Nuclear Free Local Authorities

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NFLA submission to the Environment Agency and Natural Resource Wales on its Generic Design Assessment for the ABWR design proposed for Wylfa and Oldbury sites

i. Overview of Policy Briefing

This edition of New Nuclear Monitor provides the NFLA submission to the joint Environment Agency / Natural Resource Wales Generic Design Assessment of proposed environmental permits for the Horizon Nuclear (Hitachi owned) Advanced Boiling Water Reactor (ABWR) design planned for the nuclear sites at Wylfa, Anglesey and Oldbury, Gloucestershire. The submission has been developed for the NFLA by Tim Deere-Jones, an independent marine radioactivity consultant. A summary of this report was presented to the NFLA Welsh Forum meeting in Aberystwyth on March 10th 2017. The submission focuses on spent fuel cooling points, issues around potential leaks from the reactor, aqueous radioactive discharges into the marine environment and concerns over plutonium and tritium.

1. Spent fuel cooling ponds at Fukushima and with the ABWR

1.1 As was seen with the Fukushima Boiling Water Reactors (BWRs), the initial marine environmental impact of reactor LOCAs was doubly multiplied by Spent Fuel Cool Pond (SFCP) and a Loss of Coolant Accident (LOCAs).

1.2 In a number of reports issued by the IAEA, World Nuclear Association, various other nuclear industry bodies and a range of independent academics and environmental NGOs there is a broad consensus that Spent Fuel Cooling Pond (SFCP) integrity was severely compromised, at the Fukushima reactors, following the 2011 tsunami. It is reported that this occurred as a result of the failure of cooling water circulation and replenishment technology, and also as a result of physical, structural damage to the upper stories of reactor buildings where the BWR SFCPs were located (as they are in the case of the proposed UK ABWRs).

1.3 Although SFCP issues have been consistently overshadowed by the crisis attempts to restore cooling water to the damaged multiple reactors (1,2 & 3) and to control and mitigate the effects of the triple reactor fuel meltdowns, there is none the less sufficient evidence to justify a major concern about the safety and integrity of UK ABWR building design with SFCPs situated in an elevated position on the top floor of the reactor buildings and outside the major, primary containment systems.

There follows 3 detailed case studies summarising some of these concerns.

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1.4 Fukushima incident - Extract from "Science" Magazine

*'Spent Fuel Cooling Pond Near miss at Fukushima is a warning for U.S., panel says Japan's chief cabinet secretary called it "the devil's scenario." ' Two weeks after the 11 March 2011 earthquake and tsunami devastated the Fukushima Daiichi Nuclear Power Plant, causing three nuclear reactors to melt down and release radioactive plumes, officials were bracing for even worse. They feared that spent fuel stored in the reactor halls would catch fire and send radioactive smoke across a much wider swath of eastern Japan, including Tokyo.

Thanks to a 'lucky break' detailed in a report released today by the U.S. National Academies, Japan dodged that bullet. The near calamity "should serve as a wake-up call for the industry," says Joseph Shepherd, a mechanical engineer at the California Institute of Technology in Pasadena who chaired the academy committee that produced the report. Spent fuel accumulating at U.S. nuclear reactor plants is also vulnerable, the report warns. A major spent fuel fire at a U.S. nuclear plant "could dwarf the horrific consequences of the Fukushima accident," says Edwin Lyman, a physicist at the Union of Concerned Scientists, a nonprofit in Washington, D.C., who was not on the panel.

After spent fuel is removed from a reactor core, the fission products continue to decay radioactively, generating heat. Many nuclear plants, like Fukushima, store the fuel onsite at the bottom of deep pools for at least 5 years while it slowly cools. It is seriously vulnerable there, as the Fukushima accident demonstrated, and so the academy panel recommends that the U.S. Nuclear Regulatory Commission (NRC) and nuclear plant operators beef up systems for monitoring the pools and topping up water levels in case a facility is damaged. It also calls for more robust security measures after a disaster. "Disruptions create opportunities for malevolent acts," Shepherd says.

At Fukushima, the earthquake and tsunami cut power to pumps that circulated coolant through the reactor cores and cooled water in the spent fuel pools. The pump failure led to the core meltdowns. In the pools, found in all six of Fukushima's reactor halls, radioactive decay gradually heated the water. Of preeminent concern were the pools in reactor Units 1 through 4: Those buildings had sustained heavy damage on 11 March and in subsequent days, when explosions occurred in Units 1, 3, and 4.

The "devil's scenario" nearly played out in Unit 4, where the reactor was shut down for maintenance. The entire reactor core—all 548 assemblies—was in the spent fuel pool, and was hotter than fuel in the other pools. When an explosion blew off Unit 4's roof on 15 March, plant operators assumed the cause was hydrogen—and they feared it had come from fuel in the pool that had been exposed to air. They could not confirm that, because the blast had destroyed instrumentation for monitoring the pool. (Tokyo Electric Power Company, the plant operator, later suggested that the hydrogen that had exploded had come not from exposed spent fuel but from the melted reactor core in the adjacent Unit 3.) But the possibility that the fuel had been exposed was plausible and alarming enough for then-NRC Chairman Gregory Jaczko on 16 March to urge more extensive evacuations than the Japanese government had advised—beyond a 20-kilometer radius from the plant.

Later that day, however, concerns abated after a helicopter overflight captured video of sunlight glinting off water in the spent fuel pool. In fact, the crisis was worsening: The pool's water was boiling away because of the hot fuel. As the level fell perilously close to the top of the fuel assemblies, something "fortuitous" happened, Shepherd says. As part of routine maintenance, workers had flooded Unit 4's reactor well, where the core normally sits. Separating the well and the spent fuel pool is a gate through which fuel assemblies are transferred. The gate allowed water from the reactor well to leak into the spent fuel pool, partially refilling it. Without that leakage, the academy panel's own modeling predicted that the tops of the fuel assemblies would have been exposed by early April; as the water continued to evaporate, the odds of the assemblies' zirconium cladding catching fire would

have skyrocketed. Only good fortune and makeshift measures to pump or spray water into all the spent fuel pools averted that disaster, the academy panel notes.

At U.S. nuclear plants, spent fuel is equally vulnerable. It is for the most part densely packed in pools, heightening the fire risk if cooling systems were to fail. NRC has estimated that a major fire in a U.S. spent fuel pool would displace, on average, 3.4 million people from an area larger than New Jersey. "We're talking about trillion-dollar consequences," says panelist Frank von Hippel, a nuclear security expert at Princeton University.

Besides developing better systems for monitoring the pools, the panel recommends that NRC take another look at the benefits of moving spent fuel to other storage as quickly as possible. Spent fuel can be shifted to concrete containers called dry casks as soon as it cools sufficiently, and the academy panel recommends that NRC "assess the risks and potential benefits of expedited transfer." A wholesale transfer to dry casks at U.S. plants would cost roughly $4 billion.

(Source: Science: May 20: 2016
http://www.sciencemag.org/news/2016/05/burning-reactor-fuel-could-have-worsened-fukushima-disaster)

1.5 ***Case Study: SFCP at Reactor 4 (from Wikipedia: heavily referenced):***

Following a hydrogen explosion in reactor no 4 building (March 2011) the reactor building had been severely damaged and there was evidence that the twin SFCPs located on the top floor, at both sides of the top of the reactor, were losing cooling water and or that the temperature of the coolant was rising, causing the risk of overheating of the stored fuel elements stored in the SFCPs.

