Meeting:	NuLeAF Steering Group, 7 September 2016
Agenda Item:	6
Subject:	Update on national developments in radioactive waste management
Author:	Philip Matthews and Catherine Draper
Purpose:	To update on national developments in radioactive waste management

Introduction:

This report provides a report on recent developments in radioactive waste management. It covers:

- Changes in the UK Government
- Community benefits and fracking
- Report on meeting with NFLA Scotland
- The Submarine Dismantling Project (SDP)
- NuLeAF Briefing on Small Modular Reactors (SMRs)

Recommendation:

This report is for noting.

1. Changes in the UK Government

As members will be aware, the election of Theresa May as Prime Minister was followed by a significant restructuring of Government departments and by a Ministerial reshuffle.

The Department of Energy and Climate Change (DECC) has been integrated into a new **Department of Business, Energy and Industrial Strategy (BEIS**).

The Cabinet Minister in charge of the department is Greg Clarke while **Baroness Neville-Rolfe**, as Minister of State for Energy and Intellectual Property has responsibility for nuclear issues. She is supported by **Jesse Norman**, Minister for Industry and Energy who also has nuclear issues within his portfolio.

The civil service team supporting nuclear issues continues to be headed by **Lee McDonagh**, the Director of the Office for Nuclear Development. NuLeAF invited Ms McDonagh to attend this Steering Group meeting to explain the changes within government. While an existing appointment meant that she was unable to, it is hoped that she will be able to join a future meeting.

Bruce Cairns has been seconded from Government to RWM, where he will work as a Policy Adviser on Geological Disposal Facility (GDF) siting. Jessica Ellis has taken up Bruce's post of Head of Geological Disposal while he is on secondment.

2. Community benefits and fracking

On the 7th August the Government proposed that householders in areas affected by fracking developments could receive direct payments as compensation. These could amount to up to £10,000 per household, with the finance coming from the **Shale Wealth Fund** which is intended to receive 10% of the tax proceeds from such development.

Previously the Shale Wealth Fund would have provided money for community level investment, potentially up to £10 million per affected community. The proposal to pay benefits direct to residents is a significant departure from current practice.

At present it is not clear whether this new approach might also be applied to other community benefits or compensation funding, such as that mooted for the GDF host community or already provided to Copeland residents in recognition of their hosting of the Low Level Waste Repository.

Some clarity on this may be provided by the consultation on the community aspects of the GDF siting process, and NuLeAF will raise this issue in our next meeting with BEIS and RWM, scheduled for later this month. Member views on this issue would be welcome.

3. Report from Nuclear Free Local Authorities (NFLA) Scotland meeting

NuLeAF's Executive Director addressed a NFLA Scotland seminar on progress with nuclear energy and policy matters, held in Dunfermline on the 26th August. The Director spoke about the remit and approach of NuLeAF and also on the organisation's engagement around the Geological Disposal Facility (GDF) siting process. The NFLA has a different view on the best option for Higher Activity Wastes (HAW), favouring long term management near to the surface. The NuLeAF presentation was followed by an interesting discussion on the relative merits of each approach.

The Nuclear Free Local Authorities (NFLA) were involved in the establishment of NuLeAF and have been an important voice since its inception. NFLA Secretary Sean Morris addressed a recent NuLeAF meeting, and it is hoped that this more active dialogue and discussion can continue.

4. Submarine Dismantling Project (SDP)

The SDP, in its current and past forms, has run for 15 years. Its aim has been to identify a long term storage site for the Intermediate Level Waste (ILW) from the UK's 27 decommissioned nuclear powered submarines, prior to their final disposal in a Geological Disposal Facility. NuLeAF has been actively engaged in the SDP as a member of the Advisory Group.

Following extensive consultation and deliberation, Capenhurst has been selected as the site of the ILW store, with Aldermaston as a contingency option in the unlikely case that Capenhurst does not prove suitable.

Given this decision, the final meeting of the Advisory Group was held in Bristol on the 10th August and attended by the Executive Director. The view of NuLeAF, and of other group members, was that the site selection process had been a positive and inclusive one and that there was potential for others to learn from the approach taken.

