LLW Repository Ltd

Nuclear Decommissioning Authority

UK Management of Solid Low Level Radioactive Waste from the Nuclear Industry:

Metal Decontamination Study

December 2009

Document History

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DRAFT	November 2009	Draft for Comment	M Lindberg	A Laker	T Hedahl
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Executive Summary

The Low Level Waste Strategic Review published in October 2008 described 54 strategic initiatives that are intended to improve and integrate the low level waste (LLW) management throughout the Nuclear Decommissioning Authority (NDA) estate. Additional strategic focus was to treat the Low Level Waste Repository (LLWR) as a national asset for the disposal of LLW. Six of these strategic initiatives targeted the opportunity to reduce waste volumes for disposal through alternative waste treatment options. These complementary processes can be categorised as metal treatment, compaction, and incineration.

Metal treatment is currently taking place at a number of facilities across the NDA estate and within the Supply chain.

The initiative, designated as Waste Treatment 6 (WT6) in the UK Nuclear Industry LLW Management Plan was developed by the LLWR National LLW Strategy Team and followed on from the LLW Strategic Review. It specifically looks at the current status and opportunities to improve the efficiency of existing NDA metal decontamination facilities. This study also includes consideration of more flexible operating models where material that cannot be easily decontaminated to exempt levels, or is not suitable for the Wheelabrators, is routed to the supply chain for treatment which can include melting.

The results of the study indicate that the NDA metals treatment facilities can handle uncomplicated geometries at low levels of contamination. The amount of secondary waste from the NDA facilities was in one case very high, well over what might be expected from similar commercial facilities.

The amount of metals that are expected to arise from the decommissioning of nuclear facilities and from the waste segregation initiative by LLWR should be sufficient to utilise the NDA facilities to the design capacity.

The capacity of the NDA facilities is only a fraction, 4%, of what is available from the supply chain. The supply chain has an estimated capacity of 16000 tonnes/year vs. 650 tonnes/year from NDA facilities.

From an economic perspective, the NDA facilities currently use a subsidised pricing model that is potentially very inefficient in terms of cost recovery from the customer.

Contents

1 Introduction

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The Low Level Waste Strategic Review [1] published in October 2008 described 54 strategic initiatives that are intended to improve and integrate the low level waste (LLW) management throughout the Nuclear Decommissioning Authority (NDA) estate. Additional strategic focus was to treat the Low Level Waste Repository (LLWR) as a national asset for the disposal of LLW.

Six of these strategic initiatives targeted the opportunity to reduce waste volumes for disposal through alternative waste treatment options. These complementary processes can be categorised as metal treatment, compaction, and incineration.

The initiative, designated Waste Treatment 6 (WT6) in the UK Nuclear Industry LLW Management Plan [2] was developed by the LLWR National LLW Strategy Team and followed on from the Strategic Review. It specifically looks at improvement in efficiency of existing NDA metal decontamination facilities.

The requirement is to improve the efficiency of existing metal decontamination processes e.g. Wheelabration, by using a more flexible operating model. Material that cannot be easily decontaminated to exempt level, or is not suitable for the decontamination technology, could be routed for decontamination with other methods and/or for melting. It is very difficult to exempt some metals using grit-blasting techniques alone because of material type, amount and type of contamination, geometry, etc and inappropriate use can result in large volumes of secondary waste and/or non-exemptable material being disposed to LLWR. Using grit-blasting as a pre-treatment, followed by melting, can allow a much wider envelope of material to be recycled.

Because of the limited options available in the UK, numerous shipments of waste for processing in other countries has already occurred, although only small scale trials have been undertaken until now. These shipments have been to processing facilities in Sweden, Germany, and the United States (U.S.), where metal is melted into ingots and then recycled in the case of Sweden and Germany, the slag being returned for disposal to the LLWR. There appears to be opportunities to capitalise on the use of such facilities, whether this is a short-term or long-term solution.

In addition based on the current treatment infrastructure within the UK, there appears to be an opportunity to increase the UK contribution, whether this is introduction of local, regional, mobile, or centralised facilities. Examples of specific waste treatment technologies have proven that waste volumes can be significantly reduced and therefore have a dramatic impact on the future waste disposal profiles.

The purpose of this study is to determine and improve the use of existing metal decontamination systems within the UK. Any possible spare capacity within existing NDA and supply chain decontamination facilities will be highlighted. A list of recommendations to optimise the use of these existing systems will be developed. The study also includes technical guidance on the most effective use for decontamination systems and will consider the following issues; authorisations, commercial, technical, geographical, and stakeholder acceptance for current operating systems.

1.1 Methodology

In order to collect information from metal treatment facilities within the NDA estate a questionnaire, see Appendix A, was distributed among the members of the Low Level Waste Strategy Group [3].

Any possible spare capacity within the existing NDA decontamination facilities will be highlighted and explored. A list of recommendations to optimise the use of these existing systems will also be developed. The study also includes technical guidance on the most effective use for decontamination systems and considers other commercial facilities treating metal LLW wastes both in the UK and overseas.

Table 1 lists all the NDA Site Licence Companies (SLCs) that were asked to provide information in support of this initiative.

SLC	Answered
Sellafield	Yes
Winfrith	Yes
Springfields	Yes
Magnox North sites	Yes, section 1
Magnox South sites	Yes
Dounreay	No

Table 1 - SLC Participation

1.2 Description of NDA Metal Recycling Facilities

Sellafield, Metals Recycling Facility (MRF)

Decontamination is carried out using two wheelabrator abrasive cleaning machines where fast rotating impellers flail abrasive material at the contaminated metal on a moving conveyor within a blast cabinet. The process removes the surface contamination leaving the metallic surface clean of radioactive contamination. Secondary waste from the decontamination process, typically untreatable sections, shot blast residues, filter dust, etc are collected for consignment as LLW to the Low Level Waste Repository (LLWR).

Sellafield, Lead Facility

There is a lead melting furnace on the Sellafield site. This has not been in operation since it was discovered that the ventilation failed to meet modern standards. The capacity when operating was 3 tonnes/day.

