CHALLENGES TO PLANNING FOR AND EXECUTING SUCCESSFUL WASTE MANAGEMENT IN A COMPLEX DECOMMISSIONING ENVIRONMENT – A SELLAFIELD PERSPECTIVE - 10503

HELEN CASSIDY, SELLAFIELD LTD., UNITED KINGDOM

ABSTRACT

Waste management is arguably the most important consideration in demolition and decommissioning projects. Decommissioning activities – over the long term – will produce the greatest volume and variety of wastes requiring conditioning, treatment and disposal, from residual process wastes to plant equipment through to the actual building fabric itself [1]. The challenge for successful waste management operations in the decommissioning environment is to identify a range of appropriate and technically viable waste treatment and disposal routes for the varied range of materials likely to be generated by decommissioning, such that waste can be disposed of in a timely, cost-effective and environmentally responsible manner.

Planning and executing successful waste management operations within decommissioning environments can be challenging, in technical and project management terms, owing to the complexities of the decommissioning process. These challenges are exacerbated when dealing with so-called ‘orphan’ waste, that which has no defined treatment and disposal route, where uncertainties and unknowns with regards to history / provenance, identification, age and waste classification (be it radiological or non-radiological) mean that the waste itself is challenging to manage. These challenges have been exemplified by operational experience at decommissioning plants on the Sellafield site, notably at a project to manage orphan waste at the redundant Prototype Fast Reactor Fuel Plant facility.

INTRODUCTION

Waste management involves routing waste arisings through appropriate, safe, cost-effective and environmentally sound treatment and disposal routes; in order to minimise the accumulation of radioactive and hazardous waste on the Sellafield site. Waste management is one of the fundamental operations on the Sellafield site, supporting both ongoing commercial reprocessing operations and decommissioning of legacy plant and facilities.

The transition from continuous production operations towards a project driven decommissioning focus has created a different environment for waste management operations at Sellafield. The range of wastestreams arising from decommissioning activities (in terms of volume, type and radiological classification) has created a need for a corresponding range of waste treatment and disposal routes – the “one size fits all” approach from reprocessing operations, where waste of similar type and classification is continuously generated, is not feasible for cost-effective, timely and environmentally responsible waste disposal from decommissioning. The prevalence of so-called “orphan” wastes, particularly within decommissioning facilities, with their unique combination of physical, chemical and radiological characteristics adds another dimension to waste management at Sellafield.

The nature of the decommissioning environment poses different challenges to waste management than commercial reprocessing operations in other ways. The physical and radiological conditions of the facilities pose practical and logistical problems for planning and executing waste management operations, for example in that physical space may be limited or the radiological conditions may create constraints in terms of man access for waste handling. The project driven environment can pose more challenging constraints and expectations in terms of time and budget for delivery of waste management strategies.

These difficulties in planning and executing waste management operations in such challenging decommissioning environments can be exemplified on the Sellafield site by operational experience in orphan waste management on the redundant Prototype Fast Reactor Fuel Plant facility. This facility is undergoing accelerated decommissioning to support enabling projects to accelerate high hazard reduction in Legacy Ponds and Silos, and planning and execution of waste routing for this project has been a vital component in enabling accelerated decommissioning. Planning and executing waste management strategies for this project has been complicated by a combination of factors. The facility has a range of non-standard and orphan wastestreams arising from both former production operations and from ongoing decommissioning of differing type; provenance; history; and radiological, chemical and physical characteristics. These materials are located in different areas throughout the facility, ranging from designated chemical stores with low background activity through to active decommissioning areas with high loose alpha contamination. The location of these wastes provides complications to enabling operations such as quantity survey and characterisation, as well as to waste management itself.

This paper explores the myriad challenges posed to planning and executing successful waste management operations in a decommissioning environment, with particular reference to the management of orphan and non-standard waste, in the context of operations at the Sellafield site. This will be supported by reference to operational experience planning for and executing waste management operations on the Prototype Fast Reactor Fuel Plant facility and other decommissioning facilities at Sellafield.

DECOMMISSIONING AND WASTE GENERATION AT SELLAFIELD

The nuclear industry has been part of the industrial landscape at Sellafield, Cumbria since 1947, and operations have transitioned from military operations to power generation for the civil sector through to reprocessing nuclear fuel and latterly to a mixture of commercial reprocessing operations, decommissioning legacy facilities and waste management. Decommissioning of nuclear facilities at the Sellafield site commenced in the 1980s and has been accelerated since the introduction of the Nuclear Decommissioning Authority in 2004 [2].

