

Materials management in nuclear decommissioning –challenges and opportunities – An SD:SPUR event

On the 25th of May 2010, the SD:SPUR learning network hosted an event aimed at presenting several informative case studies illustrating effective handling of waste and the opportunities presented by re-use of materials. The event took place at the Radisson hotel in Manchester and attracted delegates from Sellafield, UKAEA, Magnox and the academic community amongst others.

John Holland, Key Account Manager with WRAP and the event's chairman, kicked the conference off by welcoming the delegates and introducing them to the agenda and content to be covered. He explained that Tim Hedahl would present to the plenary session before the group was divided into two smaller groups to hear the remaining presentations.

Tim Hedahl of LLWR – International experience in Nuclear Waste Management



Tim presented his view of the UK industry and the value of international experience in shaping it. As an American, Tim is well placed to evaluate how American skills have benefitted the UK and shared his experience of cooperation between UK and American operators.

There are several international companies performing nuclear work in the UK and their expertise is invaluable. The importation of skills and knowledge from other countries benefits the UK by passing on lessons learned from past projects and engaging with individuals or organisations with first hand knowledge of the problems. In addition, it is helpful to be able to benchmark best practice

in the UK against that in other countries.

In particular, experiences from abroad aid the Decommissioning and Demolition of Nuclear Facilities by importing knowledge around:

- Nuclear Waste Management
- Packaging and Transportation
- Characterisation and Laboratory Analysis
- Waste Treatment
- Professional Waste Services
- Research & Development

However, it is important to remember that international experience is not a panacea to the problems in the industry and cannot be equated to the cavalry riding in to save the day. There are still significant barriers to overcome, mostly stemming from people's attitudes. Ideas such as "that wasn't invented here," "we've never done this before" or "the regulator wouldn't allow that" can be counterproductive and can stifle the advantages of international cooperation.

People need to be shown the benefits of cooperation and one method enacting progress through positive action is by highlighting that the UK is in the enviable position of incorporating only those aspects that are most suitable in the UK setting. Building on the synergies between the different approaches will build continuous improvement and help people to believe in the method of what they are doing.

Kevin Barnes of the EA - Wheal Jane Minewater Project Pilot Passive Treatment Plant – Decommissioning Project

Kevin told the conference about a highly successful remediation project in the Carnon valley in Cornwall in which a treatment system was set up to deal with the increasing problem of uncontrolled discharge of metalliferous acid mine waters into the Carnon Valley and eventually Falmouth Bay, wrecking ecosystems and killing fish and birds.

Following the collapse of the tin mining industry in the UK, the pumps dewatering the Wheal Jane mine were turned off. The lack of dewatering mechanism led to a large-scale pollution event in 1992 and prompted a more effective treatment system and the Wheal Jane project was born.

The proposed treatment system would consist of an active treatment plant based on lime dosing and a settlement facility at the Clemow's Valley Tailings Dam along with a Pilot Passive treatment plant based in the Carnon Valley. The Pilot Plant consisted of three separate treatment systems, although all three of the systems had the same principal treatment processes:

- Aerobic Cells – reed beds (iron removal)
- Anaerobic cell – (zinc, copper, cadmium & iron removal)
- Aerobic rock filter (manganese removal)



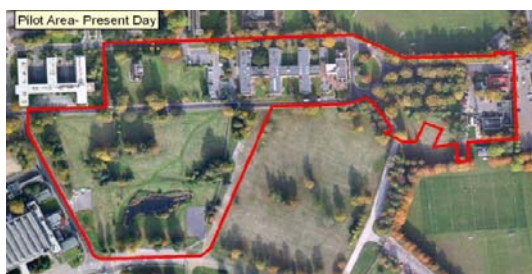
The treatment system was constructed between 1993 & 1994 at a cost of over £1.2 million and was operated from 1994 to 1998 as part of the Wheal Jane Minewater Treatment project. It was modified in 1996 to increase potential treatment regimes and was operated as part of the Link project from 1998 – 2002, a jointly funded academic research programme.