Recently an initiative has been proposed to refurbish the facility and start lead melting again. The capacity after refurbishment has been estimated at 4 tonnes/day.

Winfrith, WACM

Research Sites Restoration Ltd (RSRL) are able to provide decontamination of surface contaminated materials using the Winfrith Abrasive Cleaning Machine (WACM). The WACM is an impeller driven shotblaster with dedicated extract facility and authorised discharge point, for the surface decontamination of ferrous metal waste. The WACM is an established process for the removal of surface contamination from steel items, by shotblasting, to enable disposal as exempt waste. The WACM is based on the Winfrith site and has been used to treat waste metal arising from decommissioning activities at both Winfrith and Harwell.

The WACM is restricted to ferrous metals only. It can accept painted and/or rusty surfaces, with surfaces contaminated up to 4Bq/cm^2 alpha and 40Bq/cm^2 other nuclides. RSRL has an internal specification for items suitable for processing using WACM and the Winfrith Lead Decontamination Facility, which may eventually be used as the basis for commercial arrangements with non-RSRL businesses based either on or off the Harwell and Winfrith sites.

Cables can be treated as a cable stripper is also available on site.

Springfields, Grit Blasting Facility –S Bay B300

The Grit Blasting Facility was designed to operate two grit blasters using metallic shot. The intended design was to size reduce steel pipe via the other facilities within B300 (i.e. tip and sort, reciprocating saw/cropper, plasma cutting and pipe cutting/slitting) and then introduce the lengths of pipe into the grit blast booths. This would clean-off Uranic residue which could then be despatched to Springfields for Uranium recovery as well as suitably disposing of the pipes as exempt material, VLLW disposal or LLW disposal.

If the facility had been utilised, then their design throughput was up to 1 tonne (dependent upon severity of Uranic residue accumulated on the pipe as well as the level of rust prevalent). Due to the potential high levels of uranium being cleaned off the pipes, there was a potential danger that ILW would be generated within the grit through accumulation of uranium. Therefore the Grit Blasters were 'mothballed' prior to non-active commissioning.

In addition to the grit blasting facility Springfields also have several cutting and segmentation possibilities that are detailed in Table 2 below;

Reciprocating Saw Up to 4" diameter x 10mm wall thickness straight geometry pipe. Up to 30 - 35 cuts/shift	Never been used
Hydraulic Cropper Up to 2" diameter x 10mm wall thickness straight geometry pipe. Up to 30 - 35 crops/shift	Never been used
Plasma cutting facility 30 empty drums/shift or 3 te heavy duty materials. The large item laydown area comprises of a 1 te overhead manually operated crane. The large item Plasma Cutting Areas have been utilised to size reduce steel girders, sheet metal, large bore pipe, etc.	In use

Table 2 – Springfields cutting and segmentation possibilities

Magnox North

On a case-by-case basis, metal decontamination is carried out by Magnox North sites using portable systems such as sponge blast systems. Magnox North currently does not have any fixed-based facilities that are operated on a daily basis to process radioactively contaminated metals except at Hunterston A. The new facility at Hunterston A is a fixed-based facility with the use of glove ports within a containment. Aside from routine application of general decontamination methods which are widely in use at Magnox stations, Magnox North does not have any mobile techniques which are operated on a daily basis apart from those outlined above.

Magnox North is aware of the range of commercial metals processing facilities. Currently, Magnox North is not routinely shipping metal materials to any commercial facilities for decontamination.

Magnox South

Hinkley Point A (HPA) has an Aqueous Decontamination Facility (ADF), located in the station's old laundry building, incorporating a skip decontamination booth (SDB).

The single story ADF building comprises a north entrance doorway and corridor for forklift truck access. A conveyer system enables the loading of skips from the transport boxes into the Ultra-High Pressure Water Jetting (UHPWJ) skip decontamination booth. The UHPWJ system incorporates control cabinet, power pack, intensifier pump and skip decontamination booth. An active ventilation system incorporating local HEPA filtration is in place.

The paint removal is carried out remotely using a robotic arm in a self contained SDB. After the skip has been loaded into the SDB, the robot follows a pre-programmed path around the external and internal surfaces of the skip. The paint removal is by rotating nozzle at the end of the robotic arm.

All paint and water arisings are collected in the base of the booth before being discharged into one of three waste hold up tanks via a drain at the front of the SDB.

Fuel skips were originally used to store spent fuel within the cooling ponds at HPA until the fuel was dispatched from site for reprocessing. The skips (pre-treatment) are classified as ILW as fuel fission product leached into the skip paint and rust layers over time. 1175 fuel skips from R1 and R2 cooling ponds have been successfully decontaminated.

2 Questionnaire Summary

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2.1 Part 1 – Experience of Metal Treatment

Part 1 of the questionnaire explores if there is a treatment facility on each site and what kind of facility it is. The following answers were given to the questions.

Question	Sellafield	Winfrith	Springfields	Magnox North	Magnox South
Does your site treat metals prior to disposal?	Yes	Yes	Yes	Yes	Yes
Is metal treatment conducted on site?	Yes	Yes	Yes	Yes	Yes
Is treatment carried out using mobile systems?	Yes	Yes	Yes	Yes	Yes
Does your facility use the supply chain to provide metal treatment on your behalf?	Yes[1]	No	Not known	No	Yes
Is treatment conducted within a dedicated facility?	Yes	Yes	Yes	No	Yes

Table 3 –Answers to questionnaire Part 1

[1]Sellafield use of overseas facilities

Conclusions

Four sites in the UK have metal treatment facilities and one site will have a dedicated facility shortly.

These facilities generally treat only waste from their own site. Only one site with its own metal treatment facility has so far used the supply chain for additional metal treatment.

The risk of producing ILW from treatment of uranium contaminated metals has so far prevented Springfield from taking their grit blasting facility into active operation.

2.2 Part 2 – Facility Capabilities

From the responses received in the questionnaire, the only evidence of current large-scale on-site treatment of metals is at Sellafield, Hinkley Point A and Winfrith. Therefore, only these responses are considered within this section.