The range of nuclear operations that have taken place on the Sellafield site – including military fuel production in the earliest phases of the sites history, reprocessing of nuclear waste, electricity generation, research and development, and allied support activities – have contributed to the generation of a stockpile of legacy nuclear waste. This, in conjunction with the small footprint area of the Sellafield site and the complex interdependencies between site infrastructure, means that Sellafield is one of the most complex nuclear sites in the world. The strategic intent of the business is the delivery of accelerated, safe, secure and cost-effective nuclear clean-up. Given the inventory of wastes – spent nuclear fuel, HLW, ILW, LLW, VLLW, non-standard and non-radioactive hazardous – that exist on the site, this is a complex and challenging brief.

The decommissioning and demolition process intends to reduce radiological and conventional hazards by the safe, controlled and cost effective removal of plant and buildings. The process inevitably involves the generation of waste, either from the residual facility waste inventory (if not removed during previous phases of the facility lifecycle) and / or from the plant and building fabric itself. Decommissioning operations can thus generate both a significant range of waste types and significant quantities of waste.

The acceleration of decommissioning activities at the Sellafield site to meet regulatory and governmental expectations has thus changed the waste management environment for Sellafield

Ltd. Prior to the commencement and acceleration of decommissioning and demolition, waste generation (and so waste treatment and disposal needs) was a result of commercial reprocessing. Waste from reprocessing operations was predominantly of similar types, classifications and arisings related to the particular nature and operation of the reprocessing plant. Waste management strategy was built to meet this need and routine waste treatment and disposal routes – such as supercompaction of compactable low level process waste at the Waste Monitoring and Compaction Plant as a precursor to disposal at the Low Level Waste Repository, near Drigg – were established. As stated, decommissioning and demolition produces variable (although increased) quantities of waste of a wider range of physical, chemical and radiological classifications. Decommissioning and demolition operations have increased the volume of waste requiring treatment via existing routes and has also generated wastes that do not have available treatment and disposal routes. As decommissioning is further accelerated in the coming years, this trend is projected to continue, as illustrated in Fig. 1., with peak waste production correlating with the decommissioning and demolition of key Sellafield facilities [3].

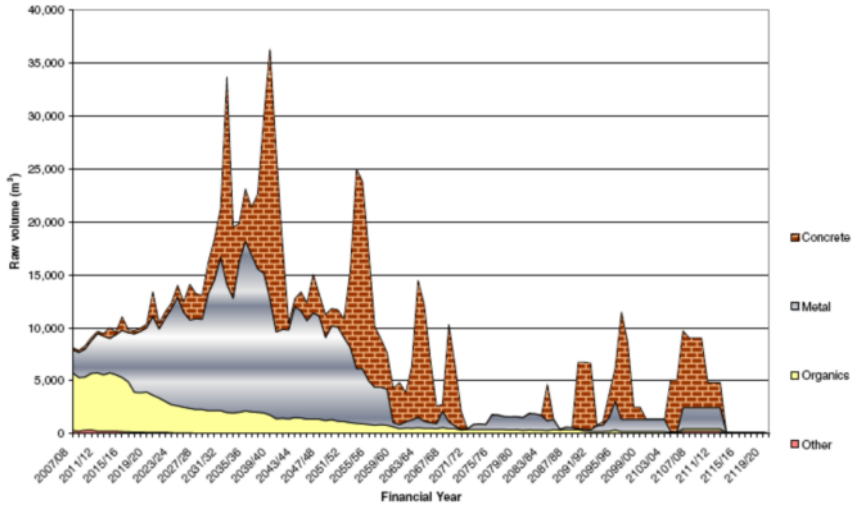

Fig. 1. Projected operational and decommissioning low level waste arisings on the Sellafield site 2007/08 – 2119/20.

ORPHAN WASTE AT THE SELLAFIELD SITE

As noted, the Sellafield site poses a significant challenge to any waste management organisation owing to the quantity and range of wastestreams within the waste inventory. One of the myriad waste management issues on the Sellafield site is the management of so-called 'orphan' waste. This is defined as waste which has no technically underpinned and available (in terms of being a sanctioned, formalised process within the sites management system) treatment and disposal route. The Sellafield site holds in excess of five hundred chemically and radiologically diverse orphan wastestreams in varying quantities across the Sellafield site, such as mercury, radiologically contaminated oil and spent ion exchange resins. There has been limited consolidated management of these materials and as such the wastes are predominantly stored in small quantities by individual plants. The absence of treatment and disposal routes for these waste types has contributed to the stockpiling of waste. Consequently, the inventory of orphan waste consists of both legacy waste and, albeit minimised, new arisings.