By 2008 the plant was no longer operational and the major project objectives had switched to decommissioning:

- To discharge condition 7 of the 1993 planning decision to the satisfaction of Cornwall County Planning Authority by March 2009 for under £300,000.
- In discharging the planning condition ensure that potential pollution pathways from the treated material, storage and treatment mediums within the Pilot Passive Treatment Plant to groundwater, surface water and to the atmosphere were mitigated.
- Public Safety issues identified with the Pilot Passive Treatment Plant infrastructure were addressed by March 2009.

The decommissioning was completed on time and to budget, including the disposal of 9000 tonnes of metalliferous material. By clearly defining the waste classification of the material arising from the decommissioning, disposal of the metalliferous material was possible at the Clemow's Valley Tailings Dam just over 3 km away from the site. This generated a reduction of 263,568 miles equivalent to 937 tonnes of CO² when compared to the original disposal site at Swindon 415 miles away.

Paul Ateyo of RSRL - Experiences with the Reuse of Buildings on Nuclear Sites



Paul gave an interesting presentation covering the opportunities and challenges presented by the reuse of materials from nuclear sites. His experiences on nuclear energy generating sites, research sites and other nuclear sites has aided him in minimising waste generation and making use of an existing resource.

Reuse of resources from nuclear sites, both under NDA licence and after the completion of the delicensing process, has been occurring in the UK for some time and helps organisations avoid acquiring new materials and resources associated with Newbuild facilities. Adaptive reuse is the act of finding a new use for a building. It is often described as a “process by which structurally sound older buildings are developed for economically viable new uses.”

The potential savings in materials, time and money make reuse an option to be encouraged and promoted. There are, however, several barriers that must be overcome to ensure that reuse is appropriate and feasible in a given situation.

There are several stages at which reuse can occur. Reuse of buildings from the Pre-nuclear phase is unlikely to occur in the modern era and those buildings from the operational stage seldom become redundant and thus free for reuse. The decommissioning phase presents good opportunities for reuse as the priorities during the decommissioning phase are hazard reduction and release of resources. Site clearance is another objective that encourages buildings and land to be remediated to the extent that they are safe for delicensing and reuse in a non-nuclear setting.

The Harwell site offered some interesting insights into the intricacies of reusing buildings on previously nuclear licensed sites. Building 146 was originally used as an RAF sergeant's Mess in the 1930's before it was turned into a radiochemical research facility in 1946. It was refurbished in the 1980's and much of the existing contamination was sealed in place. The building was then used as offices until 2006. Final decommissioning removed the remaining traces of contamination such as those found in the sealed vent system and fixed contamination sealed in position. Removal of these systems rendered the building clean but unusable and the building was demolished. Delicensing of the land is currently under regulatory consideration.

Reuse is not always possible, as shown by the wet processes liquid effluent building. Even after decontamination of internal and external surfaces, the building was unusable and existing ground contamination under the building still needs addressing.

There are several advantages to reusing nuclear sites. The reuse of nuclear facilities for nuclear uses is easier than introducing nuclear uses in new areas and the previous nuclear usages of existing buildings ensures that minimal modification is required for the use as ancillary facilities. Reuse with contamination locked in situ maximises the benefits of radioactive decay and provides maintenance income streams. In addition, nuclear facilities tend to have robust infrastructure systems and utility supply systems beneficial to new uses as well as a local workforce with a high level of technical skill.

At Harwell 70% of buildings were reused during the nuclear licensing period but only 5% are thought to be reusable after the termination process. This is due to the presence of contamination whether it be in the building itself or in the underlying ground, but critically, also due to the difficulty of proving its absence.

Facility reuse on nuclear sites can be a useful option as they aid decommissioning support, waste storage and decontamination options. However, it is important to bear the constraints, regulatory or otherwise, so that the reuse option is practicable and economically sound.