	Sellafield	Hinkley Point A	Winfrith
Year of commissioning	2005	2005/2006	2000 relocated 2009
Capacity 2008/2009 (tonnes/year)	500	-	100-150
Processed (tonnes)	339	76	143
Tonnes recycled	339	Pre-treatment only	15
Amount secondary waste (tonnes)	30 (8.8%)	0.7-0.9 (1.1%)	1.6 (1.1%)
Staff	36	10	5
Metals – surface contaminated			
	Possibility to treat	**Possibility to treat**	**Possibility to treat**
Carbon steel	Yes 80Bq/cm^2 β/γ	Yes Highest recorded is 100GBq/t	Yes up to 4Bq/cm^2 α and 40Bq/cm^2 other nuclides
Stainless steel	Yes 80Bq/cm^2 β/γ	*Possibly; requires trials*	Yes up to 4Bq/cm^2 α and 40Bq/cm^2 other nuclides
Copper	No	*Possibly; requires trials*	No
Aluminium	No	*Possibly; requires trials*	No
Brass	No	*Possibly; requires trials*	No
Lead	No	*Possibly; requires trials*	Yes up to 4Bq/cm^2 α and 40Bq/cm^2 other nuclides
Titanium	No	*Possibly; requires trials*	Yes
Cables – Cu or Al conductor	No	*Possibly; requires trials*	Yes up to 4Bq/cm^2 α and 40Bq/cm^2 other nuclides
Other cables	No	*Possibly; requires trials*	No
Galvanized material	Yes	*Possibly; requires trials*	No

	Sellafield	Hinkley Point A	Winfrith
Metals – Other		*Possibly; requires trials*	
Tritiated metals	No	*Possibly; requires trials*	No
Activated metals	No	No	No
Uranium contaminated metals	No	*Possibly; requires trials*	No
Alpha dominated contaminated metal, such as PCM	No	*Possibly; requires trials*	No

Table 4 –Treatable Metals and accepted contamination levels

Size of treatable item	Sellafield (mm)	Hinkley Point A (mm)	Winfrith (mm)
Minimum	W×L×H 100×100×2.5	*Could be re-configured to accept wastes of different geometries. Requires trials*	W×L×H 1.6×400×1.6
Maximum	W×L×H 900×5000×700	*Could be re-configured to accept wastes of different geometries. Requires trials*	W×H 900×450 Length will be restricted by weight
Weight limitations		Mild steel, 100kg in weight	2kg – 1 tonne per item
Technical limitations According to WACs			
Contamination levels (DP6 probe or equivalent)	<50cps α <1500cps β		
Loose contamination* (DP6 probe or equivalent)	<5cps α <75cps β		
Dose rate limitations*	<25μSv/h		

* Values exceeding the limits may be accepted after consultation

Table 5 –Additional acceptance criteria information

Operations, efficiency, limitations and treatment options

According to Sellafield's experience, 3 passes through the Wheelabrator will clean most metals so that it can be released from regulatory control under Substances of Low Activity (SoLA), Radioactive Substances Act 1993 (RSA93). Each pass through the Wheelabrator is set to 10 minutes, which for a 5 metre item corresponds to 0.5 meters per minute.

WACM operates their Wheelabrator slightly differently. The time for the metal to pass is not fixed but the throughput speed can be set between 0.1 – 1.0 meters per minute. A 5 meter item can take from 5 minutes to 50 minutes to process depending on the throughput speed. The speed will be dependant on type of material, thickness of material as well as the thickness of the surface that needs to be removed.

WACM has declared that almost all the metal that has been treated could be released from regulatory control. Sellafield has declared that for certain pond materials (e.g. racks, supports, etc.), the treatment had to be terminated since the material was not possible to exempt after treatment. This material was transferred to LLWR for disposal.

The Sellafield waste stream, identified as 2X927, has declared that for the first 13 years of treatment (2007-2020), the average amount of secondary waste produced is calculated to be 21m^3/year.

The amount of slag produced from the proposed restart of the Sellafield lead melting facility has been estimated to be 20% of the incoming material.

