Nuclear Free Local Authorities RADIOACTIVE WASTE POLICY Briefing No.70 – Wylfa B and Radioactive Waste

Prepared for NFLA member authorities, January 2018

Wylfa B and Radioactive Waste – submission to Natural Resources Wales on Horizon Nuclear proposals

1. Purpose of Briefing

This briefing has been developed by the NFLA Secretariat for the NFLA Welsh Forum to respond to the Natural Resources Wales (NRW) consultation on the radioactive waste permit for the proposed new nuclear reactor development at Wylfa – Wylfa B or called Wylfa Newydd by the developer, Horizon Nuclear, which is wholly owned by Hitachi. This submission complements detailed responses on the reactor undertaken by Horizon, and for the Generic Design Assessment (GDA) consultation undertaken by the Office for Nuclear Regulation (ONR) and the Environment Agency / Natural Resources Wales.

The NFLA urges NRW to reconsider its response on the GDA with the one attached here, as it has detailed comments made on the loss of coolant and on aqueous discharges. That can be found on the NFLA website:
http://www.nuclearpolicy.info/wp/wp-content/uploads/2017/03/NFLA_New_Nuclear_Monitor_No47.pdf

This submission focuses specifically on radioactive waste concerns of the NFLA. It plans to elaborate shortly on these for the entire planned new nuclear programme in a report for the OSPAR Commission's Radioactive Substances Committee 2018 meeting.

Details on the consultation can be found on the NRW website on:
https://naturalresourceswales/about-us/news-and-events/news/nrw-consults-on-wylfa-newydd-permit-application/?lang=en

Completed submissions need to be sent to NRW by the 14th January to:
Regulated Industry Permitting Team, Natural Resources Wales, Maes y Ffynnon, Penrhosgarnedd, Bangor, Gwynedd LL57 2DW, or via email to:
WylfaNewyddConsultations@naturalresourceswales.gov.uk

2. Introduction

The role of the English and Welsh Environment Agencies is to ensure the impact of radioactive wastes on the environment is minimised. Research from around the globe, for instance the KIKK Study from Germany, has shown that there is unquestionably a strong link between proximity to nuclear power stations and childhood cancer. Independent consultant on radioactivity in the environment, Dr Ian Fairlie says:

"I can think of no other area of toxicology (e.g. asbestos, lead, smoking) with so many studies, and with such clear associations as those between NPPs and child leukemias."

This means that if cleaner ways to generate electricity are available which do not discharge radioactive wastes into our atmosphere and seas these should be used in preference. The evidence is stacking up to show that, in the words of Professor Keith Barnham, author of 'The Burning Answer: A user's guide to the solar revolution' the UK "…*doesn't need a new generation of expensive nuclear reactors or a dash for shale gas to keep the lights on. An all-renewable electricity supply can provide energy security.*"

The nuclear industry has yet to provide a credible scientific case for nuclear waste ‘disposal’. A deep geological disposal facility (GDF) is not expected to be ready to receive waste until around 2040 at the earliest. Waste from proposed new reactors is not expected to be emplaced in the GDF until after all our existing legacy waste has been emplaced which is expected to take around 90 years. So emplacement of spent fuel from the UK’s proposed new reactors could not begin until at least 2130.

In addition, the high burn-up fuel expected to be used by these new reactors could require up to 100 years of cooling before it would be cool enough to be emplaced in a GDF. So if a new reactor were to come on stream around 2030, with an expected reactor life of 60 years, this means some spent fuel could still be in storage on the reactor site in 2190.

The total amount of radioactivity in the radioactive waste in the year 2200 would increase, as a result of the proposed new reactors at Wylfa from 4,770,000TBq by around 3,801,938TBq. In other words Wylfa B alone is expected to increase the UK inventory of radioactive waste by around 80%.