Looking forward, the process of separating the Reactor Pressure Vessels (RPVs) from the submarines will begin shortly. The submarines are located at Rosyth and Devonport and, once the RPVs are separated, they will be transported to Capenhurst by road as the Vessels are too large for rail transportation. It is anticipated that approximately 1 RPV per year will be taken to Capenhurst. Low Level Waste (LLW) will also be generated and this is likely to be sent to the Low Level Waste Repository in Cumbria.

5. Small Modular Reactors (SMRs)

NuLeAF is focussed on legacy wastes, and does not engage with any proposal for new nuclear development unless it has implications for decommissioning or for nuclear licenced sites.

Proposals for Small Modular Reactors (SMRs) do have a potential impact on the management of NDA sites, as any such development is likely to take place on land previously used for nuclear generation, affecting land value and future use of sites. Their development will also impact on the UK nuclear waste inventory and thus plans for a Geological Disposal Facility (GDF). Given this, NuLeAF has prepared a briefing on SMRs, for comment by members (See Annex A).

Annex A - Small Modular Reactors (SMRs)

1. Introduction

While NuLeAF's focus is on legacy wastes rather than new nuclear, members have expressed an interest in the potential development of Small Modular Reactors (SMRs), as they have the potential to impact on the restoration and next use of NDA sites, and have implications for the UK nuclear waste inventory. This briefing provides an overview of SMRs, the approach of the UK Government, and the implications for NuLeAF member local authorities.

2. Background

2.1 An SMR is classified as a reactor which generates less than 300 Megawatts of electricity (Mwe)[1]. Rather than being constructed on site as with the current fleet of reactors, it is built in a factory and then shipped to the site of operation for installation. SMRs can be installed singly or in a complex of multiple units, with additional reactors being added as demand requires. Because of the smaller physical and environmental footprint, it may be possible to use them in brownfield sites, such as to replace decommissioned nuclear power stations or coal fired power stations (subject to licensing of the site by the Office for Nuclear Regulation). It has been difficult to find information on the anticipated operating life expectancy of SMRs, however, the NuScale Power Module is designed for a 60-year life.

2.2 The UK Government is currently considering the potential of SMRs in the UK. In the 2015 Autumn Budget, it allocated a further £250 million to the existing £250 million budget for nuclear research and innovation. In March 2016 it launched a competition seeking Expressions of Interest to find the best value SMR for the UK.

2.3 In its report on the 'Future of nuclear power in Wales', the Welsh Affairs Committee made a recommendation to government that Trawsfynydd should be designated as a site for a first of its kind SMR, and encouraged the government to move forward fast. The site is currently licenced for decommissioning, and in order for ONR to issue a new nuclear site licence it would need to be designated under the New Nuclear NPS. ONR has indicated that there may be issues regarding transportation of such a large load[2] to the

[1] International Atomic Energy Agency.

[2] For example, NuScale's Power Module™ (NPM), which when fully assembled consists of the integral reactor vessel and supporting equipment surrounded by the high pressure steel containment vessel is approximately 76 feet long by 15 feet in diameter and weighing approximately 700 tons. NPMs are pre-fabricated in a factory off site and shipped to the site of operation by barge, train or lorry. The largest shipping envelop for the NPM is the upper containment section at approximately 57 feet long by 15 feet in diameter weighing approximately 400 tons.

Trawsfynydd site (SMRs are pre-fabricated off-site), but this would all be considered under the licencing process.

2.4 There is also a category of SMRs called Very Small Modular Reactors (vSMRs). These generate between 5MWe and 15MWe. An example of this would be URENCO's prototype 'U-battery', a 'plug and play' reactor which it claims is inherently safe and which could run for 5-10 years without the need to refuel. As with other SMRs, this design is not yet in commercial production.