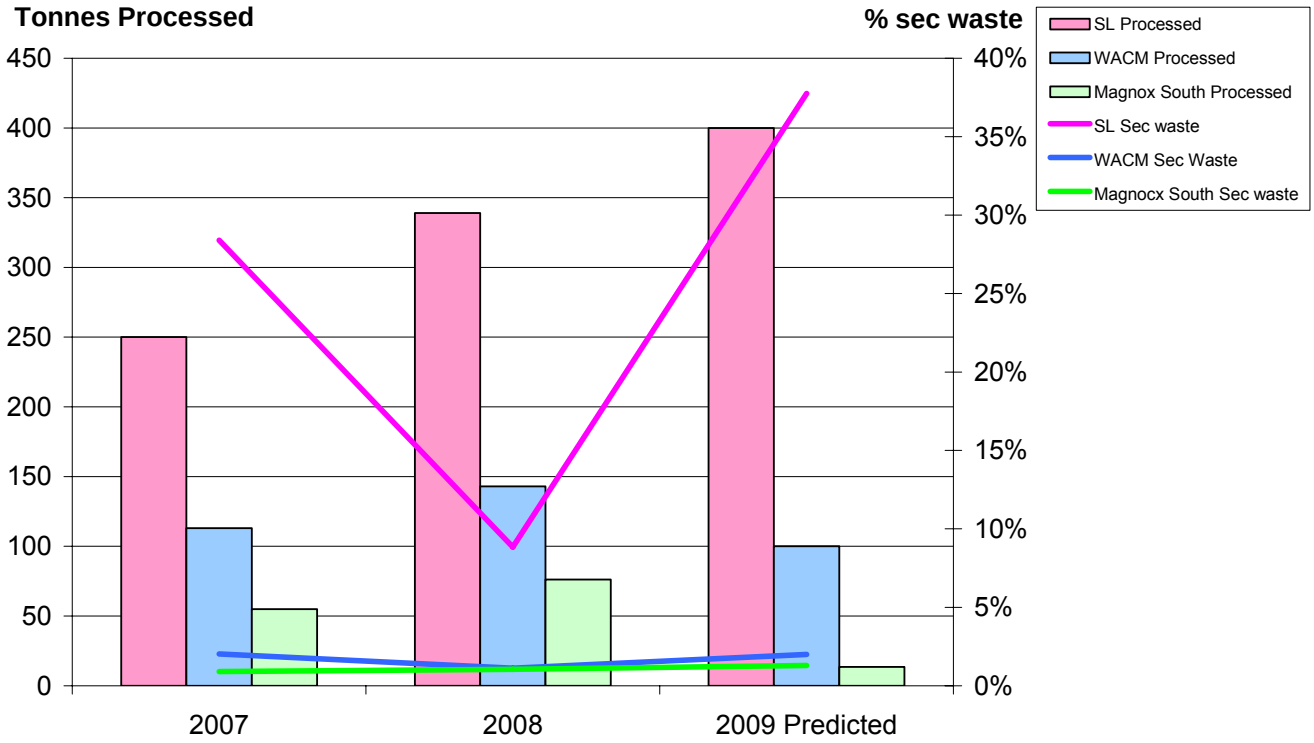

Figure 1 - Amount of processed metal and % of secondary waste from operations

As seen in Figure 1 above, the amount of secondary waste produced from the Sellafield MRF is very high in comparison to WACM and Hinkley Point A.

There are several possible explanations for this and one is the number of passes required by the Wheelabrator process in order to achieve the required decontamination factor.

Other possibilities are that metals are treated extensively and are still not exemptable after treatment and therefore still contribute to the waste for disposal, which is a possibility from the WSCD referred below.

According to the WSCD (2X927) the composition of the waste stream is

Metal	59%
Grit	35%
Soft organics, plastic, rubber wood others	6%

Conclusions

The metal treatment facilities within the NDA estate have been operating for a number of years now. The efficiency and secondary waste production from these facilities is varying, as is the cost for treatment.

The metals treatment facilities available within the NDA estate can treat ferrous metals that are surface contaminated to a certain degree. Between the 2 facilities the maximum surface activity is 80Bq/cm^2 β/γ at Sellafield and 4Bq/cm^2 α for WACM, although alpha dominated fingerprints are excluded at both facilities.

Microshield calculations show that 80Bq/cm^2 of Co-60 corresponds to 54μSv/h.

In addition to the ferrous metals, lead and cables, with a maximum activity of 4Bq/cm^2 α and 40Bq/cm^2 other nuclides, can be treated at WACM (Winfrith). Sellafield will accept galvanised material up to 80Bq/cm^2.

It is clear that the choice of the metal shape, geometry and contamination level to be treated and the method of treatment affects the amount of secondary waste. In some instances metals should not be treated at the Sellafield MRF at all, either with or without pre-treatment. The choice of treatment methods for metal objects is crucial in order not to generate large amounts of secondary waste but also for the success of the treatment.

2.3 Business Information

All other materials such as activated metals and metals with tritium contamination cannot be accepted for treatment at these two facilities.

Table 6 below details the commercial and operational costs associated with the metal treatment facilities situated at Sellafield, Hinkley Point A and Winfrith.

	Sellafield	Hinkley Point A	Winfrith
Services offered to NDA and non-NDA customers	Yes	No	Yes
NDA approved business case	No	No	No
SLC Employees	36	10	5
Operating hours per annum	5824	Dependant on demand	1400* (175 days/year)
Predicted 2009/10 Processed amount (tonnes)	400	Current anticipated waste stream and throughput can be processed according to plan.	100
Costs	£3042.4k per year	Not provided	£1736.09 per day £303.8k/year
Cost (£/kg)	7.61	Unknown	3.04
Price	0.32 - 5.60 £/kg	50 £/kg	£ 1736.09 per day
Lead melter	400-500k£ refurbishment Operational cost: similar to LLWR disposal cost		

* 1400 hours/year, assume 8 hrs/day = 175 days/year

Table 6 – Commercial costs

Table 6 above summarises the business information for the WACM, Hinkley Point A and Sellafield MRF. It is noticeable that none of the facilities have an NDA approved business case.

The Sellafiled MRF data suggests that the cost for treating the metals is currently higher than that recovered from its customers for this service. As seen in the table the average cost for treatment varies from 7.21£/kg vs 5.60 £/kg (130%) to 7.21£/kg vs 0.32£/kg (2250%) of the customer price for treatment.

3 Supply chain facilities treating LLW metals

3 Supply chain facilities treating LLW metals

In order to evaluate the treatment possibilities for different metals, capacity and efficiency of the NDA metals treatment facilities services available through the supply chain have been compared and summarised below. A cost and price comparison has not been included for the supply chain since that information varies for almost every individual consignment.

3.1 UK facilities

Studsvik Metals Recycling Facility, Workington, Cumbria

The following information was extracted from the Studsvik UK Metals Recycling Facility Waste Acceptance Criteria (WAC). [4].

Normal operating parameters

- General containerised metallic scrap
- Surface dose rate up to 0.2 mSv/h averaged per item with no hot spots above 0.5 mSv/h
- Dose rate at 1m up to 0.1 mSv/h
- Metallic surface finish or painted surface coatings
- Acceptable materials: steel (carbon and stainless), cast iron, aluminium, copper, lead, brass; and cables with copper and/or aluminium conductor
- Fingerprint to be predominantly β/γ and/or low toxicity α
- Material thickness greater than 3 mm
- Average specific activity per container < 500 Bq/g
- Individual item weight limit of 5 tonnes

Excluded material

- Non-metallic materials such as rubber, plastic or other organic materials
- Free liquids (no liquids of any kind are permissible)
- Cans of paint, grease, aerosols or other organic materials
- Toxic materials
- Materials that may cause explosion or self-ignition
- Zinc-galvanized metals or any other metals not listed as acceptable for treatment
- Cables containing tensioning wires
- Other materials not meeting the Conditions for Acceptance for the Low Level Waste Repository.