At approximately 14:30 on 16 March 2011, TEPCO announced that the storage pool, located outside the Unit 4 containment area, might be boiling. Around 20:00 JST, it was then planned to use a police water cannon to spray water on Unit 4.

On 18 March 2011, it was reported that water sprayed into the spent fuel pool was disappearing faster than evaporation could explain, suggesting leakage. SDF military trucks sprayed water onto the building to try to replenish the pool on 20 March. On 22 March, the Australian military flew in robotic equipment for remote spraying and viewing of the pool.

The IAEA reported, "From 22 March to 25 March 130 to 150 tonnes of seawater were poured into the spent fuel pool each day using a pump equipped with a long articulated arm. Seawater was also poured in through spent fuel cooling system from 21:05 UTC 24 March to 01:20 25 March. White smoke was still being observed coming from the reactor building as of 23:00 UTC 25 March" On 29 March, the seawater was changed to fresh water.

Analysis of spent fuel pool water collected on 12 April suggests that while some of the 1535 fuel assemblies stored there may have been damaged, the majority of the stored fuel assemblies are intact based on measured radiation levels.

TEPCO further stated that "the fuel rods in the Unit 4 pool had released caesium-134 and −137 in the process of being damaged", and that TEPCO would "need to continue monitoring it". On 13 April, TEPCO reported that the temperature of the spent fuel pool had increased to 90 ℃, and that the radiation level 6 meters above the pool had reached 84 mSv/h. The spike was later attributed to a failure to properly keep the SFP covered in water. As of 25 April, TEPCO was still pumping between 70 and 210 tons of water into the pool, varying the amounts depending on the temperature in the pool. TEPCO also reported that it was attempting to minimize the amount of water added to the pool for fear "the weight

of the water could weaken the reactor building". On 28 April, TEPCO announced it believed that water was not leaking from the pool but only evaporating. TEPCO based its belief on calculations that the heat generated by the spent fuel stored in the pool would be expected to evaporate 140 to 210 tons of water daily, in line with the amount of replacement water it adds. On 9 May 2011, TEPCO began work to install a supporting structure for the Unit 4 spent fuel pool, due to the concerns that explosions could have weakened the structure.

On 11 June, it was discovered that the water level in the spent fuel pool was only one third of normal, and only part of the fuel rods were covered with water. This was probably the cause of the high radiation levels measured. This pool has also been used to dump equipment. On Sunday 19 June, the pool was refilled, to minimize the radiation and making it possible to work again at this place. On 21 June, the first stage of strengthening at the second floor in the building under the pool was finished: 32 steel columns 8 meters long with a weight of 40 tons each were placed at the second floor. By 30 July, the concreting of the supporting columns was completed.

From 16 June, water injection to the spent fuel pool was switched from using the concrete pumping vehicle to an alternative water injection line.

On 31 July, the spent fuel pool was switched from the water-injection cooling system, to a circulatory cooling system.

On 31 January 2012, six litres of radioactive water (35,500 becquerels per litre) leaked from the spent fuel pool of reactor 4 onto the floor in the building from a broken pipe. The leakage was stopped after a valve was closed, and was thought to have been caused by the cold weather. The next day (1 February 2012), TEPCO released an even higher figure: 8500 liters were leaked after a pipe was dropped off after the water inside had turned into ice. The leakage appeared to have started at around 5 p.m. on 31 January 2012. This water was contaminated with radioactive isotopes, because it was mixed with water that was in contact with the fuel rods from the spent-fuel pool. TEPCO made plans to check whether there were similar cases in the other damaged reactor buildings.

In June 2012, TEPCO confirmed that reactor 4 building had indeed suffered severe damage during the 2011 hydrogen explosion. Holes were reported in the upper stories of the reactor building's external walls (described in diagrams of UK ABWR, as "secondary containment") and vertical walls in the upper stories were reported "out of the vertical".

On 30 June 2012 around 6:25 hours local time, an alarm went off, and the cooling system of the spent fuel pool halted. At that time, the temperature was 33.3 degrees Celsius; no leakage of radioactive contaminated water was reported. On 4 June, a similar situation caused the cooling to be halted. On 1 July shortly after 3 p.m. the cooling was resumed, the water temperature of the pool having risen to 42.9 °C. TEPCO had feared that the temperature could reach 65 °C, the upper limit designated in safety regulations. The cause of the troubles was laid in some parts of the emergency power system, and these were to be replaced.

On 18 March 2013 at 6:57 p.m., the cooling system for the spent fuel pools of the No. 1, 3 and 4 reactors stopped, after the electricity instantaneously went out at the plant's accident response centre. TEPCO suspects that the problem was situated in one makeshift power switchboard controlling the cooling system. The injection of water into the Nos. 1, 2 and 3 reactors was not affected. According to TEPCO, restoring the cooling system of the spent fuel pool of reactor No. 4 had the "highest priority", because the number of fuel assemblies stored in that tank was larger than in the pools of unit 1, 2 and 3. On 19 March at 10 a.m., the temperatures ranged between 15.9 C and 30.5 C, and it would take about four days until the temperature of the water inside the No. 4 spent fuel pool reaches the upper safety

limit of 65 C. TEPCO was prepared to inject water into the pool whenever needed in case the water warmed up and started to evaporate.

On 19 March around 1:20 p.m., one of the two lines forming the cooling system of the No. 4 spent fuel pool was restored. Around 8 p.m. TEPCO was expecting to get the other line in operation. The cooling system of the No. 1 spent fuel pool was put back in action at 2:20 p.m. The power loss caused anxiety and questions among residents of the region. The news was communicated by the Nuclear Regulation Authority around three hours after the incident happened. On 22 March 2013, the evacuation zones were to be reclassified, and some residents would be allowed to make day trips to their homes. Some people thought that all was under control, and others with little children were afraid for yet another evacuation. Electricity went out simultaneously at nine facilities of the plant in total, a filter system to remove radioactive materials from cooling water for the reactors, and a cooling system for yet another pool were affected too. TEPCO admitted, that this was the first occasion that such a power failure happened at so critical facilities at the site since the plant was brought under control in December 2011.

