Note of SAFESPUR Meeting

Benefits of research and innovation in nuclear and defence decommissioning, CIRIA offices, London EC1, 22 June 2012

Chair's welcome

The meeting was chaired by Peter Booth (WSP). He explained that this was the second of two related SAFESPUR meetings. The first one (at the University of Salford in May 2012) had focused on learning from overseas organisations. In his introductory presentation at that meeting, Peter had summarised how the UK nuclear industry had changed over the past few years. The subsequent presentations had illustrated how overseas experience and expertise has benefitted UK decommissioning and radioactive waste management, for example by increasing safety, by enabling faster resolution of long-standing problems, by leading to smarter working and by lowering costs. This second meeting was intended to show how research and innovation could help to meet future UK decommissioning challenges.

Environment Agency R&D related to nuclear decommissioning and clean up

Presentation

The first presentation was by Peter Orr, who is Decommissioning Programme Manager at the Environment Agency (EA). He began by saying that innovation is an important element in sustaining and increasing the rate of progress of decommissioning at UK nuclear sites. EA aims to encourage innovation through the way it regulates nuclear sites, the advice it gives to operators and others, and the strategic partnerships it forms (e.g. with the Office for Nuclear Regulation (ONR)). The environmental regulatory principle of "best available techniques" (BAT) is about recognising innovations and introducing them wherever it is appropriate to do so. In addition, EA leverages innovation through its own modest R&D programme and by influencing the R&D programmes funded by others, including nuclear site operators, the Nuclear Decommissioning Authority (NDA), Research Councils and the European Union. It is also influential in international fora such as groups set up by the Nuclear Energy Agency (NEA) and the International Atomic Energy Agency (IAEA).

Peter emphasised the need for innovation to be built on a platform of knowledge management and a learning culture. Knowledge management processes should include capture, consolidation and sharing of existing knowledge. These could then feed into training, education and the identification of R&D requirements. He said that, at present, there are still too many bespoke approaches in the UK. EA is trying to change this situation by acting as a "knowledge broker", where appropriate, and informing those it regulates about innovations in the UK and other countries. Peter then invited questions and views.

Q&A

The first question was whether techniques that have been the subject of recent R&D are actually being used. Peter replied that he thinks it is more difficult to introduce new techniques on nuclear sites than on, for example, chemical sites. He said there is a need for better knowledge networks and EA is trying to promote these. A second questioner asked about the "not tried and tested here" barrier that seems to exist on many UK nuclear sites. Peter agreed that such a barrier exists and said it should be made easier to test techniques on a small scale in a nuclear environment. A third questioner felt that much of the problem was that many nuclear companies would not accept the results of others but insisted on testing techniques themselves.

In subsequent discussion there seemed to be agreement that there was a need for a change of mindset at many nuclear sites. This should include relying less on over-engineering. There should also be recognition that some current decommissioning programmes are too long and that strategic innovation is required to reduce them. The nuclear industry could make more use of its supply chain to provide innovation. In addition, regulators would like the industry to do more to codify existing knowledge, for example by compiling lists of techniques, with track records and lessons learned in applying them. It was also suggested that more use could be made of model procedures and model safety cases.

A questioner asked whether the Nuclear Waste Research Forum (NWRF), which is sponsored by NDA but involves all existing nuclear sites, the Ministry of Defence and regulators, could help. The three chairs of NWRF working groups who were present at the meeting said that it was only recently that NWRF had been reorganised, with new terms of reference. In future it would act as a forum for sharing knowledge, for identifying R&D needs common to several sites and for joint commissioning of R&D. In time, NWRF working groups would create better interfaces with the research community. It was pointed out that the supply chain was willing and able to provide input to NWRF but was rarely invited to its meetings.

The final question was about how EA's role in relation to R&D and innovation compared to that of the US Environmental Protection Agency (USEPA). Peter Orr said that EA has good links to USEPA and is well aware of USEPA's work in establishing databases of techniques and of its technical fora that bring together industry, universities and regulators. EA is constrained by Government instruction and policy to fund much less R&D than USEPA.

