BRIEFING NOTES:

Liquid Radioactive Waste Discharges from the UK's Proposed new Reactors:

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Contents:

This briefing seeks to answer a few of the basic queries raised by colleagues and fellow campaigners regarding the nature of liquid radioactive waste discharges to the marine environment from the two reactors types proposed for the proposed new UK fleet of nuclear electricity generating stations.

Please feel free to disseminate this briefing as freely as you wish.

The briefing is necessarily a summary of the available information (which is itself less than complete) and contains my personal interpretation of the available data based on 28 years experience as a marine pollution consultant.

The information/data bases specifically used in the production of this briefing are:

1: *Environment Agency Generic design assessment*
UK EPR nuclear power plant design by AREVA NP SAS and ELECTRICITE de France SA
Assessment report Aqueous radioactive wastes disposal and limits

2: *Environment Agency Generic design assessment*
AP1000 nuclear power plant design by Westinghouse Electric Company LLC
Assessment report Aqueous radioactive waste disposal and limits

3: *Distribution of Tritium in estuarine waters: the role of organic matter :* Journal of Environmental Radioactivity: volume 100. Oct 200.
An overview of Tritium behaviour in the Severn estuary: Journal of Radiological Protection: Volume 21. 2001.
Organically bound Tritium (OBT) dispersion and accumulation in Severn Estuary sediments: Food Standards Agency Report: R.O. 1034.

Should campaigners need more detailed information, a copy of my CV or any further assistance I would be happy to assist:

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Introduction:
Under the Generic Design Assessment (GDA) process, carried out by the Environment Agency, the UK Government is considering licensing the construction of 2 types of pressurised water reactors at a number of sites around the UK coast line: the **UK EPR** and the **US AP1000.**
The manufacturers of both reactors have stated that the expected service life of their reactor will be 60 years.
A number of different consortiums are bidding for the right to construct and operate reactors at the identified sites.
Currently it appears that the number of reactors to be proposed for each site is dependant upon the generating output of the reactor type. Since the AP1000 reactor has a lower electricity generating out put than the UK EPR, sites where the AP1000 is chosen will have three reactors whereas the sites where the UK EPR is chosen will have two reactors.

Liquid radioactive wastes will be discharged from the reactors via a number of routes.
Sources:
1: Primary and secondary reactor coolant waters

2: Further aquatic discharges will arise as a result of unforeseen site leaks of liquid radioactive material (all currently operating sites have experienced such leaks) or "contingencies" as the industry chose to name them.

3: Such "contingencies" may give rise to uncontrolled and unquantified leaks of liquid waste, which may be confined to established site drains or may be totally unconfined and subject to additional dispersal by rainfall surface water.

4: Additional inputs of radioactive wastes to the marine environment will derive from the fall out and wash out of atmospheric gaseous and particulate wastes discharged via site stacks and chimneys, due to a range of meteorological conditions such as rainfall, temperature inversion etc.

The UK EPR reactors are expected to generate liquid radioactive wastes consisting of a cocktail of 14 named radionuclides and a number of "others".

The GDA lists the major components of the liquid discharges as:
Tritium, Caesium 137, Carbon 14, various (but un-defined) isotopes of Iodine, and Cobalt 60

The minor components of the liquid discharges are listed as:
Ag 110, Co58, Cs 134, Mn54, Sb124, Sb 125, TeI123m, Ni 63, Cr51

However, the GDA makes reference to a number of un-named "others" which appear to include alpha emitting actinides, which may include isotopes of Plutonium, Americium, Curium and Uranium.

The AP100 reactors are expected to generate liquid radioactive wastes consisting of a large number of radionuclides.
The GDA lists the major components of the liquid discharges as
Tritium, Carbon 14, Cobalt 60 and Caesium 137.