Capacity

The licensed capacity of the facility is 3000 tonnes/year.

Treatable metals;

- Steel (carbon and stainless)
- Cast iron
- aluminium
- Copper
- Brass
- Cables with copper and/or aluminium conductor
- Lead

Secondary waste

Secondary waste can be returned to customer or sent directly for disposal at LLWR.

3.2 Overseas facilities

Studsvik metals treatment and melting facility, Sweden

The Studsvik metal treatment and melting facility has a licensed capacity of 5000 tonnes per year of which no more than 1000 tonnes can be lead. The technical capacity for the melting plant is around 8000 tonnes per year.

Waste streams that fall outside the Studsvik Nuclear standard WAC's can always be discussed on a case-by-case basis in order to find the most appropriate way of dealing with these metals. The following information has been extracted from the Studsvik WACs for Melting Services 2009 [5]. The WACs are extensive so the information extracted is based on the information given in the questionnaire in order to compare to the NDA metal treatment facilities.

Sizes	Decontamination and Segmentation	Ready for melting
Size of items that can be treated (minimum)	10 mm for blasting minimum thickness 3 mm	
Size of items that can be treated (maximum)	For larger dimensions segmentation is offered with diameters up to 4 m	Diameter/width <0.6m Length <1.2 m
Weight limitations	No weight limitations Items up to 310 tonnes have been treated	Minimum Steel 5 tonnes Copper 3 tonnes Brass 3 tonnes Aluminium 2 tonnes Lead 2 tonnes
Dose rate limitations	Surface dose rate <0.2mSv/h "hot spots" up to 0.5mSv/h allowed after acceptance by Studsvik Dose rate at 1 m <0.1mSv/h Dose rates above these limits may be accepted on a case-by-case basis	N/A
Contamination levels	Guidance Paint free surfaces Ratio:Loose and fixed (in Bq/cm^2) to Material thickness (mm) should be ≤10 More then 50% painted surfaces Ratio:Loose and fixed (in Bq/cm^2) to Material thickness (mm) should be ≤15	N/A

Table 7 - Studsvik Nuclear waste acceptance criteria for incoming materials

Other acceptance criteria

Studsvik has licence to treat uranium contaminated metal with an enrichment of less than 5 %.

If there is any doubt as to the acceptability of a particular type of scrap Studsvik should be consulted. Such scrap may comprise of;

- Free liquids
- Grease, oil or spray cans
- Toxic or hazardous components such as Asbestos
- Galvanised metallic scrap (Zinc)
- Combustible materials that may self-ignite or cause explosion
- Vulcanised layers and other organic coatings
- Closed, concealed cavities, when delivered as “ready for melting”
- Lead composites (embedded in steel or other metal), when delivered as “ready for melting”.

Secondary waste

Secondary waste has to be returned to the consignor within 2 (two) years after delivery at the Studsvik site. This is a regulatory requirement. The two year period is defined as when the material crosses the Swedish border.

The amounts of secondary waste from treatment at the Studsvik Facility are generally around 4-5%. For large components the secondary waste varies as the contamination levels varies. In Figure 2 below some examples are given for large components.

The amount of secondary waste from lead melting is from experience 1% - 3%.

Recycling

The bulk of the metal is, after analysis and verification, capable of meeting the Swedish free release criteria. It is then recycled through certified foundries back into the public domain, all in compliance with the Studsvik licence and the European Commission’s Recommendation, RP89, Table3-1.

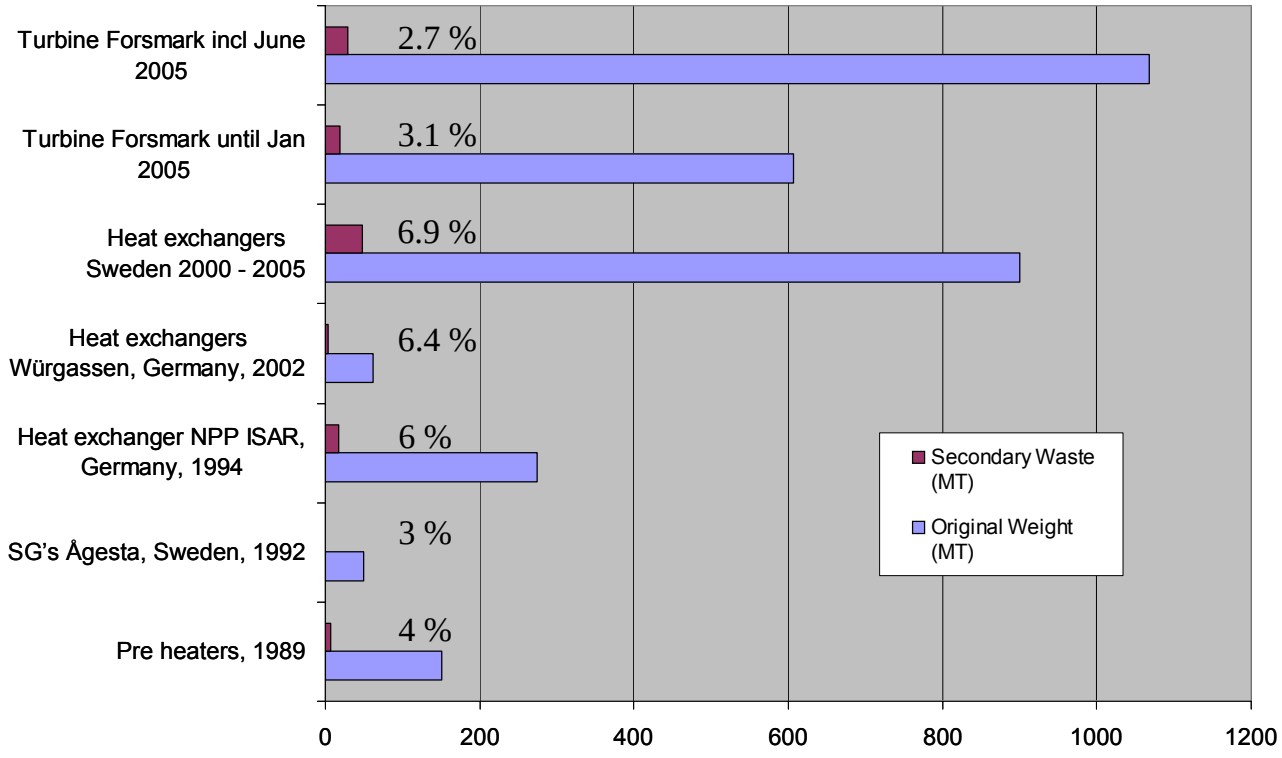

Figure 2 - Secondary waste production from treatment for large components (MT = metric tonnes)

Siempelkamp, Germany

The following information is available on the Siempelkamp website [6].