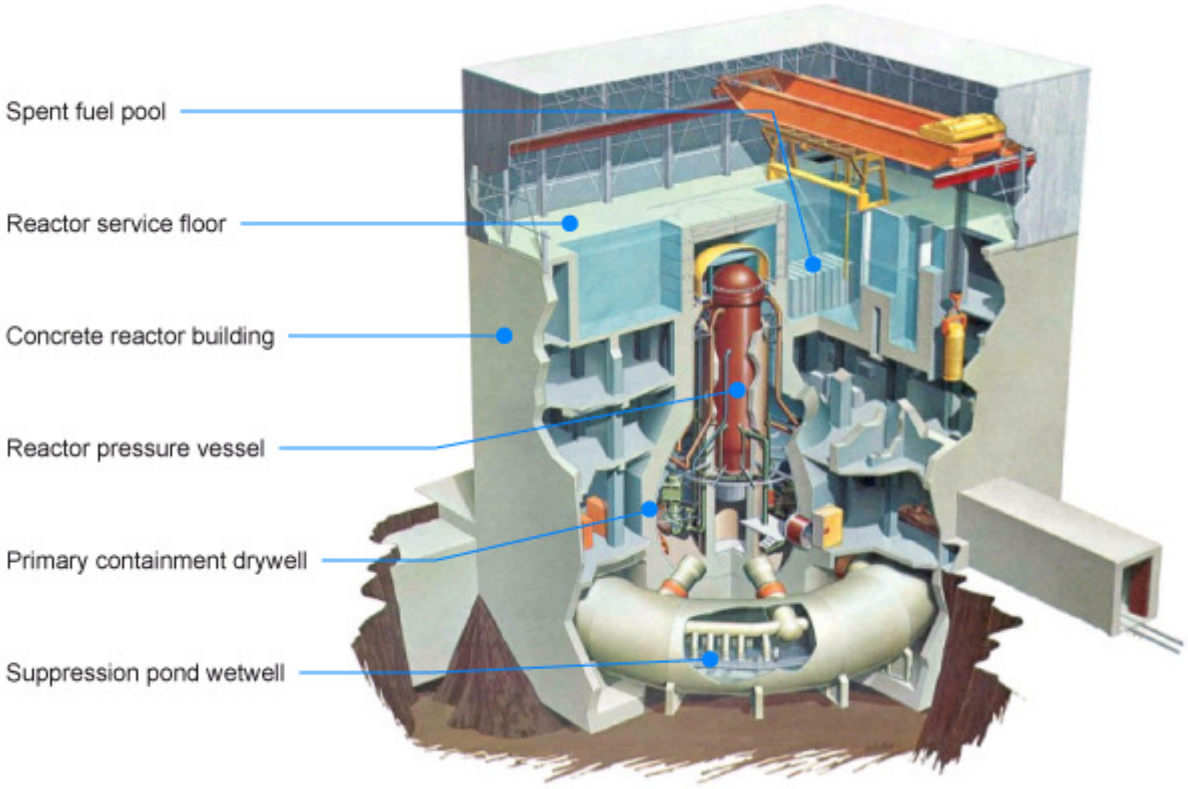
On 20 March before 1:00 a.m. all systems were online again. The cooling system of pool no. 4 was restored as last. TEPCO blamed a provisional power switchboard to be the cause of the troubles. According to TEPCO, this was the last remaining makeshift power switchboard at the plant, installed after the nuclear crisis. Criticism was there from the central and prefectural government, the late announcement three hours after the power loss had caused “significant anxiety” among local people. TEPCO promised that it would seek to communicate relevant information more quickly on issues that could stir public concern. During the investigation to find the cause of the power loss, a 6-inch rat was found electrocuted near a switch board. Further investigations were needed to find out whether this was the only cause.

It is widely reported that although cooling water backup systems were available for the reactors, the power loss proved that that was not the case for the spent fuel pools.

1.6 **The World Nuclear Association report - Fukushima: Background on Fuel Ponds *(Updated February 2016)***

Used fuel needs to be cooled and shielded. This is initially by water, in ponds. After about three years under water, used fuel can be transferred to dry storage, with air ventilation simply by convection. Used fuel generates heat, so the water is circulated by electric pumps through external heat exchangers, so that the heat is dumped and a low temperature maintained.

There are fuel ponds near the top of all six reactor buildings at the plant, adjacent to the top of each reactor so that the fuel can be unloaded under water, when the top is off the reactor pressure vessel and it is flooded. The ponds hold some fresh fuel and some used fuel, pending its transfer to the central used/spent fuel storage on site. (There is some dry storage on site to extend the plant’s capacity.)



The intention was to ship used fuel from the plant periodically for recycling. Tepco and JAPC are building a Recyclable Fuel Storage Centre in Mutsu, due to operate from mid 2012 with 5000 t capacity. The JPY 100 billion facility will provide interim storage for up to 50 years before used fuel is reprocessed at Rokkasho. NISA approved this in August 2010. Until the Mutsu storage is finished and operational in 2012 there has been a build-up of used fuel at reactor sites. The Rokkasho plant has been much delayed, and is now expected in commercial operation in October 2012. There is some storage capacity there, though this may be full.

At the time of the accident, in addition to a large number of used fuel assemblies, unit 4's pond also held a full core load of 548 fuel assemblies while the reactor was undergoing maintenance, these having been removed at the end of November.

The temperature of these ponds is normally low, around 30℃ when circulation is maintained with the Fuel Pool Circulation and Clean-up (FCP) system, but they are designed to be safe at about 85℃ in the absence of pumped circulation (and presumably with moderate fuel load). They are about 12 metres deep, so the fuel is normally covered by 7 metres of water.

Unit 2, 3 & 4 ponds are about 12 x 10 metres, with 1240, 1220 and 1590 assemblies capacity respectively (unit 1 is about 12 x 7 m, 900 assemblies). Unit 4 pond contained a total 1331 used assemblies (783 plus full fuel load of 548), giving it a heat load of about 3 MW thermal, according to France's IRSN, which in that case could lead to 115 cubic metres of water boiling off per day, or about one tenth of its volume. Other estimates put the heat load at 2 MW. Unit 3's pool contains 514 fuel assemblies, unit 1 has 292 and unit 2 has 587, giving it a heat load of 1 MW. There is no MOX fuel in any of the ponds. Unit 4 pond also had 204 fresh fuel assemblies which were ready for loading. In 2012 some of these were removed and checked, and found to be undamaged. Unit 4 fuel pond was emptied by the end of 2014.

Two of the reactor unit ponds (2 & 4) were unusually full even before unit 4 core was unloaded in November, since there was little spare space (only for 465 assemblies) in the

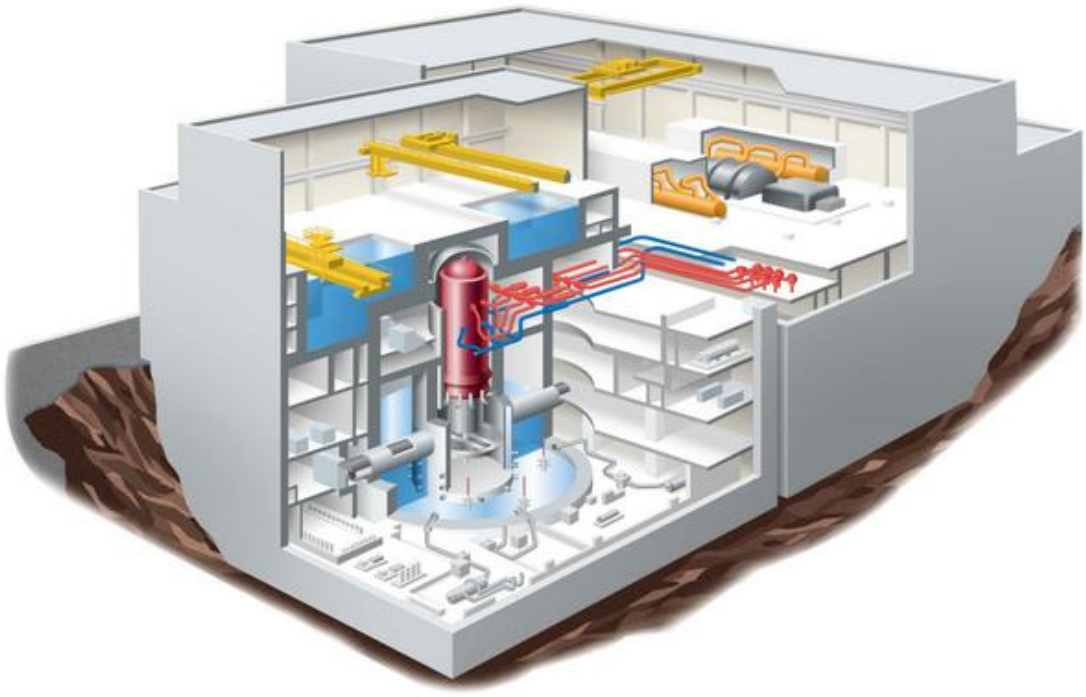
central fuel storage pond on site. Thus there was a lot more fuel in the reactor ponds with correspondingly high heat loads and cooling requirements than might have been the case.