However, the Environment Agency has published a copy of Table3.4-6 of the AP1000 European Design Control Document and the Environment Report which lists a total of **65** nuclides, including 5 isotopes of Plutonium, 3 isotopes of Uranium, 2 isotopes of Americium and 2 of Curium.
No such document appears to have emerged from the manufacturers of the UK EPR.
However, it is evident from the published Table that ***both manufacturers have failed to engage in a full discussion of the full discharge inventory of their reactors and the potential impacts of aquatic discharges. EDF/AREVA appear to have been particularly remiss in this area. The Environment Agency has accepted the manufacturers position on this issue.***

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Aquatic Tritium discharges Tritium half life = 12 years
Evolving understanding of the behaviour of Tritium in the marine environment
Since the year 2000 ongoing research is producing data that challenges some of the earlier understanding of Tritium's environmental behaviour. This research shows that Tritium

- rapidly associates with organic materials and suspended sediment particles
- shows elevated concentrations in sedimentary deposits
- has significantly greater interactions within the environment than previously predicted
- rapidly incorporates into marine organisms (fats and carbohydrates)
- sediment associated bottom feeding species show the highest concentrations
- which in turn generate higher than predicted dietary doses (up to 36 micro Sv) in Bristol Channel seafood critical groups

academic research now implies that

- current IAEA thinking on the behaviour and significance of tritium **"may require reconsideration"**
- the view that Tritium "dissolves to infinity" should now be **"considered cautiously"**
- mobilisation and transport of tritiated sediments **is very poorly understood**

It is uncertain whether the Environment Agency GDA has taken account of this evolving understanding of the behaviour and significance of Tritium

EDF and AREVA, the manufacturers of the UK EPR have stated that the expected liquid discharge" of Tritium per reactor (with no allowance for "contingencies") will be 52 TBq (52,000,000,000,000 or 52 million, million Bequerels) per year.

Thus a UK EPR station with two reactors is expected to discharge 104 million, million Bqs of liquid Tritium per year.

EDF and AREVA, the manufacturers and proposers of the UK EPR have asked for an annual liquid disposal limit for Tritium of 75 Tbq per reactor (75 million, million Bq).

The UK Environment Agency has granted this request and consequently the proposed annual limit for liquid Tritium discharges, for a two reactor UK EPR station will be 150 million, million Bqs per year.

Westinghouse, the manufacturers and proposers of the AP1000 reactor have stated that the expected liquid discharge of Tritium per reactor (with no allowances for contingencies) will be 35.09 Tbq per year (35.09 million, million Bqs).

Thus an AP1000 station with three reactors is expected to discharge 105.27 million, million Bqs per year.

Westinghouse has asked for an annual liquid disposal limit for Tritium of 60 TBq per reactor per year (60 million, million Bqs).

The UK Environment Agency has granted this request and consequently the proposed annual limit for liquid Tritium discharges, for a three reactor station will be 180 million, million Bqs per year.

N.B. Both requests for annual limits of Tritium discharge have been granted in full. The limits for the two different station types differ by 30 TBq per year (30 million, million Bequerels).

No explanation is given by the Environment Agency for the wide variation in limits.
In the absence of such an explanation it may be surmised that the two widely varied limits are based on the demands/requests of the reactor manufacturers.

No explanation is given as to why the proposed limits are so much higher than the expected discharges.
In the absence of any such explanation it may be appropriate to assume that the manufacturers either
a: have little faith in their "expected liquid discharge" predictions
or
b: expect that, at some stage during the plant's 60 year operating life, some "contingency" will arise which is likely to breach a lower discharge limit.

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Carbon 14 aquatic discharges Half life= 5,710 years
Carbon 14 enters the marine environment in aquatic discharges and also via fall out and wash out from gaseous/atmospheric discharges.

Carbon 14 assimilates well into marine primary producers such as plants and plankton. C14 transfers up the food chain to higher trophic levels such as fish, mammals and human end consumers. Doses to humans may occur via ingestion and inhalation pathways. The GDA says initial dose rates to humans may be comparable to those received from Tritium. Further more, due to its long half life, C14 has a relatively high potential for accumulating in the environment, especially in association with organic materials such as organic based silt and sediment deposits

EDF and ARREVA, the manufacturers of the UK EPR have proposed no specific technique for the reduction of C14 in the liquid waste discharges. The Environment Agency have accepted the EDF/ARREVA position.

EDF and AREVA have stated that “expected liquid discharge” of Carbon 14 per reactor (with no allowance for “contingencies”) will be 0.0023 TBq (2 thousand 300 million Bqs or 2,300,000,000 Bqs) per year.
Thus the expected liquid discharges of C14 from a 2 reactor UK EPR station is 4 thousand, 600 million Bqs per year

EDF and AREVA, the manufacturers and proposers of the UK EPR have asked for an annual liquid disposal limit for Carbon 14 of 0.0095 TBq per reactor (9.5 thousand million bequerels per year.).
The UK Environment Agency has granted this request and consequently the proposed annual limit for C14 in liquid discharges, from a 2 reactor potential UK EPR station, is 0.019 TBq per year (19 thousand, million Bequerels.)