Stephen Murdock of Sellafield - Characterisation to Justify the Appropriate Management of Solid Wastes in the Nuclear Industry

The remediation process was established following a warning of intent by the Environment Agency to issue an Enforcement Notice for the 'failure to adequately maintain an operational effluent pipe line'. As the pipe was found in a controlled area, there was a possibility of radioactive contamination. The main aspects of the refurbishment included replacement of the concrete piers, truss, concrete shield and a reduction in the width of the deck. There was an estimated 600m³ of solid waste to be disposed of to the Low Level Waste Repository at a cost of approximately £1.3million.

An extensive characterisation process was carried out to determine the extent and nature of the contamination associated with the sea line pipe bridge. This would aid application of the waste hierarchy and optimise waste routing. This would further enable a reduction in waste disposal



costs by establishing and maximising the RSA 93 SoLA exempt waste route and reducing the burden on the LLWR. The waste management hierarchy was in the early stages of implementation at Sellafield and the project aided a step change in the approaches towards waste management and HP&S.

Non-destructive surface monitoring using hand held instruments provided detailed information regarding the surface contamination of the area. The methodology used biased sampling to derive a radiological fingerprint, discrete sampling on the concrete shield and piers and multi-incremental on the deck edge and truss. The data interpretation utilised the NiCoP guidance and, as it was one of the first Facility Characterisation projects on site, helped define the Facility Characterisation Process and Site Standard.

More than 90% of the solid wastes contained an average bulk activity below the RSA SoLA exemption threshold of 0.4Bq/g but some areas of elevated activity were identified on the piers and the deck edge. A radionuclide fingerprint was produced for the area and surface clearance levels established. The hazardous chemical properties associated with the waste were realised i.e. the lead content in paint and the bitumen in the truss coating.

Characterisation allowed the waste routes to be defined before work commenced and more than 50m³ of metal was sentenced as RSA exempt and cleared into the recycling market. In addition, more than 500m³ of concrete was sentenced as RSA exempt and re-used on site as infill material.

These savings in waste reduced the burden on the LLWR and realised significant cost savings of around £1 million. Furthermore, it built confidence in the radiological condition of the area and improved the chance of tools and equipment to be declared RSA exempt and the process improved methods to the extent that they become quicker and cheaper. The characterisation of the bridge had wider implications for the site as this practical implementation of the waste hierarchy provided proof of concept and improved uptake of reuse and recycling within Sellafield.

Joe Toole of Mactec - Automated and intelligent waste segregation technologies – the US experience

Joe introduced the conference to an interesting piece of technology – the MacTec Orion Radiological Soil Sorting Survey System. The system uses large volume spectroscopy grade solid state detectors with MACTEC's advanced Scanning Spectrometer software, SPARTAN to detect gamma emitting radionuclides and sort radioactive waste from less harmful waste streams.

In essence, the system uses multiple detectors arrayed above material conveying equipment to provide real time radiological data and material sorting. A variety of material conveying equipment can be used to handle most common waste forms. The system supports multiple gamma spectrometers of any size and can accommodate up to 12 auxiliary detectors to provide additional characterisation and control.

The system is extremely flexible, with a procurement lead time of just 30-90 days. In addition, onsite setup, integration and calibration typically requires around 5 days with a similar timeframe for disassembly, decontamination and preparation for transport.

The benefits of using the system include the minimization of waste disposal costs, industry leading process rates and superior sensitivity. Indeed, this technology could help deal with the enormous LLW problem facing the LLWR by drastically reducing the quantities of waste sent to the LLWR.

John Morrison of GE Healthcare - The Maynard Centre Decommissioning Project

The Maynard Centre, based in Cardiff, was one of three nuclear licensed sites owned by GE healthcare in the UK. It was the principle reagent and kit manufacturing for the GE consumables business and around 420 staff were employed at the building. In December

2008, a business decision was taken to exit the radiochemical and custom synthesis business and decommission and delicense 90% of the site. While the contamination levels did not



exceed background levels in the area, the nuclear site boundary needed to be redefined in order for the delicensed areas to be used for growth opportunities.