COMPONENTS OF SUCCESSFUL WASTE MANAGEMENT

The purpose of waste management at the Sellafield site is to identify and implement strategies for the storage, treatment and disposal of legacy and newly arising wastes generated from production and decommissioning operations in a safe, cost-effective and environmentally sound manner. Waste management at Sellafield is undertaken both as routine processes for production-type wastes (e.g. operation of the low level waste supercompaction facility) and on a project basis for more non-standard wastes (e.g. shipment of low level contaminated lead overseas for metal melting). In either case, the main phases of the waste management process remain the same, as described in Fig. 2, but vary in scale depending on the size and complexity of the project.

There are five key phases in the waste management process:

- Identifying the objective and purpose of the waste management operation – establishing who the customer is, what the waste is, why the waste requires management, the timeline and budget, and key constraints to enable risk mitigation.

- Data and information gathering – the identification of the most appropriate waste management route is dependent on the physical, chemical and radiological characteristics of the material to be disposed of. The collection of relevant data and information relating to the material (whether from intrusive sampling and analysis, non-destructive measurement and/or from history and provenance) is thus a vital stage in the process.

- Optioneering – for standard waste types (such as solid compactable wastes and ferrous metals) and orphan / non-standard wastes (such as mercury, lead and oil) a range of waste treatment and disposal routes may exist. A structured approach to optioneering is required and should be applied to ensure that an appropriate, cost-effective and environmentally sound waste management strategy which is in line with project objectives and the waste management hierarchy is selected. Transparent, structured and technically robust optioneering is a vital tool in ensuring regulatory and stakeholder confidence in the waste management strategy.

- Planning for waste treatment and disposal – this involves planning for the execution phase in terms of seeking necessary regulatory and legal approvals where required, procurement of necessary services and equipment, identifying appropriate resource, undertaking training etc.

- Execution of waste treatment and disposal – this is the operational phase of the waste management process, involving waste retrieval, packaging, treatment and conditioning, transfer for interim storage or disposal of the waste.

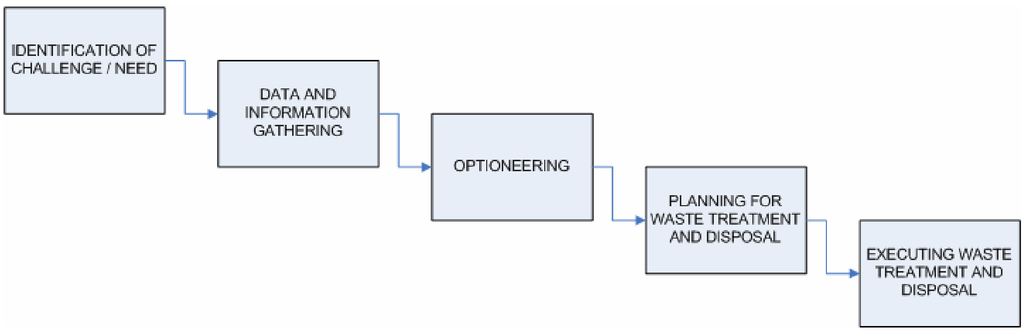

Fig. 2. Summary of the main phases of the waste management process.

PROTOTYPE FAST REACTOR FUEL PLANT PROJECT

One of the key decommissioning projects being currently undertaken on the Sellafield site is the decommissioning of the redundant Prototype Fast Reactor Fuel Plant. This plant operated from 1971 to 1992 to manufacture fuel assemblies to support the Dounreay Fast Reactor programme. Decommissioning of the facility commenced in 1994 and has been accelerated to reduce hazard, as the facility is a high alpha inventory plant, and to support the sites highest priority hazard reduction projects in the Legacy Ponds and Silos facilities. The facility is currently in the final stages of decommissioning prior to demolition. Decommissioning operations at the facility identified a quantity of orphan and non-standard wastes which required characterisation, treatment and disposal in order to enable the completion of decommissioning operations. Characterisation, Land Quality & Clearance, and latterly the Waste & Effluent Disposition Directorate, have been providing technical support to this facility to facilitate management of these wastes since early 2008.