Westinghouse have reported that the expected annual average “expected liquid discharge” from each AP1000 reactor will be somewhere between 0.0042TBq and 0.005304TBq (4.2 thousand to 5.3 thousand million Bequerels).
Thus the annual expected discharge of liquid radioactive waste from each 3 reactor AP1000 station will be somewhere between 12.6 thousand million Bqs per year and 15.9 thousand million Bqs per year.

Westinghouse Toshiba have asked for an annual discharge limit of 0.007 TBq (7 thousand million Bequerels) per reactor per year.
The UK Environment Agency has granted this request and consequently the annual C14 limit for a 3 reactor AP1000 site is 0.021 TBq (21 thousand million bequerels).

NB: The UK Environment Agency has accepted two widely differing applications for annual limits for C14 in liquid discharges (19 thousand million Bequerels for a UK EPR station and 21 thousand million Bequerels for an AP1000 station). Thus there is a 2 thousand million bequerel difference between the two limits.

The EA has not offered any discussion of the reasoning behind its preparedness to accept such widely varying proposed limits.

In the context of the EAs willingness to accede to the requests of both EDF/AEVA and those of Westinghouse/Toshiba it appears that these limits have been set in order to comply with the potential performance of each

reactor rather than in order to comply with a common understanding of best environmental requirement or most limited environmental impact.

No explanation is offered as to why the proposed annual limits are so much higher than the proposed expected annual discharge.
In the absence of any such explanation it may be appropriate to assume that the manufacturers either
a: have little faith in their "expected liquid discharge" predictions
or
b: expect that, at some stage during the plant's 60 year operating life, some "contingency" will arise which is likely to breach a lower discharge limit.

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Caesium (Cs) 137: Half Life 30 years
Caesium 137 in liquid waste streams is considered to be a useful indicator of fuel failures because it's released as the fuel pin cladding begins to fail and/or breach.

Caesium 137 is water soluble, and hence dissolves efficiently into the water column of receiving waters and is therefore well distributed across the marine environment. It appears to re-concentrate in certain marine environmental media such as marine surface micro layers, aerosols and sea sprays. Marine discharged Cs 137 has been proved to transfer across the surf line and penetrate to at least 10 km inland where it has been shown to contaminate pasture grass and hence the dairy and meat food chains.

Marine discharged Cs 137 is found throughout the marine biota, in seaweeds, shell and fin fish and marine mammals. It bio-concentrates through the food chain. Highest levels are found in marine top predators such as marine mammals, where it is found in muscle tissue and maternal milk, there is good evidence to show that it transfers (in-utero) to the pre-natal and (via maternal milk) to the post natal.

EDF/AREVA estimate that **the UK EPR** reactor will produce an "expected" annual discharge (excluding "contingencies") of 0.0567 Giga Bqs, or 56 million 700 thousand Bqs per year. **Thus, a 2 reactor UK EPR station will produce an expected 113 million, 400,000 Bqs per year.**
EDF/AREVA do not appear to have proposed an annual limit for Cs 137 discharges.

The Environment Agency have set the annual limit for liquid discharges of Caesium 137 from a UK EPR reactor at 0.5 Giga Bequerels, or 500 million Bqs per year. **Thus, the Environment Agency limit for a UK EPR 2 reactor station will be 1,000 million Bqs per year (1,000,000,000)** *(about 10X greater than the manufacturers proposed "expected annual discharge").*

Westinghouse et Al: estimate that that the **AP1000 reactor** will produce an expected average annual discharge of 30 million, 100 thousand Bqs (excluding "contingencies"). **Thus a 3 reactor AP1000 station will produce an expected annual average discharge of 90 million, 3000 thousand Bqs.**

Westinghouse have proposed an annual limit for discharges of Cs137 of 50 million Bq per reactor or 150 million Bqs per year for a 3 reactor AP1000 station.

The Environment Agency have accepted the Westinghouse proposal and set the annual limit for Cs 137 discharges at 50 million Bqs per reactor or **150 million Bqs per year for a 3 reactor AP1000 station.**

NB : there is a huge discrepancy (nearly ten times) between the annual "expected discharges" of Caesium 137 and the annual limit proposed for a UK EPR station, accepted by the Environment Agency, (limit=1,000 million Bqs p.a.: expected =113 million 400 thousand).
No explanation is offered in the GDA documentation for this discrepancy.