NDA research, development and knowledge transfer activities

Presentation

Darrell Morris of NDA gave the second presentation. He summarised NDA's R&D and knowledge transfer activities, focusing on those with an international component. NDA has a remit to ensure that sufficient R&D is carried out to enable it to deliver its mission. Most of the required R&D is funded by NDA's Site Licence Companies (SLCs). NDA itself funds R&D to inform development of its strategy, to encourage innovation and to support key technical skills; this is done mainly through its Direct Research Portfolio (DRP). The NDA Research Board has a governance role for NDA and SLC R&D. Key NDA international interactions on R&D are through:

- the IAEA Radioactive Waste Technical Committee and IAEA's Co-ordinated Research Programmes
- the NEA's Radioactive Waste Management Committee, its forum on stakeholder confidence, and its working party on management of materials from decommissioning and dismantling (WPDD), plus the NEA Databank and joint NEA projects such as the Thermo-Chemical Database
- EU projects, particularly the Implementation of Geological Disposal Technology Platform, in which NDA's Radioactive Waste Management Directorate plays a leading role

- Memoranda of Understanding with various organisations in other countries (e.g. the US Department of Energy, CEA in France).

Examples of international work funded through NDA's DRP included the EU ACSEPT, ASGARD and ANDES projects, a peer review by SKB of a Sellafield Ltd paper on options for AGR fuel, and a contribution to an NEA study on the economics of the backend of the fuel cycle. The consortia of framework contractors for the four lots currently in the DRP included major UK nuclear R&D organisations, SMEs and organisations from other countries (e.g. the US, the Netherlands). Future NDA interactions internationally on R&D would include work related to the clean up at Fukushima. NDA, the Technology Strategy Board (TSB, backed by the Department for Business, Innovation and Skills), the Department of Energy and Climate Change (DECC) and the Engineering and Physical Sciences Research Council (EPSRC) had recently announced the start of a competitive application process for a £15 million programme of civil nuclear R&D.

Q&A

The discussion after the presentation focused on arrangements for maintaining and using the NEA Databank. Most countries have a central arrangement for contributing to the upkeep of the Databank through funding and expertise, and for all their relevant organisations (nuclear industry, universities, hospitals etc.) to use the Databank. In the UK the situation is fragmented and bureaucratic because Government requires each organisation, however small, to pay its own subscription. There is also a difficulty in that UK experts who contribute to the Databank are nearing retirement and there is no succession planning. It was suggested that the ad hoc Nuclear R&D Board chaired by Sir John Beddington might consider this issue.

PACTEC soft-sided lift bags

Presentation

The third presentation was given by Mike Nicholls of PACTEC and Paul Atyeo of Research Sites Restoration Ltd (RSRL). Mike began by explaining that PACTEC Inc. had developed its soft-sided bags system in the US, with the involvement of universities. The bags can be used for wastes such as rubble, soils and sludges. PACTEC offers standard size bags and bespoke solutions. It can also supply a loading system with proprietary containers and on-site training. The company has an office near Sellafield and has collaborated with LLWR Ltd to test its soft-sided bags to IAEA transport standards. It has ISO 9001 accreditation and its own Radiological Protection Adviser. It is working interactively with client teams and PACTEC bags are being, or will be, used at Harwell, Dounreay, AWE and Sellafield. They are also used by the UK oil and gas industry for NORM wastes. Developments in other countries include a flexible package for use for uranium ore in Canada and packages for soils and debris from clean up after the Fukushima accident in Japan.

Paul said that RSRL and Augean had worked with PACTEC to develop the soft-sided bag system to be used to transfer low and very low level radioactive waste (LLW and VLLW) from Harwell to Augean's East Northants Resource Management Facility. Together the three companies had developed the right size and type of product for transport and disposal. EA had confirmed that the bags met its environmental permit requirements. Paul showed a series of slides of the testing of the bags, their transport and their emplacement in the landfill in East Northants.

Q&A

A questioner asked whether UK nuclear operators had expressed concerns about the use of soft-sided bags for transporting radioactive wastes. Paul said that RSRL had had to act as a pioneer and it had taken some time to convince all concerned that these bags were the best solution. He thought that UK nuclear sites still operated to some extent in isolation from each other but that LLWR Ltd was helping to spread best practice and new techniques. He said that soft-sided bags could also be used for on-site transport, where they had the potential to reduce contamination.