Moving the used fuel from reactor ponds to central storage involves loading it under water into casks which are lowered down and trucked the short distance (see RH side of cutaway diagram above). It requires access from the service floor and the use of cranes which were damaged in the hydrogen explosions.

The central fuel storage on site near unit 4 has a pond about 12 x 29 metres, 11 m deep, with capacity of 3828 m^3 and able to hold 6840 fuel assemblies. In March 2011 it held 6375 assemblies, and was not damaged in the accident. Its building is about 55 x 73 m. Due to the fuel here being older, it has very low decay heat. As well as this pond, there are 408 used fuel assemblies in dry cask storage - utilized since 1995 for used fuel no longer needing much cooling.

A further concern raised during the accident was regarding criticality in the spent fuel ponds. Studies of safety and security of spent fuel storage have noted this possibility but not analysed it, pointing out that no previous criticality accidents have resulted in significant radioactive releases outside the plants, since the criticality itself immediately disperses the source material.

1.7 Similarity of the Spent Fuel Cooling Ponds in the ABWR and with the Fukushima BWR



Hitachi GE diagram of proposed UK ABWR reactor showing the Spent Fuel Cooling Ponds, located above and to either side of the reactor, in the upper stories of the reactor building.

NFLA notes that the design siting of the SFCPs in the UK ABWR is currently proposed to be a replication of the Fukushima type BWR SFCPs.

1.8 Hitachi GE documentation on the height of the building reports that the reactor building is expected to be 45 metres high. Some Hitachi GE documentation refers to the exterior concrete outer wall of the reactor building as “secondary containment”.

1.9 The Hitachi GE diagram of the UK ABWR and its associated SFCPs shows no apparent difference from the layout of the SFCPs at the Fukushima BWR. To date there is no evidence that significant major changes, structural or design based, have been made to the SFCP design and layout in the light of the Fukushima experience.

1.10 Accordingly, the NFLA believes that the design flaws leading to some of the reported Fukushima SFCP failure issues have been carried over to the UK ABWR. Issues of particular concern are:

- the potential for structural failure in the event of a severe reactor accident: due to the highly elevated position of the UK ABWR SFCPs a severe reactor accident has the potential to damage both SFCPs and the “secondary containment”/exterior concrete wall (as indicated in the case of the Reactor 4 cooling ponds at Fukushima);
- the potential for structural failure in the event of a terrorist attack aimed at the upper reaches of the reactor building where SFCPs are located, appears highly likely in the event of mortar, RPG or aerial attack;
- both types of incident (severe reactor accident and/or terrorist attack) carry a high potential to generate breaches not only of the “secondary containment” concrete exterior wall of the upper stories of the reactor building, but also to the “primary containment” concrete walls of the elevated SFCPs themselves;
- such breaches are consensually agreed to carry with them varying degrees of potential for criticality of SFCP used fuels, though it must be noted that different commentators attribute different degrees of risk and potential magnitude of impact severity from such events;
- as the Fukushima events have clearly demonstrated, such breaches will inevitably require rapid, effective and medium to long term remedial action to maintain cooling water levels and ambient safe temperatures in damaged SFCPs;
- such action will generate high levels of ECW (emergency cooling water) application to the damaged SFCPs over potentially long term time scales;
- breaches of SFCP containment carry with them a high potential for uncontrolled release of radioactive contamination : either as a result of the initiation of criticality due loss of temperature control/cooling water, and/or as a result of loss of, and subsequent “escape” of liquid coolant from the reactor building containment system.

2. NFLA’s key concerns to Spent Fuel Cooling Pond issues

The NFLA therefore requests that the environment regulators and the GDA process undertake a further review and description of these and associated issues with specific attention to

- the potential for occurrence of breaches of SFCP containment in the event of terrorist activity or reactor accidents;
- processes/safeguards to reduce the risk of criticality and SFCP coolant loss in the event of SFCP breaches of containment;
- effectiveness of long term SFCP ECW supply and application in the event of a severe INES scale incident;
- strategies for the collection, containment, treatment, safe management and disposal of escaped primary SFCP coolant in the event of any such breach;
- strategies for the collection, containment, treatment, safe management and disposal of remedial ECW (under long term/high volume application scenarios);

- clear and complete strategies for the total prevention of either "primary" SFCP coolant or ECW escaping from the "reactor island" and subsequently entering the terrestrial environment, freshwater environment or marine/tidal environment;
- in the event of such a breach, strategies for the complete monitoring and analysis of ALL radio nuclides present in the primary SFCP coolant and in any ECW, thus enabling a complete assessment of potential dose impacts to regional human and wildlife populations;
- in the context of the TEPCO statement that "the weight of the *(ECW)* water could weaken the reactor building" the ability of damaged SFCPs and the reactor building to carry the weight of large volumes of ECW under post event containment breach conditions.

3. ***Aqueous discharge issues***

3.1 The NFLA notes that the only ABWRs which have ever been "operational" are 1st generation ABWRs and that prior to their post Fukushima mothballing, their operating life was plagued with technical problems to such a degree that their overall operating efficiency was often less than 50%.
(to date no 2nd, 3rd or 4th Generation [i.e. Wylfa Newydd) have been constructed

ABWR Operating Efficiency Factors (OEF):

Reactor station	Start of Commercial Operation	OEF until 2011
Kashiwazaki Kariwa 6	07/11/96	72%
Kashiwazaki Kariwa 7	02/07/96	68.5%
Hamaoka	18/01/2005	46.7%
Shika	15/03/2006	47.1%

NB: Inexplicably, 2006 Hitachi PR material for the UK ABWR claims OEF of 90%+ "on the basis of "operating experience". No supporting evidence was offered for this claim.

3.2 The EA/NRW GDA consultation document makes the following statement *"Variability in quantity of aqueous discharges has been considered" and "All sources of aqueous radioactive wastes have been identified".* In the context of this statement the NFLA notes that the GDA document under discussion contains no discussion of historical leaks or "accidental discharges" of liquid or gaseous radioactive wastes at UK and Japanese NPS of any type, and specifically none relevant to ABWR performance.

NFLA research, to date, has been unable to find any example of a NPS where absolutely no leak of gaseous or liquid radioactive waste has occurred during the lifetime operation of such stations.

NFLA research to date has been unable to find any example of a NPS where absolutely no leak of gaseous or liquid radioactive waste has occurred during any single year of operation.

3.3 The NFLA therefore requests that the EA/NRW GDA for UK ABWRs re-examines this issue in depth and provides:

- a summary of the leakage/accidental discharge occurrence frequency of worldwide NPS of all types;

- a detailed analysis of the frequency of leaks and accidental discharges of both liquid and gaseous radioactive wastes from all UK NPS and all ABWRs that have been operational.