Similarly, there is a large discrepancy between the "expected discharge" of an AP1000 station and the proposed limit, accepted by the EA, (limit = 150 million Bqs p.a.: expected = 90 million 300 thousand
Neither the manufacturers, nor the Environment Agency have offered any explanation as to why such discrepancies have arisen and why they are to be permitted.

In the absence of any such explanation it may be appropriate to assume that the manufacturers either
a: have little faith in their "expected liquid discharge" predictions
or
b: expect that, at some stage during the plant's 60 year operating life, some "contingency" will arise which is likely to breach a lower discharge limit.

In the absence of any further information, and given that Cs 137 production is linked (by the Environment Agency) to fuel pin cladding failure issues, this discrepancy highlights uncertainties regarding the performance integrity of fuel pin components, assemblies and cladding and demands further consideration and review of the integrity of reactor burn processes and fuel performance.
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Cobalt 60 aquatic discharges.   Half life 5.27 years
Cobalt 60 enters the discharge stream, in both dissolved and particulate form, as an activation product of stainless steel components found within the reactor and the cooling system.

Cobalt 60 is considered to be a useful indicator of levels of corrosion in the primary coolant circuit and a good reflection of the effectiveness of primary coolant water chemistry with higher concentrations indicating greater inefficiencies in chemistry efficiency.

Co60 is shown to concentrate in marine and estuarine sediments and in marine foodstuffs. It has been shown to mobilise in association with both the water column and mobile sedimentary particles.

EDF/AREVA have stated that they expect the annual discharge of Co60 (not including any “contingencies”) , from each reactor, will be 0.00018TBq per year or 180 million Bqs per year.
Thus each 2 reactor UK EPR station is expected to discharge 360 million Bqs of Co 60 in its liquid radioactive wastes per year.

EDF/AREVA have proposed an annual aquatic discharge limit of Cobalt 60 per reactor, of 0.0015 TBq per year (1thousand 500 million Bq per year). The Environment Agency has accepted this proposal.
Thus the annual Cobalt 60 discharge limit for each 2 reactor UK EPR station will be 3 thousand million Bqs per year.

NB : there is a huge discrepancy (nearly ten times) between the annual “expected discharges” of Cobalt 60 and the annual limit proposed by EDF/AREVA and accepted by the Environment Agency.
No explanation is offered in the GDA documentation for this discrepancy.

In the absence of any further information, and given that Co60 production is linked to corrosion of stainless steel components, this discrepancy highlights uncertainties regarding the performance integrity of stainless steel reactor and cooling system components and demands further consideration and review of the integrity of reactor and cooling system steel components may be relevant.

In the absence of any such explanation it may be appropriate to assume that the manufacturers either
a: have little faith in their “expected liquid discharge” predictions
or
b: expect that, at some stage during the plant’s 60 year operating life, some “contingency” will arise which is likely to breach a lower discharge limit.

Westinghouse/Toshiba have stated that they expect the annual discharge of Co60 per AP1000 reactor (not including any contingencies) will be 230 million Bqs
Thus for each 3 reactor AP1000 station the annual expected liquid discharge of Cobalt 60 will be 690 million Bqs.

Westinghouse/Toshiba have proposed an annual liquid discharge limit of Cobalt 60 for each AP1000 reactor of 500 million Bqs The Environment Agency has accepted this proposal.
Thus the annual limit for liquid discharges of Cobalt 60 for each three reactor AP1000 station will b 1,500 million Bqs

NB. There is a marked discrepancy between the expected discharge performance of the AP1000 (3 reactor) stations and the limit demanded by

the manufacturers and granted by the Environment Agency. As with the UK EPR, this discrepancy highlights uncertainties regarding the performance integrity of stainless steel reactor and cooling system components and demands further consideration and review of the integrity of reactor and cooling system steel components.

In the absence of any such explanation it may be appropriate to assume that the manufacturers either
a: have little faith in their "expected liquid discharge" predictions
or
b: expect that, at some stage during the plant's 60 year operating life, some "contingency" will arise which is likely to breach a lower discharge limit.