General description

The CARLA melting plant has a licence according to BImSchG for an annual melting quantity of 4,000 tonnes. Additionally it is licensed, according to radiation protection ordinance (StrlSchV), to accept metals up to a specific activity of 1,000 Bq/g and to store and treat metal by sorting, dismantling, decontaminating and melting. Radioactive wastes like slag, filter dust and furnace lining will be sent back to the customer.

Technical Data

- Melting plant approved according to Para 7 of the German Radiation Protection Ordinance for the treatment of radioactive materials
- Melting unit: 3.2 to MF induction-furnace
- Equipped with a 3-step filter unit in 2 lines
- Mechanical and thermal cutting facilities available
- Pre-decontamination by blasting
- Melting and pouring to 1 tonne metal blocks or to granules
- Recycling of the metal to shielding or to waste containers made from ductile cast iron or heavy concrete
- Storage of metal blocks for decay
- Release of metal for recycling or waste for disposal

Treatable metals

- Carbon steel (coated, uncoated)
- Carbon steel (galvanized)
- Stainless steel
- Alloys
- Compound materials (e.g. lead/steel)
- Aluminium
- Cooper, brass
- Lead

Acceptance limits

- Specific total activity < 1,000 Bq/g
- For the nuclides H-3, C-14, Fe-55, Ni-63 < 10,000 Bq/g in total
- Nuclear fuel according to Para 2 of the German Atomic Law max. 15 g/100kg
- NORM < 1,000 Bq/g

History of Siempelkamp

Since starting operation, 25,000 tonnes have been melted in the CARLA plant. From this quantity, 9,000 tonnes was decontaminated in a way so that a release for further use as secondary raw material in metal recycling was possible. 14,500 tonnes did not conform to the conditions for release and were preponderantly applied in the production of cast iron containers which were used for transport and final storage of radioactive wastes. Thus, CARLA has essentially contributed to reducing the radioactive waste volume and only 5 % had to be deposited in a final storage as radioactive waste.

Bear Creek, EnergySolutions, USA

The following information is available on the EnergySolutions website [7].

Technical Data

- Bulk metals may be processed through decontamination, volume reduction for burial or melted for recycling. See below for size and prior approval requirements.
- Materials for mandatory recycling require special approval.

Treatable metals

Metals requiring prior approval and possibly special pricing

- Metal pieces larger than 16 ft x 8 ft x 8 ft (approx. 4.9 × 2.4 × 2.4 m) per individual piece or combination of integral pieces
- Metal pieces heavier than 20,000 lb (approx. 9072 kg) per single piece
- Metal melting for the following requires special evaluation:
- Metals coated with asbestos
- Alloys with melting points above 3000 degrees F (1649ºC)
- Galvanized metal with zinc weight percentage >1% of the galvanized metal weight
- Aluminium
- Cadmium
- Copper/copper alloys (Brass, Bronze, Monel, etc.)
- Lead
- Stellite
- Tin

- Crushed metal items that contain entrained non-metallic materials
- Bulk metals containing >2% incinerable by weight (e.g. wire insulation)

Radionuclide[1]	TBq[2]	Curies[2]
Co-60	0.3	8.1
Cs-137	1	27
Gd-153	10	270
Ir-192	0.8	22
Pu-238	0.6	16
Se-75	2	54
Sr-90(Y-90)	10	270
Yb-169	3	81

Table 8 – Bear Creek WAC for total radioactive materials quantities

1 If more than one radionuclide is being shipped, the sum of fractions rule applies.

2 The primary values used for compliance with this Order are TBq. The curie (Ci) values are rounded to two significant figures for informational purposes only.

3 The QOC Table is abbreviated based on site possession limits.

Lead (Pb)

- Lead bricks, sheets or shapes are accepted for recycling through casting.
- All lead shapes and waste forms shall be packaged separately from non-lead materials and the Pb package labeled as such.
- Lead-encased metal shapes (LEMS) are accepted for removal of the encasing material and survey and recycling. All LEMS are considered out of WAG and require prior approval prior to shipment. Schematic diagrams shall be provided for all LEMS prior to shipping

Not Candidates for Melting	Not Candidates for Volume Reduction
Non ferrous metals such as brass, bronze, aluminum, cadmium, copper, and Chromium	Lead/lead alloys
Molybdenum	Cadmium
Uranium metals	Chromium/chromium alloys (excluding stainless steel)
Tantalum	Metals contaminated with oils or solvents
Tungsten	Titanium
Zirconium	Magnesium thorium
Oil or solvent contaminated metals	
Titanium	
Metals exceeding 20 mrem/hr (0.2mSv/h)	
Magnesium thorium	

Table 9 - Metals requiring out-of-Waste Acceptance Guidance approval prior to shipment to Bear Creek

It shall be noted that importing metallic waste to the U.S. is currently under review by USNRC which might limit this route in the future. It shall also be noted that secondary waste cannot be returned from treatment at Bear Creek since metals are not treated in customer specific batches.