3.4 The NFLA requests that such analysis should address the following specific issues:
- annual frequency of, and specific (per year) number of liquid and gaseous leaks at sites during their working life and through their subsequent decommissioning process;
- range of "magnitudes" of leaks (gaseous/liquid discharge volume and radioactivity aggregate of each leak)

3.5 The NFLA notes that over the 60 year proposed operating life span of the proposed UK ABWRs such leaks may represent highly significant additional and un-quantified aggregated radioactivity inputs into marine, coastal and tidal environments, via pathways of direct discharge to sea (liquid wastes) and fallout and washout (gaseous wastes).

3.6 The NFLA also notes that the majority of operating UK NPS have been granted additional lifetime operating extensions following the completion of their original proposed design life and notes that such an eventuality may have an additional significance in terms of the frequency and number of leaks and accidental discharges from UK ABWRs.

3.7 The NFLA requests that the GDA process comment on whether, or not, such lifetime extensions will be prohibited in the case of any future operating UK ABWR

3.8 NFLA notes that in February 1979, a single Hinkley Point NPS leak lasted for 6 months (January to June) and discharged an officially estimated 185 million Bqs (of mainly Cs 137) across the open, and publicly accessible, foreshore and into the sea during this incident. No additional detail was ever provided of the other radio nuclide constituents of the leak.

3.9 NFLA also notes that in 1983 a leak/accidental discharge of radioactive liquid wastes to sea occurred through the Sellafield reprocessing plant's sea discharge pipelines. This leak was not discovered by site operators but by Greenpeace campaigners working at sea. BNF and relevant government agencies were unable to provide precise details of the constituent radio nuclides or of the total/aggregated radioactivity yield of the discharge. It was widely stated that the leak approximated to roughly a years' worth of authorised liquid discharges (multiple Terra Bqs).

4. 'Washout' or 'fallout' of radioactive waste

4.1 The NFLA notes that the GDA paper under discussion makes no reference to the phenomenon of washout or fallout of radioactive wastes discharged via the proposed site "stacks" to the atmosphere. The NFLA notes that these discharges to atmosphere would be expected to consist of gases, steam and particulate material.

4.2 To date the NFLA has been unable to find any detailed discussion of the behaviour and fate of the totality of such radioactive discharges to the atmosphere. In particular there appears to be a major dearth of information relating to fall out and washout of the full range of radio nuclides listed for atmospheric discharge from proposed UK ABWRs.

4.3 A number of scientific papers have discussed the fallout/washout of atmospheric radioactive pollution discharged following major nuclear accidents such as Chernobyl and Fukushima. The evidence of such papers, and indeed the experience of affected populations at considerable distance from the point source, have amply demonstrated that fallout and washout from such relatively short duration, "single incident" events has made major contributions to increasing concentrations of ambient environmental radioactivity on

terrestrial and marine/coastal/tidal environments at considerable distance from the point source.

4.4 The UK experience of the Chernobyl fallout/washout has been tolerably well recorded, especially in the context of Cs 137 inputs, by UK annual radiological monitoring programmes in the years following the Chernobyl event. The (then current) Aquatic Environment Monitoring reports (AEMRs) produced by MAFF from 1986 onwards are a case in point.

4.5 The relevant AEMRs make it quite plain that significant amounts of radioactive fallout (Cs 137) entered UK marine/coastal/tidal environments by a variety of pathways including direct "primary" fallout/washout to sea surfaces and "secondary" input via fluvial etc run off from land surfaces and fresh water courses contaminated by Chernobyl fallout and washout.

4.6 Contemporary AEMRs (1986 onwards) recorded rapidly rising and notably enhanced concentrations of Chernobyl derived radio nuclides in UK marine/coastal and tidal environments and biota.

4.7 The NFLA notes the proposed 60 years life span for UK ABWRs, and has already alluded to it in earlier paragraphs. The NFLA has also alluded to the possibility that UK ABWR reactors may yet be granted additional operational life span extensions to the proposed design life although normal operational atmospheric discharges.

4.8 The NFLA proposes that, although chronic atmospheric discharges from normally operating UK ABWRs will plainly not generate the elevated, short term, very high aggregated radioactivity loading of the atmosphere seen during the acute Chernobyl and Fukushima events, planned and un-planned releases to the atmosphere of the range of radioactive wastes proposed for discharge from normally operating UK ABWRs have the potential (over the proposed 60 years' operating life span plus any possible "extension") to make potentially significant, long term inputs of washed out and fallen out radioactivity to UK marine, coastal and tidal environments. Given the half-lives of some of these radio nuclides, the long term implications of such phenomenon may have significance.

4.9 The NFLA notes that the current proposed sites for UK ABWRs (Severn estuary, and Wylfa Newydd) exhibit features likely to support relatively high levels of fallout and washout of atmospheric radioactive wastes: including "wet" prevailing winds, relatively higher rainfall than other parts of the UK and, in the case of Wylfa Newydd, mountainous topography.

4.10 The NFLA requests that the EA/NRW GDA process examine the issue of atmospheric radioactive waste discharges and fallout/washout in order to clarify the inevitable additional inputs to marine/coastal and tidal environments from fallout/washout.

4.11 The NFLA requests that, in the context of the above request, the EA/NRW GDA process investigates and reports on the following specific issues:

- provide a detailed review of the available empirical scientific data on the fallout and washout of atmospheric radioactive waste discharges;
- such a review should report the available empirical data on the behaviour and fate of ALL forms (gas, steam, particulates) of atmospheric radioactive waste discharges under the range of environmental, meteorological and topographical conditions found at proposed UK ABWR sites;
- such a review should report the behaviour and fate of each individual radio nuclide constituent of proposed atmospheric radioactive waste discharges (normal operational performance) under the range of environmental, meteorological and topographical conditions found at proposed UK ABWR sites;
- such a review should report the available empirical evidence on the amount (aggregated radioactivity) of each constituent radio nuclide entering the UK

marine/coastal and tidal environments as a result of fallout and washout mechanisms due to normal operational conditions;

- in the case of an absence of such empirical data, the proposed review should attempt to model/calculate the above factors for UK ABWRs located at the proposed UK sites, while making plain that this is a modelling, not empirical data, and while referencing and describing all empirical data inputs;
- as indicated in the previous chapter (above) such a review should also provide full data on the number, frequency, volume and aggregated radioactivity of the historical un-planned, accidental discharges of gaseous, steam and particulate radioactive wastes from historically and currently operating UK NPS;
- such a review should also provide detailed empirical data on the operational discharges of "atmospheric" radioactive wastes at Japanese ABWRs;
- such a review should also provide detailed empirical data on the accidental, un-planned discharges of gaseous, steam and particulate radioactive wastes discharged during the operational life of the Japanese ABWRs.

5. "Relevant guidance" of "significant" radionuclides

5.1 The EA/NRW GDA document under discussion states that with regard to aqueous radioactive wastes: "significant" radio nuclides have been identified and quantified in line with relevant guidance." However, the NFLA is concerned that the "Relevant Guidance" uses an out-dated definition of "Significant" radio nuclides: (Euratom/2004/2) which does not reference the most recent scientific evidence on some specific radio nuclides discharged to sea from existing operational UK NPS, and proposed for discharge to sea, or likely to be a constituent of the liquid discharges to sea from the UK ABWR.

5.2 One example of such a radio nuclide is Plutonium (Pu) 241 and its decay/daughter product Americium (Am) 241.

5.3 During the late 1980s it was realised that there was an issue of rising marine environmental concentrations of alpha emitting Americium 241 derived from the decay of Plutonium 241 which had been discharged to sea in unlimited and largely un-quantified quantities since the inauguration of discharges to sea.