The proposed Co 60 limit for the UK EPR is two times higher than that proposed for the AP1000. The EA has not offered any discussion of the reasoning behind its preparedness to accept such widely varying proposed limits.

In the context of the EAs willingness to accede to the requests of both EDF/AREVA and those of Westinghouse/Toshiba it appears that these limits have been set in order to comply with the potential performance of each reactor rather than in order to comply with a common understanding of best environmental requirement or most limited environmental impact.
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Discharges of Alpha emitters/actinides (Plutonium, Americium, Curium and Uranium)
These substances are by-products of the use of uranium based fuels and many of their isotopes have very long half -lives. Many of the decay products of these isotopes also have very long half-lives.

In the context of the postulated 60 year life spans for both the UK EPR and the AP1000 these alpha emitters and actinides may have a significant long term potential for concentration in the marine environment. This factor is particularly relevant to fine sediment sub-tidal and inter-tidal marine and estuarine deposits (mud flat, salt marsh et al). These substances have been shown to be easily susceptible to short, medium and long range transport through the marine environment.

The Environment Agency's GDA says that these substances will only appear in the aquatic discharge stream as a result of problems with the fuel pins such as: surface contamination on the fuel pin cladding and/or impurities in the fuel cladding and perhaps the fuel.

Both manufacturers have stated that improvements in fuel design and manufacture will minimise these problems.

However the Environment Agency's GDA admits that the presence of various nuclides (e.g. Caesium 137) in the liquid effluent discharge streams of both proposed reactors are “an indicator of fuel cladding failure” and the section above, covering Cs137, comments on data which questions the integrity of fuel pin performance.,

Evidently such problems are expected because Westinghouse/Toshiba have published a list (Table3.4-6 of the AP1000 European Design Control Document and the Environment Report), described as “expected annual release of radioactive effluent discharges” and containing 12 individual isotopes as follows: 5 isotopes of Plutonium, 3 isotopes of Uranium, 2 isotopes of Americium and 2 of Curium.

EDF/AREVA also predict that there will be discharges of various unspecified actinides and other alpha emitters.

Westinghouse have not provided any quantification for the discharges of 11 of their listed actinides (restricting themselves to stating that the discharges of the 11other individual isotopes are expected to be “negligible” and noting that the definition of negligible is “values less than 3.7E+4 Bq” (37,000 Bqs per year). However they have at least provided some information on aquatic Plutonium 241 discharges as follows:

Plutonium 241 half-life 14 years
As it decays, Plutonium 24 produces Americium 241 as a decay product. Americium 241 is reported by some sources to be possibly twice as radio-toxic as some of the Plutonium isotopes.

Americium already has a significant presence in UK waters, especially the Irish Sea and those into which the Irish Sea flushes (Bristol Channel, Hebridean waters etc) as result of both direct discharge of Americium and also as a result of the historic decay of historically un-regulated quantities of Plutonium 241.

Americium is very susceptible to transport through the marine environment, deposition and concentrate into fine sediment environments and has been observed to be highly enriched in sea surface micro-layers and airborne sea spray and marine aerosols.

Westinghouse have calculated Worst Case Plant Discharge (WPCD) for only one of the actinides (Pu 241) for the AP1000 reactor and concluded that it will be 178,000 Bq per year per reactor.
Thus for an AP1000 station with three reactors the annual maximum expected discharge of Plutonium 241 will be 534,000 Bqs per year

Westinghouse et Al have proposed an annual limit for aquatic discharges of Pu 241from 1 reactor of 200,000 Bq per year
Thus for a 3 reactor station Westinghouse propose an annual limit of 600,000 Bqs.

However, the Environment Agency’s proposes no specific limit for Pu 241.

EDF/AREVA have failed to provide such a high degree of clarity and the Environment Agency's GDA consultation documents are only able to report that the discharge from the UK EPR will include a number of un-named "others" which appear to include alpha emitting actinides which may include unspecified isotopes of Plutonium, Americium, Curium and Uranium. **There is no evidence that the Environment Agency have requested that EDF/AREVA provide such data for the UK EPR reactor.**

Both reactor manufacturers have stated that high removal efficiencies of coolant filtration will minimise actinide discharges and promise that alarmed alpha detectors will be installed at point of discharge.