3. Gaseous Discharges

According to the Environment Agency’s ABWR Assessment Report on gaseous radioactive waste disposal and limits published in 2017, it is expected that each year the proposed ABWR-type reactors would emit to air 2700 gigabecquerels1 (GBq) of tritium; 910GBq of carbon-14; and 9180GBq of radioactive noble gases. These are large amounts of radioactivity when compared with the French EPR proposed for Hinkley Point C. The table below compares gaseous emissions from ABWR with the AP1000 (originally proposed for Moorside near Sellafield) and EPR reactor types.

Radionuclide	EPR	AP1000	ABWRs	Range for 1000 MWe station
Tritium	500GBq	1800GBq	2700GBq	100 – 3600GBq
Carbon-14	800GBq	606GBq	910GBq	40 – 530GBq
Radioactive Noble Gases	350GBq	8047GBq	1980GBq	100 – 10,000GBq

Table 1: Predicted gases discharges for a single reactor of each type.

The Committee on Medical Aspects of Radiation in the Environment (COMARE) recommended that as: “*…part of a new generation of plants, it might be expected that discharges would be lower than existing facilities, rather than ‘within the range of historic discharges’ which seems to be the criterion being applied by EA.*”

This begs the question: if EPRs can reduce tritium emissions to the atmosphere to 500GBq per reactor why can’t ABWRs?

4. Radiation Risks

In the assessment of radiation risks to local people, aerial emissions from nuclear reactors are more important than liquid discharges for two reasons. First, the key parameter in estimating radiation doses to local people from radioactive isotopes is their concentration in environmental materials. Contrary to popular perceptions, air emissions result in much higher environmental concentrations than sea discharges, because water is much more effective than air at diluting contaminants. This is not to accept that dilution is the solution to pollution: it isn’t. It merely reflects the fact of current (ill-advised) methods of disposing nuclear wastes.

Second, individual and collective doses from aerial emissions are much larger than from sea discharges. People living near Nuclear Power Plants (NPPs) receive doses from eating contaminated food, drinking contaminated water, breathing contaminated air, and skin absorption (especially of tritiated water vapour).

For example, the contamination of local foods occurs by air emissions - particularly tritium and carbon-14 emissions. The only exception is contaminated sea foods. But these concentrations are very low. People who elect to live near discharge sites can largely avoid eating contaminated sea foods but, they cannot avoid breathing contaminated air from aerial emissions. It is for these reasons that NPP operators go to considerable lengths to divert radioactive releases away from aerial emissions towards sea discharges. The tritium discharges to sea for example from the AP1000 type of reactor are almost 20 times larger than tritium air emissions. With the ABWR this situation is revered with tritium emissions to the atmosphere thirteen times larger than tritium emissions to the sea.

It's also worth noting that COMARE has highlighted the recent report of the Advisory Group on Ionising Radiation (AGIR) (November 2007) which suggests that current dose estimates for tritiated water are too low.

5. Tritium

The largest aerial emissions are of tritium in the form of tritiated water vapour, i.e. radioactive water. In recent years, many official reports have discussed the hazards of tritium - the radioactive form of hydrogen. In the past, this isotope had been regarded as being only "weakly" radiotoxic: this view is now changing among governments and international agencies concerned with radiation exposures. For example, recent reports have been published by radiation safety agencies in the UK, Canada and France. These reports draw attention to the hazardous properties of tritium including its extremely rapid distribution in the environment, its heterogeneous distribution within tissues, its ability to bind with organic molecules resulting in higher doses, and its high biological effectiveness compared with gamma radiation.