2.5 In 2015, the Utah Associated Municipal Power Systems (UAMPS) announced its intention under its Carbon Free Power Project to deploy a NuScale 600 MWe (gross) facility in the state of Idaho. In August 2016, UAMPS announced that it had selected its site for the deployment at a location on the U.S. Department of Energy's Idaho National Laboratory, near Idaho Falls. NuScale is one of the companies which expressed an interest in the UK SMR programme (see below).

2.6 In addition to land based SMRs, Russia, China and France are also developing floating and sea-bed based SMRs.

2.7 Advocates of SMRs over larger scale reactors list the potential advantages as:

- Shorter construction time (approx 3 years);
- Lower costs of production and operation[3];
- Suitable for use on a smaller site;
- Some designs are built with a high level of passive safety features;
- Can be installed underground so improved resistance to terrorist attack; and
- More attractive to finance market because of lower price tag.

The disadvantages are:

- No SMR is yet commercially available for the civilian market; and

[3] For example, in 2014, NuScale quoted an overnight capital price of $2.8Bn for its first U.S. plant or approximately $5,000 per kWe. Using U.S. Department of Energy's Energy Information Administration modelling assumptions, this translates to approximately $100 per MWh on a levelised cost of electricity (LCOE) basis, which compares favourably with DECC's latest LCOE estimate of £90 per MWh for large scale nuclear. NuScale claims that its LCOE will reduce with increased production by an estimated 10% or better for the 'nth-of-a-kind' facility. Costs are reduced by producing modules in a factory environment and applying advanced manufacturing techniques, rather than constructed on site. The use of a modular construction techniques also reduces on-site construction time further reducing costs. NuScale claims reduced operating costs are as a result of:

- Making refuelling a routine task instead of a bi-annual outage
- Using standard smaller turbines which require little maintenance
- Fewer nuclear systems means fewer opportunities for equipment to fail and require less maintenance
- Multiple module sites lead to centralised maintenance and reduced costs
- Improved reliability reduces time the reactor is offline

- No SMR design has yet gone through the Generic Design Assessment (GDA) process in the UK. ONR estimates this would take four years, plus additional 2 years for the site licence.

3. UK Government approach

3.1 In 2011, the House of Lords Select Committee on Science and Technology published the 3rd Report on Nuclear Research and Development Capabilities[4]. The Report contained 14 recommendations to Government on how it should take the UK's nuclear R&D forward.

3.2 In response, in 2013 the Government published the 'Nuclear Industrial Strategy – The UK's Nuclear Future'[5] which set out a number of key objectives including:

- To be a 'top table' nuclear nation, working in international partnerships leading the direction of future technology advances across the fuel cycle.
- To be a key partner of choice in commercialising Generation III+, IV and SMR technologies worldwide.
- To have a joined up approach to nuclear R&D.
- For the research base to be underpinned by world-leading facilities.
- To be a respected partner contributing to appropriate international research programmes
- To have the right level of nuclear innovation and R&D to ensure near-term commercial success in domestic and global markets.
- For industry to be supported by a workforce with the skills, capability and capacity required to successfully deliver current and future UK nuclear programmes.

3.3 With regard to SMRs, the Strategy identified that there "is a global race to bring the first commercial SMR to market. Building on our reactor design and fuel cycle heritage, the UK has an opportunity to make our mark on this global market through partnership and collaboration with US companies and the US Government." It went on to identify the potential advantages of UK engagement in an SMR development programme as:

- "SMRs could play an important role in a long-term nuclear energy Cost Reduction Programme by reducing the unit cost of nuclear power. This could be achievable though moving away from onsite construction to much greater in-factory manufacture and minimal onsite assembly. In the UK we can capitalise on existing and developing high value manufacturing capabilities by industry involved at the Nuclear-AMRC;
- Support of the aftermarket of SMR fleets in the UK and globally through in-life service support drawing on remote monitoring capabilities;
- Offering complete SMR solutions with international partners into markets from the UK."