Use of gamma spectrometry for characterisation

Presentation

This presentation was about characterisation of redundant sludge storage tanks at Harwell and was given by Philippa Towler of RSRL and Helen Beddow of Nuvia. Philippa began by describing the context for the work. She said that the Liquid Effluent Treatment Plant (LETP) at Harwell was built in 1946. It had now been replaced by a much smaller plant. Decommissioning of the LETP was being carried out in two phases. The first would be completed by 2015 and would involve removal of all above ground structures. The second would deal with below ground structures and would end by 2020, when the site of the LETP would be delicensed. The eight sludge storage tanks at the LETP were to be removed by the end of March 2013. They would be reduced in size and managed through the LLWR Ltd metals recycling route. Characterisation of the tanks prior to removal was a key part of the programme. Non-destructive testing was being used to obtain an overall picture of contamination in the tanks. Limited destructive testing was being used to confirm the results and obtain more data where contamination was non-uniform.

Helen described the non-destructive testing, which involved taking gamma dose rate measurements all round the tanks and then limited use of gamma spectrometry. The tanks are close together and shine is a major problem in measuring the activity levels for each tank. Previous health physics survey data had shown that there are hotspots. There are also contaminated pipes below the tanks, which Groundhog measurements had shown give rise to elevated background levels. A teletector system was used to make 56 measurements of gamma dose rates on each tank. A software package was then used to produce a 3D picture of dose rates around, above and below the tanks. This work led to the conclusion that a highly collimated gamma spectrometer would be needed to make measurements of activity levels of specific radionuclides in each tank. The spectrometer was mounted on a fork lift truck, which meant measurements could be made at different heights around most of the tanks. Modelling was then used to take account of the differing materials in the tanks and their linings. Results indicated that caesium-137 and cobalt-60 were mostly present in the ebonite tank linings. At the time of the meeting, laboratory measurements were awaited to confirm the calculated activity levels.

Q&A

One questioner said that a robotic vehicle was available that had tracks to enable it to climb up structures such as tanks. This could have been used as complementary technique for making gamma dose rate measurements. Another questioner asked whether fewer measurements could have been made before taking the tanks down, leaving most measurements to be made afterwards before the tanks went for recycling. The answer was that a considerable amount of information was needed in order to plan tank removal and make the safety case for it.

Innovative sorting station, underwater plasma technology

These presentations were given by André Wakker of NRG, Petten, the Netherlands. He began with some background about NRG (the Nuclear Research and Consultancy Group). It employs about 450 people at two sites: Petten and Arnhem. It carries out research and does consultancy and contract work on nuclear sites. It has an annual turnover over of about €70 million.

Hirarchi innovative sorting station for solid wastes

NRG at Petten has about 1600 drums of mixed solid radioactive waste and has developed an in-house system to characterise and sort it, so as to meet acceptance standards for the COVRA national radioactive waste store. Proof of principle for the system was achieved in 2008-2010. Proof of production is expected in 2012 and a licence in 2013. The first step is to carry out a high resolution gamma scan and a neutron activity measurement on each waste drum using the Vinish equipment. The second step uses the Hirarchi equipment. It takes place in a hot cell and involves using robots to empty the contents of a drum on to a table. There is a collimated gamma spectrometer above the table that moves in a circular fashion. Software then constructs a 2D image of each waste item and its radionuclide contents. This enables the waste to be sorted into items that can go for disposal as LLW and those that are to be sent to COVRA (after supercompacting and grouting). The Vinish/Hirarchi system will be available in 2013 for use at other sites.

Underwater plasma technology for treating liquid wastes

This part of André's presentation was about the underwater plasma technology (UPT) that has been developed by a small company in Hungary and implemented at the Paks nuclear power station. NRG had invested some effort in order to understand the technology. UPT is designed to treat the large volumes of radioactive waste water that arises at nuclear power stations and that contains organic liquids such as EDTA. It uses underwater electrodes to remove the organics with the activity bound to them (e.g. cobalt-60 bound to EDTA). This results in a much smaller volume of liquid waste for disposal (perhaps 1% of the original water volume). NRG is open to discussion with nuclear sites that may wish to use UPT.

Q&A

The questions were about the Hirarchi system. One was about the advantages of the system compared to those typically used in the UK, in which a gamma spectrometer moves backwards and forward over waste, rather than in a circular way. André said that the Hirarchi system was faster and more accurate. Another question was whether Petten used X-ray of waste drums prior to Hirarchi. The answer was no, because Vinish provided the necessary information. There was also a question about whether Hirarchi could be used for alpha contaminated waste, in answer to which André said he would check. A final question was about barriers to the use of untried technology in the Netherlands. André said that it had taken 3 years to develop Hirarchi and convince COVRA and the regulator of its effectiveness, which was not long.