5.4 It has been projected that, by the end of the 21st century, marine Americium 241 production from the decay of previously discharged Pu 241 will be delivering approximately 1,300 curies (48 TBq) per year into Irish Sea (and associated marine area) environments. *(First report of the House of Commons Environment Committee. HMSO: London 1986)*

5.5 The annual RIFE reports confirm, and make regular reference to, this issue (Am production by Pu 241 decay, in relation to marine sediments). However, neither the reactor manufacturers, new build developers nor the regulating agencies (via GDA) discuss the phenomenon in relation to the proposed ongoing discharge of Pu 241 (which generates decay production of Am 241), nor have they discussed the issue in relation to the direct discharge of un-quantified volumes of Am 241

5.6 In this context the NFLA draws attention to the wide independent scientific consensus that:

- Americium 241 is a known alpha emitter and considered potentially at least as radio toxic as the plutonium radionuclides (if not more so);
- Americium 241 has a very long half, is known to be environmentally persistent, mobile through marine environments in association with mobile sediments, to readily and effectively bio-accumulate through marine food webs, and to transfer from the sea to land with (under specific circumstances such as the formation of marine aerosols) major enrichment factors relative to ambient marine concentrations;
- All the available evidence confirms that, like the other alpha/actinides, decay product Americium 241 will eventually appear in coastal and estuarine fine sediment deposits.

5.7 The NFLA concludes that, in the context of the information set out in the preceding paragraphs, there are significant issues relating to the discharge to sea of both Pu 241 and Am 241 from proposed nuclear new build which have not been examined during the GDA process.

5.8 Thus the potential environmental and subsequent public health impacts of the discharges of Pu 241 and Am 241 (in conjunction with the decay product Am 241 arising) currently remain unknown and un-quantified in the context of Pu 241 discharges from proposed UK ABWRs.

5.9 The NFLA therefore requests that the EA/NRW GDA process undertake a review of the issue of Americium 241 production by decay of Pu 241 discharged from UK ABWRs and further requests that the GDA process provide details of, and review in depth, the following specific issues:

- Will UK ABWRs discharge any Plutonium 241 and or any Americium 241, and if so, in what quantities?
- Will the discharges, from UK ABWRs, of Pu 241 and Am 241 be at a constant rate or are there likely to be pulses or intermittent inputs of such radio-nuclides?
- If such discharges are expected to be pulsed or intermittent what is the reason for such pulsed or intermittent discharges?
- What annual aggregated discharges of Pu 241 will be discharged to sea from each single UK ABWR per year?
- On the basis of current understandings, what is the expected annual arising of Am 241 in UK waters (by decay) from proposed discharges of Pu 241 from a single UK ABWR?
- What is the expected lifetime (60 year) aggregated discharge of Pu 241 to sea from a single UK ABWR?
- On the basis of current understandings, what is the expected lifetime (60 year) arising of Am 241 in UK waters (by decay) from proposed discharges of Pu 241 from a single UK ABWR?
- What is the expected total lifetime (60 years) aggregated discharge to sea of Pu 241 from the totality of all of the proposed UK ABWRs?
- On the basis of current understandings, what is the expected total lifetime, aggregated arising of Am 241 (by decay of sea discharged Pu 241) from the totality of all proposed UK ABWRs?

6. Definition of "significant"

6.1 The NFLA is concerned that the "Relevant Guidance" uses an out-dated definition of "Significant" radio nuclides: (Euratom/2004/2) which does not reference the most recent scientific evidence on some specific radio nuclides discharged to sea from existing operational UK NPS, and proposed for discharge to sea, or likely to be a constituent of the liquid discharges to sea from the UK ABWR.

6.2 Another specific example of such a radio nuclide is Tritium (H3), discharged to sea as liquid radioactive waste, most specifically tritium discharged in the form of tritiated water and (post discharge) becoming organically bound and forming OBT after discharge into organically enriched marine/coastal/tidal environments. The NFLA notes that neither the Relevant Guidance, nor the GDA paper under consideration, makes reference to OBT.

6.3 Historically there has been a wide consensus between the nuclear industry and the regulatory agencies that Tritium was of little radio biological significance, largely based on their stated assumption that discharged tritium (as tritiated water) would naturally dissolve to infinity once in the marine environment and thus present no radio biological hazard. This attitude was typified by the following example:

6.4 In 1985, liquid Tritium discharges from the Hinkley A Station were increased following work to clean the coolant circuit. The 1985 discharge was 23 TBq, compared to previous years when the annual liquid discharge of Tritium from this station was less than 1 TBq per year.
(MAFF Aquatic Environment Monitoring reports (AEMRs) nos 12, 13, 14: Table 1)

6.5 Despite the observed 23 fold increase in tritium discharges in 1985, the regulatory authority stated that: "the increased discharges were of negligible radiological significance"
(MAFF AEMR: no 14, section 6:6: page 36))

6.6 However by 1999 this approach appears to have been under review, when a more precautionary position began to appear when reference was made to the "relatively high levels of organically bound tritium (OBT) in local fish and shellfish" from the Cardiff area of the Bristol Channel/Severn Estuary (max of 33,000 Bq/Kg in cod and 26,000Bq/Kg in mussel).
(RIFE Report no 5: pub' 2000: section 8:2 and 11:2 and tables 8:2a and 8.2c: page 111)

6.7 It was also reported that additional sampling of tide washed pasture and wildfowl (of curlews, pintails, shelducks and "ducks") that feed in the Bristol Channel/Severn Estuary intertidal zone had found elevated levels of tritium in most samples with:

- lowest wildfowl concentrations at 2,400 Bq/Kg;
- "the highest values found were in Shelduck at about 61,000Bq/Kg total tritium";
- grass concentrations ranging from less than 3 Bq/kg to 2,000Bq/Kg;
- intertidal sediment concentrations ranging from 18Bq/Kg to 2,500Bq/Kg.

6.8 While the ambient sea water concentrations of total tritium were reported to range from 9.2 Bq/Kg to 10Bq/Kg: thus representing an extremely high rate/level of biological accumulation of total tritium (assumed to be OBT + tritiated water)

6.9 In the context of these findings it was reported that research and further sampling were underway "to examine the mechanisms by which tritium becomes incorporated into biota in the marine environment"
(*RIFE Report no 5: pub' 2000: section 8:2 and 11:2 and tables 8:2a and 8.2c: page 111)*

7. **Tritium studies**

7.1 A follow on study of the behaviour of Tritium (3H) in the Severn Estuary and Bristol Channel (published in 2001) found that:

- Tritium concentrations in sea water from the Atlantic approaches to the Bristol Channel is estimated to be less than 0.4 Bq/Kg;
- Measured Tritium concentrations in sea surface water samples at the mouth of the Bristol Channel were lower than the detection level of 2 Bq/Kg;
- Measured Tritium concentrations in seawater inside the Bristol Channel were at their highest (between 2 and 10 Bq/Kg) on the English side of the Bristol Channel in the vicinity of the Hinkley Nuclear Power Station outfalls;
- Measured Tritium concentrations reached their Bristol Channel second highest concentrations (between 2 and 7Bq/Kg) in the vicinity of the Cardiff outfalls;
- In general, measured concentrations were at their most elevated (2 to 5Bq/Kg) in the eastern end of the sea area and at their least elevated to the west of the Hinkley discharge points.