They also state that operational experience in other PWRs shows that no alpha emitters have been detected at point of discharge.
In this context it should be noted that the annual UK Radioactivity in Food and the Environment (RIFE) Reports state (in the context of sample analysis at the UK PWR at Sizewell) that
*a: "concentrations of artificial radionuclides were low and **mainly** due to the distant effects of Sellafield discharges and to weapons testing" (i.e. some of the material was NOT from those sources)*
b: 3 isotopes of Plutonium and also Americium 241 and Curium were positively detected
c: some isotopes of Curium in some samples were reported "not detected by the method used" (i.e. possibly detectable by other methods.)

In the context of alpha emitters and actinides in liquid discharges, and on behalf of the Nuclear Free Local Authorities, this author has submitted the following queries to the Environment Agency's GDA process:

- *what is the detection performance/threshold of the in-line Alpha detectors*
- *what is the calculated quantity of alpha emitters for the UK EPR*
- *what is the expected isotopic content of alpha emissions for the UK EPR*
- *what are the sources of the expected alpha emitters*
- *what factors might lead to the presence of detectable amounts of alpha*
- *if/when the in-line detectors "detect" the presence of alpha emitters, what mechanisms will "prevent" the discharge of alpha emitters*

The Environment Agency response was that they did not have the answers to these questions and that they would submit them to the manufacturers. As of yet no further response has been received.

NB: In the context of the estimated 60 year, operating life of proposed stations the discharge of long lived alpha emitters discussed above may have a high environmental significance especially in the context of their tendency to concentrate in environmental media such as marine fine sediment deposits, marine micro-layers, marine aerosols and sea spray.

Thus it may be calculated that, over the 60 year life span of a Westinghouse, AP1000 3 reactor station,
a: the annual maximum expected discharge of Plutonium 241 : 534,000 Bqs per year X 60 years = 32,040,000 Bqs (32 million and 40 thousand Bqs) **while**

b: the annual maximum expected discharge of the 11 other alpha emitters (i.e. other Plutonium isotopes, direct (non-decay product) Americium, Uranium isotopes and Curium isotopes)
37,000 Bqs per year X 60 years = 2,220,000 (2 million, 220 thousand Bqs) per reactor or 6,660,000 Bqs per year per 3 reactor station

and thus
c: there is a potential for the environment to receive over 38 million 700 thousand Bqs of alpha emitters from each 3 reactor AP1000 station across it's proposed 60 year life span.
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Some Unresolved Environmental Issues arising from the
"Aqueous radioactive waste disposal and limits" Assessment Reports for the UK EPR and the AP1000 reactor

During the preparation of briefings on the environmental impact and fate and behaviour of liquid radioactive waste discharges from proposed new build nuclear power stations it has become apparent that a number of issues remain outstanding, in that they have not been addressed at all, or have been inadequately addressed by the manufacturers Reports and Environment Agency's Generic Design Assessment (GDA) process. The most significant of those issues are summarised below.

Issue 1:
Lack of transparency on the part of manufacturers regarding the information on the total inventory of the proposed aquatic discharge.
One source (*Table 3.4-6: AP1000 European Design Control Document and the Environment Report)* reports that the liquid effluent discharges from such reactors will contain 65 radio-nuclides or isotopes.
(Radio-nuclide= species of radioactive substance e.g. Plutonium. Isotope= a variety of the species e.g. Plutonium 239, Plutonium 240 or Plutonium 241)

However the Environment Agency's GDA for both reactor types engages in no discussion of the majority of those nuclides, identifying only a small group of nuclides (4 or 5 depending on the reactor type) which it considers to be of major significance and a slightly larger group of lesser significance (up to 12 depending on the reactor type), leaving over 50 nuclides/isotopes not discussed.

The "significance" of the nuclides/isotopes is defined by the "amount" of radioactivity being discharged. Insignificant nuclide/isotope discharges are those described as "negligible", and the definition of "negligible" is "values less than 37,000 Bq per year" per reactor. In the context of multiple reactor (2 or 3) sites with a proposed operational life span of 60 years, such a figure for many nuclides including alpha/actinides is not insignificant or negligible.