The orphan and non-standard wastes have been identified in three main areas of the facility (the COSHH Store, the Drum Store and the Fuel Line Cubicles) and consist of a range of predominantly liquid waste types. Whilst the project is ongoing, progress has been made with regards to characterisation, optioneering and waste disposal for a number of these wastes. The COSHH Store is the lowest radiological environment, the Drum Store is a more highly contaminated environment and the Fuel Line Cublicles is within the most highly contaminated environment.

COSHH Store Waste

This area of the plant is used as a storage facility for chemically hazardous materials used in operations on plant. Non-standard waste in this area consisted of a total of 326 litres of liquid waste (including paraffin, mineral oil, hydraulic oil, organic solvent, aqueous coatings, water-glycol and mineral acids) and 10kg of solid waste (calcium fluoride). Executing the project involved intrusive sampling and analysis of each of the eighteen individual containers of waste. Data analysis enabled radiological classification of the materials and identified that thirteen containers of hazardous waste were classifiable as exempt or excluded from regulatory and control purposes under the provisions of United Kingdom legislation (namely the Radioactive Substances Act 1993). This enabled the facility to dispose of these containers of waste via the site waste disposal contractor. This characterisation identified that the remaining five containers were radioactive under the Radioactive Substances Act 1993 and identification of waste storage, treatment and disposal routes, with a preference for using site infrastructure where possible, is ongoing.

Drum Store Waste

The Drum Store houses 725 litres of organic liquid waste (consisting of mineral oil and water-glycol hydraulic fluid) as illustrated in Fig. 3. This area is a more radiologically contaminated environment than the COSHH Store. Similarly to the project for the COSHH Store wastes, an intrusive sampling and analysis programme was undertaken to enable radiological classification of the material. Of this volume, 206 litres has been categorised as exempt or excluded from regulatory and control purposes under the Radiological Substances Act 1993 and 125 litres of this to date has been disposed of via the site waste disposal contractor. Pre-treatment, notably phase separation, of the remaining material is ongoing as a precursor step to waste disposal. Optioneering for disposal of the radioactive portions of the material is also ongoing, but it is expected that the organic waste will be routed for thermal treatment off-site.

Fuel Cubicles Waste

This area is the most radiologically challenging area in the building, as the area is a high loose alpha contamination environment. This is the primary location for decommissioning operations in the building and has an inventory of orphan and non-standard waste arising from historical production operations and more recent decommissioning. The waste types in this area include lead, jabrock, wood, mercury, oil, water-glycol and x-ray fluid; and given the nature of their storage environment are pessimistically (owing to a lack of analytical or non-destructive measurement data) assumed to be plutonium-contaminated materials. The facility has made progress with the transfer of the solid waste (lead, jabrock etc.) to the site PCM Stores using non-destructive measurement to gather data about the material. A project is ongoing, and has recently concluded options assessment, to treat the mercury waste to enable transfer to PCM Stores and future disposal. Following assessment of the environment where the waste is stored, waste management of the remaining liquid wastes has been deferred until decontamination of the cubicle area has been undertaken and intrusive sampling or non-destructive measurement can be undertaken.

Fig. 3. Storage of organic liquid waste in the South Drum Store area of the Prototype Fast Reactor Fuel Plant.

CHALLENGES FOR ORPHAN WASTE MANAGEMENT IN DECOMMISSIONING ENVIRONMENTS

Learning from operational experience in undertaking orphan waste management operations and projects for decommissioning facilities has identified numerous challenges to the successful planning and implementation of waste management strategies. These challenges can be categorised as those arising from the nature of the waste, those arising from the physical environment of the decommissioning plant, those related to the historical lack of more global site waste management strategy for site and those relating to the project management of decommissioning. There are significant inter-relationships between these issues, for example time and cost constraints from the management of a project can influence the implementation of a particular site-wide strategy, which makes identifying solutions and mitigating risks for waste management in decommissioning all the more difficult.

Radiological, chemical and physical nature of the waste

Orphan waste is characterised as those waste types that have no technically underpinned and available (in terms of being a formalised process within the site management system) waste treatment and disposal route. These wastes are prevalent at the Sellafield site and are generally distributed in small volumes undergoing interim storage at facilities across the site. Such wastes are stored in decommissioning facilities owing to this lack of defined and available waste treatment and disposal routes. The radiological, chemical and physical nature of these wastes themselves poses fundamental challenges to identifying and implementing waste management strategy.