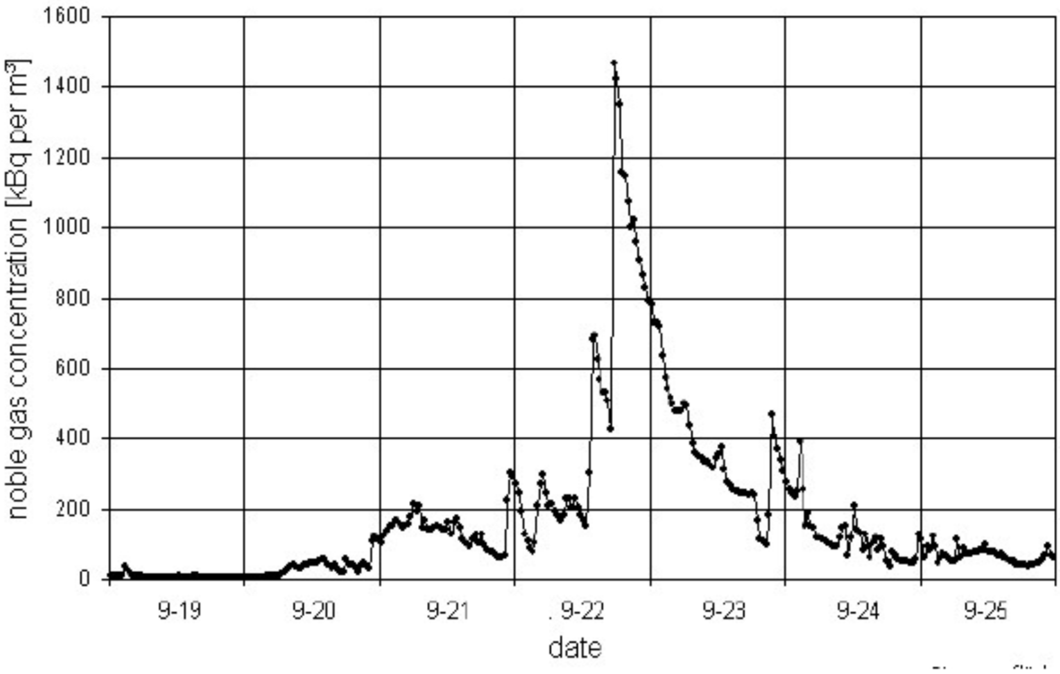
Over 60 epidemiological studies world-wide have examined cancer incidences in children near nuclear power plants (NPPs): most of them indicate leukemia increases. These include the 2008 KiKK study commissioned by the German Government which found relative risks (RR) of 1.6 in total cancers and 2.2 in leukemias among infants living within 5 km of all German NPPs. The KiKK study has retriggered the debate as to the cause(s) of these increased cancers.

Although several studies in the late 1980s and early 1990s revealed increased incidences of childhood leukemia near UK nuclear facilities, official estimated doses from released nuclides suggest these would have been too low by 2 to 3 orders of magnitude to explain the increased leukemias.

A suggested hypothesis is that the increased cancers arise from radiation exposures to pregnant women near NPPs. However any theory has to account for the >10,000 fold discrepancy between official dose estimates from NPP emissions and observed increased risks. An explanation may be that doses from spikes in NPP radionuclide emissions are significantly larger than those estimated by official models which are diluted through the use of annual averages. In addition, risks to embryos/fetuses are greater than those to adults, and haematopoietic tissues (stem cells that create other blood cells) appear more radiosensitive in embryos/fetuses than in newborn babies. The product of possible increased doses and possible increased risks per dose may provide an explanation.

The evidence for radionuclide spikes during refuelling was revealed for the first time in November 2011. Published data from the Gundremmingen NPP in Southern Germany showed that very large spikes of radioactive noble gases were released during refuelling than were emitted during normal power operation throughout the rest of the year. (See graph below). According to the International Physicians for the Prevention of Nuclear War (IPPNW) in Germany, the normal emission concentration during the rest of the year is about 3kBq/m3 but during inspection/refuelling episodes this concentration increased to ~700kBq/m3 with a peak of 1,470kBq/m3. Nuclide emissions during the period of refuelling were about 65% of total annual releases. Noble gas concentrations can be used as a proxy for other gaseous emissions, including tritium, C-14 and iodine releases.