4 Summary

4 Summary

All facilities in this study will have to review waste characterisation information prior to accepting any waste. The following tables give an overview of the metals and contamination levels that can be accepted

It should also be noted that the RSA93 exemption orders in the UK are under review and the limits maybe changed in the near future

The optimisation of the use of either the NDA facilities or the supply chain should take into account the following:

- Metal to be treated
- Contamination levels
- Cost of treatment
- Amount of secondary waste
- Possibility to recycle outside the nuclear industry

	Studsvik MRF	Siempelkamp Germany	Bear Creek USA (melting)	Studsvik Sweden	Sellafield	Winfrith	Hinkley Point A
Capacity (tonnes/year)	3000	4000	4000	5000	500*	150	-
Weight limitations	5 tonnes	Heavy weight lifting can be arranged	Approx. 9.1 tonnes (20 000 lb)	300+ tonnes	15 tonnes general lifting capacity (3 tonnes in cutting booth)	1 tonne lifting capacity	100kg
Size limitations	Min thickness 3 mm			4 m diameter for cutting	Min: W×L×H 100×100×2.5 Max: W×L×H 900×5000×700	Min: W×L×H 1.6×400×1.6 Max:W×H 900×450	*Could be re-configured to accept wastes of different geometries. Requires trials*
Typical % of secondary waste	TBD but is assumed to be similar to Studsvik Sweden			4%	25% average	2%	1.1%
Activity or dose rate limitations	Surface dose rate <0.2mSv/h averaged per item no hot spots ≥0.5 mSv/h Average specific activity per container < 500 Bq/g	Specific total activity < 1,000 Bq/g For the nuclides H-3, C-14, Fe-55, Ni-63 < 10,000 Bq/g in total		Surface dose rate <0.2mSv/h "hot spots" up to 0.5mSv/h allowed after acceptance	80Bq/cm^2 β/γ	up to 4Bq/cm^2 α and 40Bq/cm^2 other nuclides	-
Recycling of metals	Yes, according to SoLA	Yes, as shielding blocks or containers	Yes within the nuclear industry	Yes, according to RP89**	Yes, According to SoLA	Yes, According to SoLA	Pre-treatment only

* The annual capacity of the Sellafield MRF has so far not been reached, the limiting factor for treatment have been the amount of suitable material for treatment at the facility

** European Commission's Recommendation, RP89

Table 10 – Overview of facilities covered in this report

	Studsvik MRF	Siempelkamp Germany	Bear Creek USA (melting)	Studsvik Sweden	Sellafield	Winfrith	Hinkley Point A
Metals – surface contaminated possible to treat							
Carbon steel	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Stainless steel	Yes	Yes	Yes	Yes	Yes	Yes	Requires trials
Copper	Yes	Yes	After approval	Yes	No	No	Requires trials
Aluminium	Yes	Yes	After approval	Yes	No	No	Requires trials
Brass	Yes	Yes	After approval	Yes	No	No	Requires trials
Lead	Yes	Yes	After approval	Yes	No	Yes	Requires trials
Titanium	No	No	No	No	No	No	Requires trials
Cables - Cu or Al conductor	Yes	Not known	After approval	Yes	No	Yes	Requires trials
Other cables	No	Not known	Not known	No	No	No	Requires trials
Galvanized material	No	Yes	After approval	No	Yes	No	Requires trials
Metals – Other							
Tritiated metals	Yes	Yes	Not known	After approval	No	Yes	Requires trials
Activated metals	Yes	Not known	Not known	After approval	No	No	No
Uranium contaminated metals	Yes	NORM	Not known	Yes	No	No	Requires trials
α-dominated contaminated metal, such as PCM	After approval	Not known	Not known	After approval	No	No	Requires trials

Table 11 – Summary of current SLC and Supply chain metal treatment capability

5 Conclusions

5 Conclusions

From the summary tables it is clear that the NDA metal treatment facilities have limitations when it comes to treating metals other than ferrous metals. Although lead and copper cables can be treated at WACM, other facilities can only handle uncomplicated geometries at low levels of contamination.

The amount of secondary waste from the NDA facilities is in one case very high, well over what might be expected from other similar facilities. The expected amount of secondary waste from the lead melter at Sellafiled is also much higher than is common elsewhere in the industry. However, the amount of secondary waste is very much dependent on the level of contamination and the level for clearance or exemption for recycling of the metals.

The capacity of the NDA facilities is only a fraction, 4%, of what is available from the supply chain. The supply chain has an approximate capacity of 16,000 tonnes/year compared with the NDA facilities 650 tonnes/year capacity.

From an economic perspective, the NDA facilities currently use a subsidised pricing model that is potentially very inefficient in terms of cost recovery from the customer.

5.1 Recommendations

The amount of metals that are expected to arise from the decommissioning of nuclear facilities and from the waste segregation initiative by LLWR should be sufficient to utilise the NDA facilities to the design capacity.

The cost for treatment at the NDA facilities is high, much higher than can be expected from the supply chain. The possibility for making an acceptable business case based on the treatment costs seems very unlikely especially taken into account the high amount of secondary waste produced today, and to be expected from the proposed lead treatment facility at Sellafield

In order to implement the Waste Management Hierarchy the recycling of metals should be mandatory if there is a facility within the NDA or the supply chain that can accept the metal. In the recycling of valuable metals such as copper, including cables, the NDA should contract in such a way that the revenue from the recycling is shared between the facility treating the metals and the NDA. In order to optimise the use of the NDA facilities the following steps should be taken;

Segregate metals at source so that the site facilities and the facilities in the supply chain are used in an optimal way. This segregation includes activity level, contamination and metal

Providing the NDA metals treatment facilities are to continue to treat metals the following recommendations are made;

- **Implement one set of WAC's for the NDA facilities, including acceptable geometries.**
- **Exchange of operational experience between WACM and the Sellafield wheelabrator in order to minimise the secondary waste production from the Sellafield blasting operations**
- **Evaluate the treatment at Sellafield to optimise the use of the facility to materials, geometries and contamination and contamination levels that does not produce secondary waste to the levels that have been produced historically**

The time and cost for characterising exempt metals should be evaluated separately. If this process demands continued blasting, and therefore generating vast amounts of secondary waste then melting the metal should also be considered as an option.

Conduct an update to the BPEO for metal treatment considering any requirement for a UK smelter.