There are in excess of five hundred different orphan waste streams of various matrices on the Sellafield site. The variability in the waste matrix, and the fact that facilities predominantly have an inventory containing a number of different wastes, results in waste management strategy needing to solve numerous problems simultaneously. This is exacerbated by the lack of consolidated orphan waste management strategy for site as a whole. Waste routings currently need to be established on a case-by-case basis. This range of waste matrices has other impacts; for example, characterisation can be more problematic for orphan wastes than for more standard waste matrices. This is because analysing laboratories may be presented with unusual waste matrices which cam be incompatible with particular analytical methods. This was observed during the Prototype Fast Reactor Fuel Plant project, where analysis was delayed owing to the need to adapt analytical methods for the range of matrices and because of experimental incompatibilities (for example, explosive behaviour from some organic liquid samples was noted during pyrolysis for tritium analysis). Thus, the chemical nature of the waste can reduce the ability to gather meaningful and relevant data, which can reduce the ability to determine and confidence in radiological and non-radiological classifications of material. This can constrain the range of waste management options available. Chemotoxic hazards can make waste handling for repackaging or in-situ pre-treatment, or indeed characterisation, more difficult and careful planning is required to mitigate these hazards during execution of such activities. For example, the mineral acids in the Prototype Fast Reactor Fuel Plant project required samplers to use acid-resistant personal protective equipment, sampling equipment and packaging to enable safe handling and transport of the material. This can add cost to the project, as well as potential delay in terms of sourcing and procurement.

There is significant variation in the radiological classifications of orphan waste on site, ranging from RSA93 exempt waste through to ILW and PCM. The variation in radiological classification requires similar variation in waste management strategy, where waste routing must be tailored to the radiological nature of the waste. A single decommissioning plant may have waste across all of these classifications, as is certainly the case at the Prototype Fast Reactor Fuel Plant, and waste management strategy must be able to deal with these wastes; particularly as orphan wastes currently are not specifically and holistically considered within site waste management strategy for LLW, ILW or PCM.

The age and condition of the waste is another contributory factor to determining the treatment and disposal route. Age can have numerous impacts on the physical, chemical and radiological characteristics of a waste. The risk of chemical and / or radiological cross-contamination is increased, particularly where historical containment arrangements were not robust, which can produce multi-phasic systems or change the classification of a waste. Age and radiolytic effecs can cause physico-chemical degradation of waste; creating a more problematic waste for characterisation, handling and management. For example, management of the contaminated LLW oil inventory at Sellafield involves handling an inventory viscous, degraded oil sludges resulting from degradation which are difficult to retrieve, handle, characterise and ultimately treat for disposal [4].

A further fundamental difficulty with orphan waste management that is prevalent in decommissioning environments is that of wastes of unknown provenance, history or identification. Many of the facilities that are undergoing active decommissioning or are undergoing care and maintenance in preparation for decommissioning are aged, historical plants. There is significant opportunity for wastes to be uncovered during decommissioning that are unidentifiable; for example unlabelled or without any identifying documentary evidence. Such ‘unknown’ wastes are categorised as orphan waste. A material which cannot be identified cannot, owing to UK transport legislation, be transported from site. There is limited analytical capability on-site for the chemical identification of materials – as the on-site analytical capability has been developed to support collecting radiochemical measurements for standard wastestreams – and so there is limited opportunity currently for any meaningful waste management strategy for these ‘unknown’ wastes, beyond a safe interim storage regime. Improvements in non-radiochemical analyses by the on-site analytical capability are required to enable progress in identifying and executing waste management strategies for unknown wastes.

Radiological, chemical and physical nature of the plant

Decommissioning environments are different to routine operational environments. For the plants currently undergoing decommissioning at Sellafield, these are typically aged facilities which have been under a care and maintenance regime for some time following cessation of operational activities and post-operational clean out. Radiological, chemical and conventional hazards are different in decommissioning environments as a result of facility age, the nature and extent of asset care, the degree of post-operational clean-out and indeed the nature of decommissioning operations themselves.