[4] http://www.publications.parliament.uk/pa/ld201012/ldselect/ldsctech/221/221.pdf
[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/168048/bis-13-627-nuclear-industrial-strategy-the-uks-nuclear-future.pdf

3.4 In December 2013, a workshop led by Dame Sue Ion was held to address the issue of the UK being a 'partner of choice' in the development of SMRs and to help develop a roadmap. The workshop found that there was a lack of evidence to inform a robust investment case in this area and recommended that further work should be carried out in the form of a feasibility study. This would gather the evidence necessary in order to form a view. The study would particularly address:

- Whether SMRs would reduce the cost of nuclear power generation, and therefore electricity in the UK;
- Whether UK industry might have a role to play in the market and in which areas;
- The size of the market opportunity;
- The role innovation might play;
- The technologies best suited to a UK partnership; and
- Market applications.

3.5 The consortium commissioned to undertake the feasibility study included representatives from the National Nuclear Laboratory (NNL), Amec, Atkins, KPMG, Lloyds Register, NAMRC, Rolls-Royce, and The University of Manchester.

3.6 The study identified that Small Modular Reactors have the potential to become a significant market, both in the UK and worldwide (on a global scale potentially £250bn-£400bn by 2035). However, SMR development is not mature enough for private finance to operate on its own, and needs public investment in order to develop to the point of deployment. The study also said that it would be desirable for the UK to partner with another country if it wished to gain access to the worldwide market.

3.7 The Autumn 2015 budget announced an extra £250 million over 5 years for nuclear research and innovation. Research into Small Modular Reactors was included in this programme.

3.8 In March 2016, Government launched a competition seeking Expressions of Interest to identify the best value SMR for the UK. DECC said this initial phase was "to gauge market interest among technology developers, utilities, potential investors and funders in developing, commercializing and financing SMRs in the UK." 38 responses were received and 33 were eligible to go forward to the next stage. None of the entrants currently have an SMR commercially available. Government officials have now met with all the eligible entrants with the aim of informing further policy development.

3.9 Once initial policy development is complete Government has indicated that it intends to publish a 'Roadmap', (scheduled for autumn of 2016) which will set out the policy framework and clarify plans for siting, skills development and regulatory approvals. A techno-economic assessment will also be produced.

4. Economic viability

4.1 Investment in SMR technology is already underway in countries such as the USA, China, and Korea. If the UK government decided to start from scratch in developing its own technology it would be behind those already developing designs. An alternative approach would be to partner with an existing developer.

4.2 One of the 'selling points' of SMRs is the reduced cost of construction and operation compared to a giga-watt size nuclear reactor. Based on current information, the National Nuclear Laboratory believes that every doubling of SMRs constructed would reduce the capital cost of each unit by 10%. It has been estimated that 15 units would need to be produced to fully realize the cost reduction potential. In some instances, the technology vendor may also manufacture the equipment; others will need to identify a manufacturer capable of producing its equipment. Where the technology vendor is also the manufacturer there may also need to build the factory to produce its modules, so start-up costs could be significant. It is estimated that the first SMR could be operational within 10 years of the UK Government selecting a development partner. Subsequent units would be delivered within a shorter timescale as a significant portion of this period is taken by regulatory approval for the design and site.

5. Regulatory approach

5.1 An SMR will be subject to the same Generic Design Assessment (GDA) by the Office for Nuclear Regulation (ONR) and Environment Agency as other existing reactors. As part of the GDA, the reactor developer must demonstrate that it is safe to operate, and in a report to the Climate Change Committee, ONR noted that the more novel a design is, the harder a developer may find it to find the evidence to demonstrate and support the safety case. However, many SMR designs are based on existing reactor designs, and demonstration of the safety case for these designs should prove easier. ONR anticipate the GDA process for an SMR will take a similar length of time (four years) as that for a giga-watt size new reactor design. A further two years would be needed for a site-specific licence application.

5.2 ONR would expect that should any SMR developer apply for a licence to operate an SMR on a site which is currently licenced for decommissioning, that they would work with Magnox and NDA to ensure that decommissioning work is not adversely affected by construction and operation of the SMR. In turn it would expect that decommissioning activity did not compromise safe operation of the reactor.