Following business closure a Decommissioning Project Team was formed in Jan 2009 to clear potential liabilities from around 90% of site and satisfy all other regulatory requirements. The objectives of the team were to build the foundations for future growth by clearing buildings for reuse by inactive processes and removing the main area

of the site from NLS requirements.

The Maynard Centre is subject to two principal regulations as a result of its work with radioactivity:

- The Nuclear Installations Act – administered by the NII – which regulates the operation of the site.
- The Radioactive Substances Act – administered by the EA – which regulates radioactive wastes.

A site (or part of site) may be de-licensed from NIA if the operator demonstrates that ‘no danger’ from radioactivity remains on the site as defined by the SoLA exemption thresholds.

In addition, the following criteria have been agreed with NII:

- Areas of site to be delicensed will be clearly identified;
- Activities for which licensing is required will no longer be carried out on that site;
- Risk factors from the remaining licensed site will be assessed, controlled and justified
- ‘No danger’ (i.e. no significant risk) will remain to any person from residual activity above background.
- The application for delicensing will be supported by a safety case that as a minimum will include demonstration of ‘no danger’ and ALARP.

GEHC chose to use the Data Quality Objectives (DQO) methodology and support tools which rely on the use of statistical techniques to support clearance decisions and will underpin their site license variation submission. Clearance in Principle for the first building agreed with the NII in Jan 2010 and analysis and DQO workshops completed for the first few of the remaining buildings.

Sampling could then commence and a Conceptual Site Model was developed. The building was zoned upon the basis of previous history, similarity of operations and several areas of particular interest were identified. Zones were sub-divided into material matrices (e.g. carpet, plasterboard etc) and the number of respective samples required identified.

The equation used to calculate the number of samples is based on a Sign test. For this site, the null hypothesis is rejected in favour of the alternative one if the mean is sufficiently smaller than the threshold. The number of samples will be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of sample numbers. A nonparametric systematic grid sampling approach was selected to determine the number of samples. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

The DQO methodology is a robust and rigorous process supported by fully validated statistical calculations. It provides a clear and consistent basis to prepare the clearance

submission as accepted and agreed by the EA, NII and HPA and is underpinned by a solid and high integrity sampling & analysis procedures. The initial delicensing sample numbers upper estimate was greater than 100 000 but the use of the DQO approach has reduced sample numbers to 10 000. Using typical sample costs (@£200/ea) the DQO methodology led to a reduction in costs from over £20M to £2M.

Rob Stone of Carillion - Sustainable Demolition and Site Clearance for the Scottish Prison Service

At the outbreak of World War 2, the government constructed RAF Bishopbriggs as a barrage balloon facility and after the war it was used as a civil defence base. In 1967, part of the complex was sold to the Scottish Prison Service and converted to a low security prison. In 2007, it was decided that a new prison was to be constructed and the site of the existing structure would be cleared.



The contract comprised a number of initial site surveys, followed by demolition of the former prison and site clearance. The project was in effect an enabling works contract for the development of the new HMP Low Moss on the same site. Prior to the commencement of the demolition works certain planning conditions had to be discharged and Carillion, as the principal contractor, was responsible for this.

One of these conditions included how the project would deal with waste management, sustainability and the environment when deconstructing the site. Carillion's tender submission included detailed responses to all key issues raised in the invitation to tender. As a result, the site team implemented a waste management programme to achieve an agreed target. The target was set at 98% of demolitions being recycled and re-used and to send only 2% of the waste material to landfill sites.

To achieve this goal, the project team set some ambitious targets for demolition and site clearance phases of the project. These included:

- Existing steel frame buildings were dismantled and sold
- Existing timber buildings were processed on site for use in production of chipboard
- Remaining timber was refined as bio-fuel
- The demolition contractor stripped the metal roofing sheets for re-use
- The concrete, brickwork and blockwork was crushed on site and approximately 35,000t of Class 6F2 material was produced for re-use
- Internal fittings were salvaged: radiators, toilets, sinks, light fittings, metal sockets and switches and over 200 fire extinguishers for re-supply to the market.