The highly hazardous environment within decommissioning plants – with a combination of radiological, chemical and conventional hazards – is often problematic for planning and executing waste management operations. As previously described, such hazards can change or impact on the chemical and radiological nature of the waste, making characterisation and waste handling more difficult. Hazard mitigation must be carefully considered during planning for waste management operations to enable execution of operations safely. High hazardous environments can impose restrictions on access which can make intrusive sampling, non-destructive measurement or waste handling more onerous or indeed impossible. The Fuel Cubicle wastes at the Prototype Fast Reactor Fuel Plant are located within a high loose alpha environment, which constrains potential survey, sampling or in-situ treatment operations owing to the risk of cross-contamination and the limit on the degree of man access to the area where the waste is stored. In more constrained and hazardous environments, other technologies such as non-destructive measurement or remote handling may be required, which has implications on the cost of and time for delivery of waste management strategies, which has a consequential impact on decommissioning delivery.

Fig. 4. Ad-hoc storage of organic waste at a Sellafield plant prior to recontainerisation and transfer to interim storage; showing degraded containers and insufficient bunded containment.

An issue at the Sellafield site has been the historically inconsistent approach to asset care and maintenance, particularly of non-operational facilities. Facilities in care and maintenance or active decommissioning have historically suffered from reduced investment in asset care, which has had negative impacts on the physical condition of the building fabric and in some cases waste containment. Efforts are currently focussed on improving asset care across Sellafield, but the historical decisions have impacted on decommissioning and waste management operations. Limited asset care has meant that some decommissioning environments have additional hazards from degrading building fabric and degrading waste containment, which must be considered and mitigated against in execution of waste handling operations. Degrading waste containment, as exemplified on a small scale by Fig. 4., has created the need in some instances for waste repackaging prior to any subsequent waste management operation, with cost, time and resource implications as well as the generation of additional waste in the form of previous redundant packaging and containment.

Historical lack of site waste management strategy

The existence of orphan waste across the Sellafield site, and the operational challenges it poses to both commercial and decommissioning plants, means that orphan waste is fundamentally a site wide problem. Despite recent progress in the development of an integrated waste management organisation for the Sellafield site, there has been a historical lack of a consistent consolidated waste management organisation and the devolution of responsibility for orphan waste management strategy to waste owning plants. This has created a number of technical and temporal problems for progress in terms of waste management for site and has contributed to delays in the development of and thus access to new waste management routes for orphan wastes.

The historical lack of a consistent, consolidated site strategy for orphan wastes has led to the distribution of orphan wastes in small volumes in numerous facilities across the Sellafield site, predominantly managed by the waste owners. Storage arrangements have, in the past, been ad-hoc and non-standardised, contributing to additional opportunities for chemical and radiological cross-contamination of wastes where storage arrangements have not been robust, which has exacerbated the challenge. Space constraints and the historical lack of consolidated organisation also have resulted in extremely limited opportunities for consolidated interim storage of orphan wastes. This has contributed to a delay in opening new, appropriate disposal routes; as the economy of scale means that there is reduced desire or ability, particularly on a plant-by-plant basis, to fund and resource programmes to develop waste management strategy for small volumes of waste. The lack of interim storage facilities has impacts on the ability to deliver a decommissioning project to programme, as it inflicts a “treat/dispose or keep” option set on the project, meaning that decommissioning operations can be delayed whilst solutions to the waste management problem are determined. For example, on the Prototype Fast Reactor Fuel Plant project, the lack of available interim storage locations has resulted in waste routing development for some wastes (e.g. mercury) needing to be accelerated, with cost implications to the project, whilst characterisation and waste route identification for other wastes (e.g. organic liquids) is delayed until decontamination operations are completed, with implications to cost and time. The availability of a suitable alternative waste storage location for orphan wastes would enable parallel working on waste management and decommissioning, and with significantly less impact to the delivery of decommissioning operations.

The physical, chemical and radiological nature of orphan waste means that existing site infrastructure and existing site waste routes are for the most part, and generally without modification, unsuitable for the treatment and disposal of orphan waste or unavailable for commercial reasons. For example, the site has infrastructure for the thermal treatment of organic solvent from reprocessing operations which theoretically could be used for the thermal treatment of contaminated waste oil. This infrastructure would require significant modification to enable oil to be treated and its capability is tied to support ongoing commercial reprocessing operations, making the facility unavailable and so thermal treatment, where an appropriate option, must be pursued via the supply chain. Additionally, potentially useful site infrastructure has been allowed to fall into disuse and disrepair, owing to historically limited asset care and a lack of incentive or priority to modify, which has closed or precluded certain site based waste routes. For example, Sellafield site historically possessed an oil burner for the thermal treatment of waste oil which, following a reduction in suitable throughput material and a lack of management will to modify to accept different throughput, has become redundant and unavailable for use [5]. The lack of a consolidated site approach to waste management has contributed to reduced or indeed missed opportunities for the use of site based infrastructure and realising benefits from applying the proximity principle. The absence of site infrastructure, and indeed the absence of available infrastructure on Nuclear Decommissioning Authority sites, has created a need to seek for new waste routes involving developing new site infrastructure or the use of processes available via the supply chain.

