to a combination of its environmental behaviour and its alpha emissions.

This Submission contends that the proposal to de-limit Pu 241 discharges from the Sellafield site fails to reflect the concerns of the House of Commons Environment Committee and the evidence given to them by a number of eminent scientists and the discharge controls imposed on Pu 241 by subsequent regulators.

This Submission contends that the de-limiting of discharge controls on the Ce, Cm, Np and Pu 241 has major potential implications for the future alpha emitter content of the Irish Sea environment, since those nuclides are either alpha emitting in their own right, or generate alpha emitting “decay” products and thus increase the already elevated concentrations of alpha emitters sequestered in Irish Sea coastal and estuarine sediments, which are now shown to be endemic throughout the Irish Sea and in every estuary of the Irish Sea, the Bristol Channel, the Hebridean seas and the Atlantic coast of Northern Ireland.

In the context of Sellafield’s application for the de-limiting of various nuclide discharges, this Submission wishes to remind the Environment Agency of concerns related to the discharge to sea of tritiated water and of “particulates” or “radio-active” particles.

Tritiated water has historically been discharged to the Irish Sea marine environment, from Sellafield and most other licenced nuclear sites, in un-limited quantities. This has been historically permitted because there has been a consensus between the nuclear industry and regulators that tritium was of little biological significance because it was believed that tritium would naturally dissolve to infinity in the marine environment.

However, this is now known NOT to be the case as tritium has a strong tendency to become incorporated into organic matter in the marine environment and to enter marine food webs, as Organically Bound Tritium (OBT). Rates of bio concentration of OBT, through marine food webs are very high. A 2001 study found that although concentrations of Tritium in seawater near Hinkley Point NPS in the Bristol Channel were of the order of 2 to 10 Bq/Kg, concentrations in downstream shelduck were 61,000 Bq/Kg (biological EFs of 6,100). The magnitude of the effect is largely attributed to OBT derived from organic bonding of the tritium discharged to sea.
(Deere-Jones. TD, (NUC 33) Written Evidence to House of Commons: Energy and Climate Change Committee : Sixth Report of Session 2012-13: Volume 2. Additional written evidence pps Ev w56 to Ev w 59)

This Submission ALSO contends that, IN THE CONTEXT OF A WHAT APPEARS TO BE A MAJOR EXERCISE REVISING LIMITS AND PERMITS FOR THE SEA DISCHARGE OF RADIOACTIVE WASTES TO THE IRISH SEA, the absence of discussion of limits/restrictions to the discharge to sea of radioactive particles and micro-particles is a weakness in the Sellafield/ EA covering of marine radioactivity issues in the context of this consultation.

The EA will not need reminding of the long efforts to remove radioactive “particles” from beaches along the Sellafield coast. The EA will be well aware of the fact that there is no evidence to support any proposition that there are no such particles on any other Irish Sea coasts. It is clear that all forms (dissolved, particle adsorbed, or particulate) of anthropogenic radioactivity are subject to long term transport throughout the Irish Sea environment and beyond.

This Submission contends that the latest round of applications for Sellafield permit modifications presented an ideal opportunity for the EA to tighten up on the regulation of tritiated water and particulate material discharges to the Irish Sea and believes it a matter of regret that this was not done.

This Submission invites and welcomes the Environment Agency’s comments on these issues.

Tim Deere-Jones (Marine Radioactivity Research and Consultancy) November 2019