5.3 ONR is currently reviewing its approach to the regulation of new build and how design assessment, licensing and construction activities can be modified to better support the Government's future intent for SMRs, recognising and addressing the unique nature of their construction and deployment.

5.4 The UK regulatory regime is held in high esteem around the world. An SMR design which had passed through the UK regulatory process would be seen as a 'kite mark' of good practice and open doors for an SMR technology developer in other worldwide markets.

6. Waste and Decommissioning

6.1 Technology vendors will consider decommissioning in their design. For example, NuScale believe that the modular nature of the nuclear steam supply system will enable their SMR facility to be decommissioned more easily and cheaply than a comparable sized currently operating PWR facility.

6.2 Higher Activity Wastes produced by SMRs would be disposed of to the Geological Disposal Facility.

6.3 The Department for Business, Energy and Industrial Strategy has said that should the inventory for the GDF change significantly following the development of new nuclear in the UK, "then a process for agreeing material changes to the inventory for disposal (as set out in the White Paper), including any further mitigating actions or additional community investment funding, would be agreed with a potential host community."

7. Implication for NuLeAF members

7.1 Whilst Government has yet to set out its intentions for siting SMRs, there is potential for SMRs to be developed at existing nuclear licensed sites currently undergoing decommissioning. This would have implications for the site end state where previously the intention had been to return the site to greenfield. Depending on the size of the installation it would bring jobs to the area during both the construction and operation phases. In addition, NDA has been looking to realise income through the sale of land around its sites. Given the potential to use existing nuclear licensed sites (subject to necessary regulatory approval and changes to the New Nuclear NPS) for siting SMRs, it may be premature for NDA to give up this land.

7.2 Development of a fleet of SMRs in the UK, as with any nuclear new build, would also have an impact on the Geological Disposal Facility siting process. Whilst SMRs are designed with decommissioning in mind, there would, none-the-less, be a volume of Higher Activity Waste produced which would require disposal to the GDF. This has implications for any community considering

hosting a GDF. As is also the case with any new large scale nuclear reactors, this will increase the inventory destined for the GDF and lead to uncertainty as to how much material is destined for the GDF and over what timescale.

7.3 The majority of SMR developers are non-UK companies. Whilst some have experience of operating in the UK, there remains the possibility that others do not understand how to engage with UK government and regulatory bodies.

7.4 SMRs are not widely understood by the public. It remains unclear whether they would be perceived to be more acceptable than large reactors.

8. NuLeAF's position

8.1 The Government is the early stages of its SMR programme. NuLeAF will continue to monitor progress and highlight to Government any concerns that our members may have about the impact of SMRs for existing nuclear licensed sites. We will stress the need to address radioactive waste management issues and decommissioning from an early stage. NuLeAF will also ask Government to clarify its plans for disposal of Higher Activity Waste from any further new build reactors to the Geological Disposal Facility. We will continue to inform its members of developments in this area.

Resources

World Nuclear Association: http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-power-reactors/small-nuclear-power-reactors.aspx

Welsh Affairs Committee: 'The future of nuclear power in Wales' http://www.parliament.uk/business/committees/committees-a-z/commons-select/welsh-affairs-committee/publications/

DECC: SMR Competition Phase One: Expression of Interest and Guidance, https://www.gov.uk/government/publications/small-modular-reactors-competition-phase-one

ONR: Submission to Energy and Climate Change Committee on small nuclear, http://www.onr.org.uk/documents/2014/small-nuclear-for-energy-and-climate-change-committee.pdf

ONR: Submission to Welsh Affairs Committee on future of nuclear power in Wales, http://www.onr.org.uk/documents/2016/welsh-affairs-committee-submission.pdf

NNL: Small Nuclear Feasibility Study 2014, http://www.nnl.co.uk/news-media-centre/news-archive/nnl-publishes-report-on-small-modular-reactor-technology/

NuScale: http://www.nuscalepower.com/our-technology/technology-overview

Thanks to NuScale for their assistance in clarifying some technical issues and providing further information on decommissioning.