Issue 2: Lack of transparency on "inventory" of alpha/actinides discharges: which, from the table referenced above, will include 5 isotopes of Plutonium, 3 isotopes of Uranium, 2 of Americium and 2 of Curium.
The Environment Agency's GDA fails to provide

A: details of the quantity of each to be discharged per reactor and per site
B: discussion of quantity per sea area (Irish Sea, Bristol Channel, North Sea)
C: calculation of quantities released over the proposed 60 year reactor/site operating life
D: discussion of environmental fate/behaviour/impacts of discharges in the short, medium or long term
E: examination of the production of alpha/actinide decay products
F: discussion of the environmental fate and behaviour of these decay products
G: details of the detection levels of automatic shut off mechanisms
H: discussion of how those mechanisms operate
I: discussion of outcomes of shut off: (effect on discharge stream flow, build up of radioactive content of effluents, impact on plant maintenance and operation, nuclide content of subsequent discharge)

Some of these issues have been put to the Environment Agency who have agreed to pass them on to developers, as of yet no further response had been received.

Issue 2 : EA Discharge Limits
Greater clarification is required for the justification of Environment Agency limits

AP1000 nuclide/isotope reactor/station limits are radically different from those for UK EPR reactor/station limits with regard to the limits demanded by the developers for specific nuclides/isotopes. Thus Westinghouse have demanded a 60 TBq annual limit (per AP1000 reactor) for liquid discharges of Tritium, while EDF have demanded a 75 TBq annual limit (per UK EPR reactor) for liquid discharges of Tritium.

The EA have granted both demands. With regard to Tritium, and others of their defined most significant nuclides, the EA have granted limits in accord with developer's requirements rather than to any other apparent requirement.

In the context that both discrete marine areas and discrete types of environment (water columns, sediment deposits, biota) have a limited holding capacity and flushing time for pollutants, is there a national policy regarding:

A: discharge limits from any given point source,
B total sources to any given environment,
C: what totality of any given nuclide may be discharged into UK waters or discrete sea areas?
D: Cumulative totalities rather than individual reactors (strategic assessments rather than local assessments)

And if there is no such policy ….why not?

Issue 3: The impact of gaseous/atmospheric discharges on the marine environment

The GDA offers quantifications of gaseous/particulate discharges to atmosphere of various nuclides/isotopes but fails to discuss:

A: the potential impact of mechanisms such as offshore winds, wash out, fallout, inversion layers and plume-to-surface events

B: the potential effect of these mechanisms on local and regional marine environmental and biota concentrations of relevant isotopes

C: the potential effect of these mechanisms on a range of local and regional marine dietary, external and inhalation doses.

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ISSUE 4: Dose Assessments

Poor or nil discussion of the following:

A: Human doses via ingestion of terrestrial food and inhalation (via sea to land transfer)

B: Doses/impacts to wildlife

C: Lack of transparency/discussion of alpha/actinide (and decay product) input to doses to humans and wildlife.

D: complete failure to address the issue of Marine Distant Critical Groups: i.e. those population groups located “distant” from reactor point sources of radioactive waste discharges who have been shown to be in receipt of higher doses of artificial radioactivity than some Critical Groups living adjacent to reactor sites.

Plainly such weaknesses demand further review of environmental data inputs for EA Dosimetry Model, PC-CREAM98 Dosimetry Model and GDA Assessment systems

ISSUE 5: Fate and Behaviour of Radioactive Wastes in the marine environment

Neither the manufacturers nor the Environment Agency have reported any consideration of issues related to the fate and behaviour of discharged radioactive wastes in the marine environment e.g.

A: transport of different nuclide types through the marine environment in “dissolved” or un-dissolved form

B: transport of different nuclide types through the marine environment in particulate form or attached to particulate material

C: deposition of some nuclide types into marine and coastal, fine sediment deposits (estuaries etc), both adjacent to the discharged point and at distant sites

D: re-concentration of some nuclide types in differing environmental media, both adjacent to the discharge point and at distant sites (marine and coastal fine sediments, sea surface micro-layers, marine aerosols and sea sprays)

E: mechanism, inland penetration and dosimetric significance of the sea to land transfer of marine discharged radioactive wastes across the surf line and in to the terrestrial coastal zone.

In the context of the uncertainty generated by the weaknesses in GDA processes discussed above, the whole issue of dose assessments cannot be considered to be closed until those weaknesses have been remedied.

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Ongoing review of the GDA process, as it relates to aquatic radioactive waste discharges, is required in order to uncover any further issues of concern.

Ongoing review of the Environment Agency's responses to comment to date is similarly required.

More detailed analysis and review of these issues is necessary in order to provide relevant and appropriately detailed information and to fill in these data gaps.

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