These salvaged goods were advertised on www.freecycle.org through the assistance of the East Dunbartonshire Council Sustainable Development Officer. The responses to the adverts were reviewed and various local charities and residents benefited including:

- Campsie View School
- The Glasgow Humane Society
- Duke of Edinburgh Award Scheme
- The Prince's Trust

To compensate for the loss of habitat, bird boxes were procured from the Scottish Prison Service. They were erected by East Dunbartonshire Council Greenspace Officers. The boxes were for Barn Owls, Kestrels and Sparrows.

On review of the project, it becomes obvious that the project team exceeded even their own expectations and managed to reduce the amount of debris sent to landfill significantly. Of the 53659 tonnes of materials handled, only 269 tonnes were sent to landfill. Achieving these

targets and those associated with biodiversity meant the project was a sustainability success story.

Gary Clarke and Chris Hope of Sellafield - Characterisation of Calder Hall Heat Exchanger Asbestos



The Calder Hall heat exchanger consisted of four reactors with sixteen heat exchangers. Operations were stopped in 2003 and the asbestos contained within the exchanger began to deteriorate due to the lack of heat. HSE began to put pressure on Sellafield to remove the remaining asbestos due to the health concerns its presences raised. The result was the largest asbestos strip ever seen in Europe.

Disposal to landfill was deemed to be the best disposal option , which would require bag monitoring and characterisation. Characterisation was required to technically underpin a final sentencing decision. All Heat Exchangers were considered to be similar in nature and could be treated as a single population. There was no history of significant events resulting in the contamination of the main body of the heat exchanger but there was the potential for elevated activity around the chemist sampling points.

The execution of was divided into four phases with the first phase striving to derive fingerprint to support bag monitoring in line with Sellafield Ltd Fingerprint standard. 8 Samples were taken from the length of one heat exchanger, with two chemist sampling points targeted.

The results showed that the activity levels were lower than expected and that H-3 levels were variable and did not track gamma activity. NICO_P was applied and the mean concentration at 95% confidence was just 0.409 Bq/g. A technical justification for clearance and exemption was then developed using this data.

Thus the Asbestos associated with this heat exchanger was RSA exempt and a Bulk Exemption considered appropriate. However, Bag Monitoring was not appropriate and the potential to bulk exempt all heat exchanger asbestos but would require more sampling.

The objective of phase 2 was to determine whether bulk exemption of all heat exchanger asbestos was feasible and three of the additional heat exchangers were sampled. The results were similar to phase 1 and there was low gamma activity throughout. The number of samples was statistically underpinned and Sellafield's findings showed that all the asbestos was suitable for bulk exemption. However, the EA was not satisfied that an acceptable number of samples were carried out and it felt that Sellafield was pushing the boundaries of the NICO_P.

Phase 3 concentrated on satisfying the EA requirements for reassurance sampling and the remaining heat exchangers were sampled. Interestingly, the 3 heat exchangers associated with reactor 4 showed significantly higher levels of Cs-137 and H-3 activity than any of the other reactors. The apparent differences between the heat exchangers of reactor 4 and the others prompted segregation of this group for data assessment. The asbestos from the other three reactors were sentenced as RSA exempt and there would be further investigation of the reactor 4 status.

The core of the investigation repeated the sampling and analysis for the reactor 4 heat exchangers and an investigation into possible source terms. There was no evidence of contamination at the laboratory or during sampling. Re-analysis of all EA samples indicated consistent results with Phases 1-3 and analysis of samples adjacent to original sample points indicated consistency with Phases 1-3. Thus the elevated activity appeared to be associated with a

single batch of results but the source remained unknown and the remaining asbestos from Reactor 4 was declared RSA Exempt waste.

This course of action avoided unnecessary use of finite LLWR vault capacity and double handling of 90000 bags of hazardous material. This translated into a massive cost saving as indicative costs were reduced to £280000.

- David Krohn