The establishment of new waste treatment and disposal routes or the adaptation of existing routes to accept orphan waste requires time, funding and resource as it can involve a number of phases - research and development; detailed optioneering; stakeholder engagement; potential changes to authorisations, permits and consents; demonstration trials; and formalisation into a site process. This process has certain incompatibilities with a projectised decommissioning environment, where the time, funding or appropriate specialist resource may not be available to enable such activities to be undertaken. Additionally, the comparatively small quantities of orphan wastes held by individual facilities makes it difficult for waste owners to make a best value argument in undertaking such programmes to establish new waste routes on a projectised basis, particularly where there is competition for constrained funding. This leads to a dependence on existing routes or ongoing interim storage at another facility, rather than seeking final solutions for treatment and disposal problems for these waste types.

Projectised management of decommissioning

The unique and transient nature of decommissioning operations means that decommissioning is managed on a project basis. The nature of project management, and the differences to routine business-as-usual operations, also has an impact on the planning and execution of waste management operations, particularly with regards to the management of orphan waste.

Waste management is embedded in the process of decommissioning, as decommissioning is a process which is at its basest level engaged with the transformation of useful material in terms of building fabric and equipment into waste. Despite this - or perhaps because of the vast quantities of comparatively routine standard wastes such as concrete, rubble and structural metal that require management and are perceived to be of greater concern – the issues associated with managing orphan and more non-standard wastes are less acknowledged and considered, but remain arguably the most problematic. Operational experience has demonstrated that such orphan hazardous wastes only become of concern to a project when the facility is in active decommissioning and the very presence of the waste is hazardous or problematic. This means that waste management for orphan waste is often commenced later in the project life-cycle, which can have negative impacts on the cost and time for project delivery. The range of activities required to undertake appropriate management of orphan wastes – such as characterisation, optioneering, research and development, demonstration trials – can be perceived to be a hindrance to project delivery programmes as execution of these activities places a burden on time, cost and resource; which can discourage the execution of programmes for appropriate management of orphan waste and the adoption of more quick-fix approaches.

Waste management and the identification of new waste disposal routes to meet the challenge posed by orphan wastes can also be hindered by the difficulties of portfolio management. Changing priorities at a site level, owing to funding constraints or regulatory and governmental pressures, has a consequential impact on priorities at a business unit level. Projects can be, and often are, periodically stopped and started, decelerated or accelerated to enable appropriate focus on site wide priorities. This can cause allied waste management projects to be similarly effected, inevitably delaying and increasing the cost of such projects. The variability in annual funding, as a consequence of site funding prioritisation, has a similar effect; which would be mitigated if waste management was considered on a more holistic, site-wide level.

CONCLUSIONS

Waste management encompasses a range of operations involved with the safe storage or treatment and disposal of radioactive and hazardous wastes. Waste management is a key process within decommissioning, as this will generate significant volumes of a myriad assortment of wastes including demolition waste and hazardous waste in the future. Orphan waste, which has no technically underpinned and formally available treatment and disposal route, is a significant category of waste at the Sellafield site, with over five hundred different waste types of varying radiological classification fitting into this category. The issue of orphan waste management is important in the context of decommissioning, as many orphan wastes are identified or generated during the decommissioning process.

The nature of decommissioning projects and indeed the nature of orphan waste itself poses a variety of challenges to any waste management organisation. These challenges can arise from the characteristics of the waste, the hazards and condition of the decommissioning facility, the historical lack of a global site strategy for the management of orphan waste and the project based nature of decommissioning.

Operational experience undertaking orphan waste management operations at the PFR Fuel Plant facility, which is undergoing active and accelerated decommissioning, has allowed first-hand experience with some of these challenges. Despite the challenging nature of orphan waste management in decommissioning environments, experience on this project has demonstrated that progress can be made in a timely and cost-effective fashion to enable decommissioning operations to be delivered to realise project objectives.

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