Evaluate the possibility to operate the Springfields metals treatment facilities for uranium and/or alpha contaminated metals only. In this evaluation the risk of producing ILW should be included as well as the benefits for avoiding waste being disposed of at the LLWR. The possibility to recover uranium from the treatment residues as well as any cost implications should be included in the evaluation.

Use the supply chain to treat and recycle metals which cannot be treated at the NDA facilities for any reason such as weight, geometry, activity levels, etc.

Use the supply chain facilities to recycle metals other than ferrous metals

6 References

1 LLW Strategic Review, NLWS/LLWR/01, Rossiter D, LLW Repository Ltd, Issue 1, January 2009

2 LLW National Management Plan, NLWS/LLWR/03 – Rev 0, Andrew Laker July 2009

3 LLW Strategy Group; Terms of Reference http://www.llwrsite.com/llw-strategy-group

4 Studsvik Metal Treatment - Customer Owned Waste Service, Rev. D, July 2009

Studsvik Metal Treatment - Assured Disposal Service, Rev. A, July 2009

5 Metallic Scrap Acceptance Criteria, Wirendal et al, STUDSVIK/N-09/041

6 http://www.siempelkamp.com/Nuclear-Technology.765.0.html

http://www.siempelkamp.de/CARLA-Melting-Plant-for-Low-Level-Ra.773.0.html

7 http://www.energysolutions.com/alpha/license/WAG-501%20R4.pdf

7 Appendix A

Part 1

	Yes	No
Does your site treat metal prior to disposal	☐	☐
Is metal treatment conducted on-site	☐	☐
Is treatment carried out using mobile systems (e.g. abrasive techniques, wiping, chemical, fixatives)	☐	☐
Details of mobile techniques		
Do you use the supply chain to provide metal treatment on your behalf (If Yes supply details below)	☐	☐
Details of use of Supply Chain for metal decontamination		
Is treatment conducted within a dedicated facility (**If Yes continue to Part 2**)	☐	☐
Any other comments regarding metal treatment		

Part 2 (Only to be completed if metal is treated in on-site dedicated facility)

General Details

Type of facility
Manufacturer
Year of commissioning
Number of Full Time Equivalent personnel employed to operate facility

	Operational	Support	Management	Other
SLC employees				
Agency/contract				

Facility operating hours per annum
Floor space and lifting capacity
Scope of authorisations to receive/process waste
Planed amendments

Please attach pictures or layout drawing of the facility

History

Project history of treated metals
Customers (internal/external) of treated metals

Throughput and Capacity

	Data set based on	2007/2008	2008/2009	Predicted 2009/2010
Capacity (tonnes/year)				
Processed tonnes*				
Tonnes recycled				
Amount secondary waste (tonnes)				
Disposed secondary waste and to which UK National Inventory ID				

*Raw weight, not including containers

What constraints the facility capacity? e.g. design of facility, waste availability, authorisation, or other,?
Can you process the amount given in the authorisation or design, with your current set up? Including personnel and working hours? If not what is the limiting factor to reach maximum capacity?

Treated Metals

Acceptable shapes of metal?

	Yes	No	Minimum dimension	Maximum dimension	Other Limitations or comments
Sheets	☐	☐			
Mixed scrap /all possible geometries	☐	☐			
Tubing or piping	☐	☐			
Vessels	☐	☐			
Composite metals	☐	☐			
Other components, pumps valves etc	☐	☐			
Other please specify:					
Other please specify:					

Metals treated and accepted?

Metals – surface contaminated	Capability to treat		Contamination levels treated Bq/g or Bq/cm^2	Successfully treated (Yes/No) If YES please state tonnes	Comments/Limitations
	Yes	No			
Carbon steel	☐	☐			
Stainless steel	☐	☐			
Copper	☐	☐			
Aluminium	☐	☐			
Brass	☐	☐			
Lead	☐	☐			

Titanium	☐	☐			
Cables – Cu or Al conductor	☐	☐			
Other cables	☐	☐			
Galvanized material	☐	☐			
Metals - Other					
Tritiated metals	☐	☐			
Activated metals	☐	☐			
Uranium contaminated metals	☐	☐			
Alpha dominated contaminated metal, such as PCM	☐	☐			

How often are your Waste Acceptance Criteria (WAC) reviewed and revised?

Please provide a copy of your WAC's

Efficiency

What are your criteria for declaring a successful decontamination of the metal?
Have you ever given up on decontamination for a certain piece of metal? If so can you share that information?
If decontamination is not successful, what are the criteria for ending decontamination
DF, decontamination factors per cycle.
Length of one treatment cycle (Minutes/batch or similar)
Is the treatment cycle often repeated? (Yes/No) If Yes – how often?
How many times?
How large fractions of the treated metal are successfully treated? (weight%)

Costs

	Before 2007	2007/2008	2008/2009	Predicted 2009/2010
Operating costs incl. labour				
Maintenance cost				
Management and overhead costs				
How are costs of treatment (and disposal of residues) apportioned within the site LTP? (Please provide detailed PSWBS and OU References)				
Planned future development/investments				

Service offers

What is included in your services?

	Yes	No	N/A	Can be included as additional service	Limitations/Comments
Size reduction into treatable size?	☐	☐	☐		
Sorting of mixed container waste	☐	☐	☐		
Conditioning of secondary waste	☐	☐	☐		
Secondary waste disposal	☐	☐	☐		
Monitoring of secondary waste	☐	☐	☐		
Scrap value	☐	☐	☐		
Do your services require any pre-treatment other than size reduction, such as decontamination or marking of hotspots?					

Pricing and customer uptake

	Yes	No	Price level (£/kg)	Limitations/Comments/ Example customers
Do you offer services to other NDA and non-NDA customers? Direct or via third party?	☐	☐		
Please indicate price level per unit (Internal rate/external rate if applicable)				
Do you have an NDA approved business case in place?	☐	☐		
Please indicate price level per unit				

Optimisation

What do you believe to be the optimal role or use of your facility?

How do you see this in a national strategy perspective?

How do you see interaction with LLWR's metal recycling services?