Graph 1. Noble gas concentrations from Gundremmingen C. 1/2 hourly values. Sept 19 to 25



In order to refuel, the pressure vessels of all nuclear reactors are opened up about once a year. This releases large volumes of radioactive gases and vapours, including noble gases, tritium, carbon-14 and iodine-131, to the environment. Until now, these nuclide releases had been published only as annual data throughout the world. After repeated requests by the SPD-Green Party Government in Bavaria, half-hourly data were made available for scientific evaluation for the first time. Brief exposures to high concentrations are more hazardous to residents near NPPs than chronic exposures to low concentrations. Exposures to high concentrations result in higher internal doses, so these nuclide spikes during re-fuelling could go a long way to explaining the increased incidences of child leukaemias near NPPs shown by the KiKK findings.

6. Liquid Discharges

Radionuclide	EPR	AP1000	ABWRs	Range for 1000 MWe station
Tritium	52,000GBq	33,400GBq	200GBq	2,000 – 30,000Gbq
Carbon-14	23GBq	3.3GBq		3-45GBq
Iodine radionuclides	7MBq	15MBq	0.035MBq	10-30MBq
Other radionuclides	0.6GBq	2.7GBq	2.3MBq*	<1-15GBq

Table Two: Predicted liquid discharges for a single reactor of each type.

*This is Fe-55. According to the Environment Agency the aqueous discharge activity is dominated by tritium (H-3), which is not abated and constitutes over 99.99% of the activity in the aqueous discharges. The second largest contributor of activity to the discharges is iron-55 (Fe-55), which only constitutes 0.0012% of the activity discharged.

With regard to the UK's proposed new reactor programme concern has been expressed expressed about the UK's lack of compliance with its obligations under the OSPAR Convention on the Protection of the Marine Environment of the North East Atlantic.

Under the treaty the UK Government is committed to:

"...*progressive and substantial reductions of discharges, emissions and losses of radioactive substances, with the ultimate aim of [achieving] concentrations in the environment near* *background values for naturally occurring radioactive substances and close to zero for artificial radioactive substances.*" [by 2020].

The application of "*best available techniques and best environmental practice, including, where appropriate, clean technology*" is one of the Guiding Principles of the OSPAR Strategy with regard to radioactive substances.

"Clean Technology" should not, in the view of many environmental commentators, involve end-of -pipe filters to remove pollution from discharges to the environment – it should be a technique which produces no pollution to begin with. The requirement for 'Best Available Techniques' (and clean technology) for producing electricity should rule out the possibility of building new electricity generating stations which produce highly dangerous wastes when alternative ways of generating electricity are available which don't produce such wastes.

The EA's Final Assessment Report on Aqueous Waste, published in 2017, makes no mention of the OSPAR requirement for progressive and substantial reductions in discharges of radioactive substances and achieving close to zero concentrations in the environment for artificial radioactive substances by 2020.

7. Critical Group Doses

The EA and NRW have assessed that the total impact of radioactive discharges (including gaseous discharges) from a single ABRW reactor to the most exposed person to be around 14 - 24μSv y^{-1}. The contribution from aqueous discharges is less than 1 μSv y^{-1} illustrating the point made earlier that aerial emissions are more important than liquid discharges. The critical group dose from aerial emissions is dominated by carbon-14.

These numbers compare with the radiological dose limits to members of the public of 1,000μSv y^{-1} with dose from any single new source not to exceed 300μSv y^{-1}. The former Health Protection Agency (now Public Health England) had advised the UK Government to select a constraint value of less than 150 μSv (0.15mSv) per year for members of the public for new nuclear power stations.