Arvia technology for high alpha and intermediate level waste oils

This last presentation was by David Wickenden of Magnox and Mike Lodge of Arvia Technology. David began by outlining the problem that it is planned to use the Arvia technology to solve. This is the treatment of oils with relatively high levels of alpha activity, which would take a long time to incinerate, and oils that are intermediate level waste (ILW) and have thus activity levels above the limits for UK incinerators. The alternatives for treating such oils all have considerable disadvantages. Photocatalytic techniques are not suitable for bulk oils; electrochemical oxidation would be difficult to scale up from laboratory trials; chemical oxidation is exothermic and generates benzene; supercritical water oxidation has to be carried out at high temperature and pressure; microbial digestion entails the use of complex plant; plasma arc is energy intensive and involves extensive off-gas treatment.

Mike then gave some background about Arvia Technology. It is very small company (10 people), which was spun out of Manchester University and is backed by venture capital. Its core technology, which is patented in several countries, destroys organic contaminants in water. The destruction takes place in one tank in which there is a bed of Nyex graphite flakes and a series of electrochemical plates. The contaminated water is pumped into the tank, then air is pumped in to mix the Nyex and water. When the bed of Nyex has re-formed, current is passed through it, destroying the organic contaminant that has been adsorbed on to it and creating carbon dioxide. The Nyex is regenerated and can be used again. In the case of radioactive contamination, the radionuclides remain in the water, which is now free of organic contaminants and can be dealt with in an LETP. The technology was at technical readiness level (TRL) 1 or 2 in 2008-9 and was taken to TRL 8 in two years.

David said that active trials on-site trials with examples of Trawsfynydd high alpha and ILW oils were successfully completed in April 2011. The pilot plant used for the trials had been constructed and inactively commissioned off site, then delivered as a single skid-mounted unit that could be positioned using a fork-lift truck. In the trials 99.9% of the oil was destroyed. 70-80% of the activity remained in the water phase. Most of the rest of the activity was on the Nyex, which could be dewatered and sent to LLWR. Some americium and caesium was found on the electrochemical plates. These will be examined and it will be determined whether they are self-cleaning or need decontamination. Tritium largely remains in the water phase. The process gives rise to very little solid, gaseous or liquid waste, is not energy intensive and uses few natural resources.

Mike said that the next stage would be to construct a full-scale plant at Trawsfynydd. This would consist of 20 tanks and would process one litre of oil per hour. It would be able to be operated manually or in an autonomous mode. In the latter case it could operate 24 hours per day, 7 days per week, and could destroy the Trawsfynydd legacy oil waste in less than six months. (In contrast, it would take 2 years to incinerate the same quantity of oil waste because of the impact on the incinerator's permits for radioactive discharges. Furthermore, during this time the incinerator would not be able to process similar wastes from other nuclear sites.) There is considerable interest in the Arvia process at other UK nuclear sites and in countries including France, the US and Germany. It can be used for any liquids with organics in them. The Trawsfynydd operation is a batch process. Arvia Technology has developed a continuous process and this is being scaled up to about 500m^3 per day for applications such as groundwater treatment. NDA has supported the technology in a number of ways, including by funding a PhD on sludge treatment.

Q&A

A questioner asked how easy it would be to build a full-scale Arvia plant on a UK nuclear site and when this would happen. David replied that there were few technical problems in doing this. It had been shown that the technology was fully scalable and that the mobile plant could be constructed and inactively commissioned off site. Unfortunately, the time taken to explore and agree an appropriate commercial model had delayed the development and implementation of the production-scale plant at Trawsfynydd. However, these issues had been resolved and it was expected that a contract would soon be let for the engineering design of a full-scale plant and development of a safety case. Mike remarked that the delays in reaching this point had caused cash flow problems for Arvia Technology. There was general agreement that the delays should not be repeated at other sites wishing to use the technology.

Another question was whether NDA could use Arvia Technology as a case study and identify lessons for assisting small companies to develop themselves. This might also be a topic for NWRF to consider. The questioner felt that it is essential that the "monolithic" nature of engineering and safety departments on nuclear sites is not allowed to stifle innovation. In reply David said that the experience with the Arvia technology was being shared across the NDA estate and with other nuclear industry organisations. Regulators and industry agreed that the technology had considerable benefits.

Conclusion

Peter Booth concluded the meeting by thanking the speakers and participants. He was pleased that the presentations had included a number of examples of innovators and the nuclear industry working together and felt that this was the way forward.

Marion Hill for SAFESPUR

23 July 2012