(McCubbin.D et al: "Incorporation of Organic tritium (3h) by Marine Organisms and Sediment in the Severn estuary/Bristol Channel:UK. Marine Po0llution Bulletin. Vol 42. Issue 10. Oct' 2001: pps 852-863)

7.2 The 2001 study also reported that marine organisms incorporate Tritium, via exposure to tritiated water, very rapidly and, within a range of a few minutes to a few hours and reach

concentrations close to that of the tritiated sea water in which they are immersed or from which they are acquiring their food.

7.3 The NFLA believes that these are highly significant findings in the context of the information discussed in above. If there were to be discrete pulses or peaks (individually consisting of as much as 21% of annual discharge limit) of liquid tritium discharge, it follows that tritium concentrations in marine organisms, with their very rapid incorporation rates, will be subject to similar time related peaks of concentrations of tritium.

7.4 From the information currently available it remains unclear whether the various assumptions for delivered doses of tritium have been based on steady state delivery of liquid tritium discharges to the Hinkley marine environment or whether they are based on the peaks and troughs of tritium discharges implied by NNB Genco's statements.

7.5 The 2001 study also found that:

- tritium becomes incorporated into the organic matter of cells and becomes Organically Bound Tritium (OBT), but at a slower rate than above and typically reaches a concentration of about half that of the ambient tritiated seawater;
- Organisms which consume tritiated food accumulate OBT at a faster rate than those exposed only to tritiated water and may reach higher concentrations by bio-accumulation;
- environmental monitoring through out UK waters demonstrates that concentrations of 3H in seafood in the Bristol Channel/Severn Estuary sea area are significantly greater than in other UK marine areas;
- there was an observed disparity in the rate and degree of Tritium bioaccumulation between sediment, seaweed, benthic (seabed) organisms and fish; however this was provisionally attributed to different processes of Tritium uptake by different species;
- that bioaccumulation of tritium by benthic organisms and demersal fish occurs primarily via transfer up through a web of sediment dwelling microbes and meiofauna, which had been feeding on organic bound tritium. In this context it was observed that herbivorous species and pelagic fish had lower concentrations of tritium than carnivores and demersal (dwelling near the sea bed) fish.

(McCubbin.D et al: "Incorporation of Organic tritium (3h) by Marine Organisms and Sediment in the Severn estuary/Bristol Channel: UK. Marine Po0llution Bulletin. Vol 42. Issue 10. Oct' 2001: pps 852-863)

7.6 A more recent study (published in 2009) has built upon the emerging understanding of the behaviour and fate of tritium in the marine environment illustrated above and reports that:

- tritium's reactivity with organic materials and solids in the marine environment had previously been "assumed to be limited";
- previously, the accumulation of tritium in organic rich sediment and the food chain of the Severn Estuary "including concentration factors in excess of 100,000 for demersal fish and shellfish, were ascribed to the existence of organically bound tritium (OBT) in local nuclear waste in the form of specific bio-chemicals, including carbohydrates, vitamins and amino-acids".

(Turner A. et al: "Distribution of tritium in estuarine waters: the role or organic matter": Journal of Environmental Radioactivity. Vol 100. Issue 10. October 2009. pps 890-895)

7.7 However, the 2009 research demonstrated that, contrary to this assumption, the research "found that its distribution appears to be influenced by its affinity for organic matter" and that "Significantly, a measurable fraction of sorbed tritium associates with proteinaceous material that is potentially available to sediment-feeding organisms."

7.8 It was also noted that the discharge of tritiated water from a nuclear establishment on the Tamar estuary resulted in the immediate dilution to activities of less than 10 Bq per Kg in

ambient water, “whereas corresponding activities of about 300Bq/Kg (dry weight) in sediment” where observed.

7.9 In the context of the above effect (which has been noted in this and other, estuarine waters) it was reported that the research absorption and adsorption (sorption) experiments had demonstrated that “sediment organic matter is critical to the removal of tritium from the aqueous phase” and that the effect “was greater in seawater than in river water”

7.10 The 2009 study noted that “the most remarkable aspect of our investigation is the extent of associated tritium, with both dissolved HOM (hydrophobic organic matter) and fine estuarine particles”.

7.11 “Experimental results, suggest that the presence and nature of organic matter is critical to the fate of tritium in the aquatic environment, and that there is also potential for its interaction with and uptake by inorganic phases. Association of tritium with sediment organic matter was corroborated in our studies by its near complete (greater than 95%) digestion in untreated estuarine particles”

7.12 Noting that “these characteristics have not been reported previously”, the 2009 study concluded that:
“Clearly the view that tritium occurs exclusively as tritiated water and therefore dissolves to infinity should be considered cautiously. Further research into the concept and nature of tritium partitioning in natural waters is required, and the adoption of unit value (or sub-unit value) distribution coefficients and concentration factors that are currently recommended by the IAEA, but not supported by clearly defined measurements, may require reconsideration.”

(Turner A. et al: “Distribution of tritium in estuarine waters: the role or organic matter”: Journal of Environmental Radioactivity. Vol 100. Issue 10. October 2009. pps 890-895)

7.13 It is relevant to note that, as late as this 2009 study, academics were still commenting on the fact that there was a perception that radioactive wastes discharged to sea would dissolve “to infinity”.

8. Summary conclusions on tritium

8.1 Aqueous tritium discharged to sea rapidly mixes with surface water and behaves like any other water. Thus there are good technical grounds for assuming that it will transfer easily from the sea to the land in marine sea sprays and aerosol droplets.

8.2 A search of ‘Science Direct’ has been unable to find any publications/references for the subject “Tritium in sea spray and marine aerosols”, this Submission therefore concludes that there is little, or no, published research on this subject.

8.3 There is a broad consensus that there are no available techniques to remove tritium from reactor coolant and thus, to avoid the build-up of tritium in the coolant, a portion of the coolant must be discharged to sea and replaced. (i.e. reactors cannot be safely operated without the discharge of tritium)

8.4 UK GDA processes repeatedly state that discharge strategies are normally decided by the site operator and that they will identify the preferred management strategy regime before the start of operational management of the plant.

8.5 If such a strategy is employed at UK ABWR sites this could lead to as much as 21% of annual discharge being discharged in 1 month, leading to major peaks and troughs of discharge across a 12 month period. It follows that tritium concentrations in marine

organisms, with their very rapid tritium incorporation rates, will be subject to similar time related peaks of concentrations of tritium.

8.6 From the information currently available it remains unclear whether the various assumptions for delivered doses of tritium (via seafoods) have been based on steady state delivery of liquid tritium discharges to marine environments or whether they are based on the peaks and troughs of tritium discharges implied by some NPS manufacturers statements.

8.7 The previous hypothesis was that tritium would disperse and dilute to infinity after discharge into UK marine/coastal/tidal environments and hence that tritium discharges were of negligible significance.

NB This hypothesis is a re-iteration of the original hypothesis for the behaviour and fate of all radioactive wastes discharged to sea.

8.8 However, the evolving (post 2000) empirical research now demonstrates that, contrary to the previous view:

- tritium does not disperse and dilute to infinity;
- tritium rapidly bonds with suspended organic/sedimentary particles in the receiving waters;
- tritium concentrations in fine sediment deposits are significantly elevated over those found in ambient seawater;
- tritium bio-availability is much greater than expected;
- uptake through organic/sedimentary particles to marine and estuarine food webs is demonstrated to be much higher than was expected, (tritium concentration factors in demersal fish and shellfish of up to 100,000).