The UK Strategy for Radioactive Discharges 2001-2020 included an aim to progressively reduce human exposure to ionising radiation arising from radioactive discharges, so that a representative member of a critical group of the general public will be exposed to an estimated mean dose of no more than 20μSv y^{-1} from liquid radioactive discharges to the marine environment made from 2020 onwards. The 20μSv y^{-1} figure was subsequently dropped from the 2009 updated strategy without explanation, but it still aims for "*progressive reductions in human exposures to ionising radiation resulting from radioactive discharges.*"

Given that the Wylfa Newydd proposal is to build two ABWR reactors, each potentially giving a critical group dose of 24μSv y^{-1}, the 20 μSv y-1 figure could be breached albeit from a combination of liquid and gaseous discharges.

8. Collective Doses

In 1991, the International Commission on Radiological Protection (ICRP) adopted a linear, no-threshold model for radiation's effects. Thus no dose of radiation, no matter how small is without some added level of risk. Collective dose is an important measure of the total exposure of a population over time from a given release of radionuclides and it is an indicator of total detriment to health. The collective dose is, to a first approximation, the average individual dose in an exposed population multiplied by the size of the population. Collective dose represents an attempt to quantify the radiological impact of radioactive discharges to populations larger than the critical group. Collective doses are measured in person-sieverts (person Sv).

Collective doses are sometimes calculated for UK or European populations, but for radionuclides which have long half-lives and become globally dispersed, including tritium, carbon-14, krypton-85 and iodine-129, it is internationally accepted practice to calculate their global collective doses. Calculating the global collective dose can also be seen as morally important when one considers the fact that no-one outside the UK is receiving a countervailing benefit from discharges.

As with critical group doses, estimates of the risks associated with a particular collective dose are fraught with uncertainties and unknowns. The behaviour of radionuclides in the global environment must be predicted over long time-scales and the computer models used to do so are unlikely to be validated by comparison with sufficient data. Future human behaviour and the behaviour of each radionuclide in the human body must also be predicted and estimation of the dose-risk factor in itself involves a large number of assumptions and several models all with uncertainties attached which have to be multiplied together.

Such risks from collective doses are underestimates as they do not include detrimental human health effects other than fatal cancers (e,g. skin cancers) and genetic effects.

Of course the above dose/risk estimates in this report neglect detriment to ecosystems, organisms and species.

It is sometimes argued that collective doses should be truncated to 500 years, because after that the uncertainty becomes too great. However, just because there is uncertainty does not seem to be a good enough reason to assign a zero risk.

To convert from collective doses to fatal cancers, the ICRP's absolute fatal cancer risk of 10% per Sv can be used, although some analysts apply a dose and dose rate reduction factor (DDREF) which reduces the number of estimated fatal cancers in Europe by a factor of 2, and in the US by 1.5. However, as pointed out by Beyea (2012) many epidemiology studies offer little support for the use of such a factor, certainly for solid cancers (Little et al, 2008). Also, the recent WHO (2013) report on risks from Fukushima recommends that a DDREF should not be used for longer term exposures.

The EA and NRW report that its independent assessment calculated collective doses to be 30 person Sv per year of discharge for the world (truncated to 500 years).

The radiation protection community is usually reluctant to translate collective dose into numbers of deaths. This seems to stem from the Greenpeace campaign during the THORP public consultation in 1993-4 when it was argued that THORP would cause 600 deaths (calculated using a 5% risk factor). But Sumner and Fairlie have stated that radiation protection should be about protecting people, not the industry from criticism. Bearing in mind that Hitachi is proposing to build 2 ABWR reactors at Wylfa Newydd, the total collective dose would be in the region of 60 person Sv per year of discharge. By applying the risk factor of 10% per sievert we can calculate that this means there will be around 6 deaths somewhere in the world for every year the station operates. Over 60 years, the total would be 360 deaths.

9. Uncertainties

There are many uncertainties in current estimates of radiation doses and risks and larger uncertainties exist with internal radiation. These arise mainly from the many steps used to derive doses, and partly from lack of statistical precision in deriving risks from epidemiology studies. The size of these uncertainties has been estimated by a number of expert dosimetrists: for some nuclides these are very large. A report by the Committee Examining Radiation Risks of Internal Emitters (CERRIE) recommended that uncertainties should be acknowledged and dealt with by the government. Its parent committee, the Committee on Medical Aspects of Radiation in the Environment COMARE, backed these findings.

A 2001 Consultation Paper from the Department for Environment Food and Rural Affairs summed up the view which prevailed at the time:

"*The unnecessary introduction of radioactivity into the environment is undesirable, even at levels where the doses to both humans and non-human species are low, and on the basis of current knowledge are unlikely to cause harm*"

10. Radioactive Waste Volume

The nuclear industry and the government repeatedly claim that the volume of nuclear waste produced by new reactors will be small, approximately 10% of the volume of existing wastes; implying this additional amount will not make a significant difference to finding an underground dump for the wastes the UK's nuclear industry has already created. The use of volume as a measure of the impact of radioactive waste is, however, highly misleading.

Volume is not the correct measure to use to assess the likely impact of wastes and spent fuel from a new reactor programme, in terms of its management and disposal. The 'high burn-up fuel' which Wylfa Newydd is expected to use will be much more radioactive than the spent fuel produced by existing reactors like Heysham 1 and 2. So rather than using volume as a yardstick, the Bq amounts of radioactivity in the waste, (which in turn affects how much space will be required in a GDF), is a much more appropriate way of measuring the impact of nuclear waste from new reactors.

According to Radioactive Waste Management (RWM) Ltd, the radioactivity from existing waste (i.e. not including new reactors) is expected to be 4,770,000 terabecquerels (TBq) in the year 2200.

It would be interesting to see how much the mooted Wylfa Newydd reactors would add to this pile. We can estimate this from the Radioactive Waste Management Ltd Derived Inventory 2013. This calculated that the waste inventory in 2200 after a 16GW programme of new reactors would be around 27,300,000 TBq – an extra 22,530,000TBq or 1,408,125TBq for every GW of new nuclear capacity. If we multiply this by Wylfa Newydd's proposed 2.7GW of capacity we get 3,801,938TBq This is about 80% of the radioactivity in existing nuclear wastes.

The Government expects spent fuel from the proposed new generation of reactors to be stored not reprocessed. In fact the Thermal Oxide Reprocessing Plant (THORP) at Sellafield which reprocesses the spent fuel from Heysham is due to close in 2018, and there are no plans to replace it. Instead spent fuel is expected to be emplaced between 200 and 1000 metres underground in a Geological Disposal Facility (GDF) –a site for which has still to be found. A GDF is not expected to be ready to receive such wastes until around 2040.

Waste from new reactors like Wylfa Newydd is not expected to be emplaced in the GDF until after all the government's existing waste has been emplaced which is expected to take around 90 years – around 2130. This means that spent fuel could remain on the site for at least the next 100 years. The other factor which needs to be taken into account is that Wylfa Newydd s expected to use high-burn up fuel which could require up to 100 years of cooling before it will be cool enough to be emplaced in a GDF. So assuming Wylfa Newydd comes on stream around 2030, although spent fuel might start to be emplaced in 2130, as the reactors are expected to have a life of 60 years, there may be some spent fuel still stored on Anglesey up until about 2190.

11. Conclusions

ABWRs have high gaseous emissions which are far more important than liquid emissions in terms of radiation doses to local people. Bearing in mind that Hitachi is proposing to build 2 ABWR reactors at Wylfa we can calculate around 6 deaths will occur somewhere in the world for every year the station operates. Over 60 years the total would be 360 deaths.

Wylfa Newydd would produce extremely high levels of radioactive spent fuel. In the year 2200 its spent fuel arisings would amount to 80% of the radioactivity contained in all existing legacy wastes from the UK's nuclear power industry.

The requirement for ‘Best Available Techniques’ (and clean technology) for producing electricity should rule out building new electricity generating stations which produce such highly dangerous wastes. Especially as less expensive, quicker and safer alternatives are available which don’t produce such wastes.