8.9 As a result of these and other findings, independent and academic researchers have stated that:

- existing IAEA recommendations are not supported by clearly defined measurements;
- the adoption of unit value (or sub-unit value) distribution coefficients and concentration factors currently recommended by the IAEA may require reconsideration;
- further research is required.

8.10 It is highly relevant to note that the actual annual discharges, and annual limits for discharges, of Tritium from UK nuclear power stations had been markedly reduced, over the decade prior to nuclear new build applications, in response to the evolution of the understanding of tritium.

8.11 Thus, in 1999, the combined Hinkley A and B station Tritium actual discharge was 355.8TBq *(RIFE 5).* But by 2009 the combined Hinkley Point A&B station Tritium discharge was reduced to 105.232TBq *(RIFE 15*)

8.12 However the Regulating Agency has now concurred with the demand for a reversal of that recent policy and thus:

- If the proposed new Hinkley and Oldbury reactors come on line, tritium discharge limits (for combined existing and new Bristol Channel NPSs) will rise by 50% from 653 TBq to 983 TBq per annum;
- If the proposed new Hinkley and Oldbury reactors come on line the actual annual discharge of tritium (for combined existing and new Bristol Channel NPSs) will rise from 105.4 TBq to 314.6 TBq per annum (a 3 fold rise).

8.13 NFLA notes that, to date, the available empirical monitoring/sampling data (as presented in RIFE reports) on the concentrations of Tritium in seawater, sediments and biota appears to be restricted to relatively small areas adjacent to points of discharge.

8.14 However, although there remain some considerable data gaps concerning the near, mid and far field behaviour and fate of tritium in marine environments, the evidence presented in the preceding paragraphs offers a growing body of evidence to point to the environmental significance of Organically Bonded Tritium and it's potential for bioaccumulation and delivery of doses by both ingestion and inhalation to coastal human populations.

9. NFLA requests to the regulators on tritium

9.1 The NFLA notes that, in the context of tritium discharges to sea from proposed UK ABWRs, there is a strong body of evidence to suggest that there are high concentrations of organic material in the Wylfa Newydd downstream marine and tidal environment. In this context the NFLA requests that the EA/NRW GDA process examine the issue of the discharge of tritium (as tritiated water) to sea in the liquid radioactive waste streams of proposed UK ABWRs.

9.2 The NFLA requests that specific attention is paid to a review of the available data on the fate and behaviour of tritiated water (post discharge) and the subsequent formation of Organically Bonded Tritium.

9.3 The NFLA requests that the EA/NRW GDA process undertakes a specific and detailed analysis of the annual cycle of the organic content of receiving waters for the proposed liquid radioactive discharges from identified and proposed UK ABWR sites (Severn Estuary/Bristol Channel and Liverpool Bay/north-east Irish Sea)

9.4 The NFLA requests that, in the context of the scientific evidence discussed above, the EA/NRW GDA undertakes quantification of the expected Organic Bonding of tritium (as tritiated water) discharged from the proposed UK ABWRs, and summarise the rates of bio-accumulation of OBT in proposed UK ABWR discharges, downstream marine/coastal/tidal sediments and biota.

9.5 The NFLA requests that the EA/NRW GDA process provides a summary of the data (available to the GDA process) on expected doses, to the public, of sea to land transfer of both tritiated water and OBT via both inhalation pathways and ingestion (of terrestrial foods) across downstream coastlines.

9.6 The NFLA further requests (in the context that it is agreed that greater quantities of tritium are discharged to atmosphere than to the sea from proposed UK ABWRs), that the GDA process examine and provide a detailed report on the washout/fallout potential of atmospherically discharged tritium (from proposed UK ABWRs) and it's subsequent impact on tritium and OBT concentrations on marine/coastal/tidal environments associated with, and downstream of, proposed UK ABWRs.

10. Total constituents of UK ABWR liquid discharges

10.1 The GDA document under discussion states that, with regard to quantification and identification of the radiological content/constituents of radioactive aqueous wastes from proposed UK ABWRs, the discharge calculation is based upon Japanese reference methodology based on "assumed" release rates caused by fuel failures, decontamination factors and activity flow through at liquid waste treatment systems for 1st Generation ABWRs.

10.2 The NFLA notes that, semantically, it is plain that this means that such quantifications are NOT based on empirical data and that such calculations are heavily reliant on "modelled" and "assumed" assessments. The NFLA is concerned that there appears to be a lack of available empirical data on these parameters and that the input of inadequate data to such modelled assessments militates against the generation of suitably accurate information.

10.3 In support of this concern, the NFLA has noted the following data sets presented by Hitachi in relation to the UK ABWR liquid discharges of radioactive wastes to sea:

- A Summary table for Liquid releases consists of 35 radio nuclides;
- An Assumed Annual Liquid Discharge Rate from ABWRs only consists of 24 radio nuclides;
- A Calculated Annual Liquid Discharge Rate of Wylfa Newydd ABWR only presents data for 10 radio nuclides: All others deemed "insignificant";
- An Actual Measured Values for liquid discharges from Japanese ABWR which only references Tritium/H3.

10.4 The NFLA is concerned that, in the context of the above "summary", "assumed" and "calculated" liquid discharge release data and the fact that one table provides "actual measured values" on the liquid discharges of only one radio nuclide (Tritium/H3), there is

- a major absence of empirical data on the liquid discharge performance of the predecessor/precursor ABWRs;
- in such a context, the liquid discharge performance of the proposed UK ABWRs cannot be adequately and accurately assessed;
- in the absence of such data the post discharge short, medium and long term environmental impacts (behaviour & fate in marine/coastal/tidal environments, transport/mobility potentials, environmental concentrations in seawater and sediments, biological accumulations in marine algae, sea foods, sea to land transfer mechanisms and concentrations cannot possibly be accurately calculated or assessed.

10.5 Noting the absence of empirical data on the totality of the radio nuclide constituents of proposed liquid rad' waste streams from both precursor ABWRs and the proposed UK ABWRs, the NFLA requests that the EA/NRW GDA process examines and review this issue in depth and provides:

- the most recent, detailed available empirical information regarding the radio nuclide constituents of liquid discharge out-put of precursor ABWRs and also
- specifically a full list of each and every radio nuclide expected to be found in liquid discharges of radioactive waste from the proposed UK ABWRs.

10.6 The NFLA requests that the GDA process further provide empirical data on both the annual, and lifetime, aggregated radioactivity discharge of each and every radio nuclide expected, and/or likely, to be discharged in liquid rad' waste streams of the proposed UK ABWR.

10.7 The NFLA specifically requests that the GDA process provides all the available detailed and empirical data on the aggregated annual and lifetime radioactivity of "total alpha", all Plutonium isotopes, all Americium isotopes, all Curium isotopes and Tritium planned for discharge as constituents of the liquid rad' waste stream discharges from both the precursor ABWRs and the proposed UK ABWRs.

10.8 The NFLA requests that, in the event that the GDA process cannot acquire and present the empirical data requested above (as it applies to both precursor ABWRs and the proposed UK ABWR) the GDA process:

- explains how, in the absence of such empirical data, attempts to calculate environmental concentrations and potential doses to wildlife and humans, from each and every radio nuclide thus discharged, will be carried out;
- explains how, in the absence of such empirical data, any attempted modelling of environmental concentrations and potential doses to wildlife and humans can be verified PRIOR to the discharges occurring.