Symposium on Recycling of Metals Arising from Operation and Decommissioning of Nuclear Facilities

Studsvik, Nyköping, Sweden, 8th-10th April 2014

Rapporteurs report of the Symposium
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Contents

Glossary

BAT	Best Available Technique
BSS	Basic Safety Standards
D&D	Decommissioning and Dismantling
DOE	US Department of Energy
IAEA	International Atomic Energy Agency
LFE	Learning From Experience
LL-LILW	Long Lived – Low and Intermediate Level Waste
LLW	Low Level Waste
LLWR	UK Low Level Waste Repository
NDA	UK Nuclear Decommissioning Authority
NEA	Nuclear Energy Agency
NIMBY	Not In My Back Yard
NPP	Nuclear Power Plants
OECD	Organisation for Economic Co-operation and Development
PESTLE	Political, Environmental, Social, Technical and Economic
SSM	Strålsäkerhetsmyndigheten - Swedish radiation safety authority
UNF	Used Nuclear Fuel
VLLW	Very Low Level Waste
WNA	World Nuclear Association

1 Introduction

The Symposium for the Recycling of Metals Arising from Operation and Decommissioning of Nuclear Facilities was held in April 2014 at Studsvik's facility in Nyköping, Sweden. The Symposium, hosted by Studsvik in conjunction with the Nuclear Energy Agency (NEA) of the Organisation for Economic Co-operation and Development (OECD) and the International Atomic Energy Agency (IAEA), covered a wide range of topics concerning current practice, experiences and innovations within the management of contaminated metallic radioactive material. The primary objective was to understand the differing approaches to clearance and recycling of materials from the nuclear industry across Europe in order to appreciate the issues faced from recovering resources once the material meets a country's clearance requirements. The outcome of the symposium has provided some interesting reflections for national and international bodies to consider when developing waste management guidance and policies.

Over the three days of the symposium, presentations split into six topical sessions and posters regarding the recycling of contaminated metals were viewed by more than 150 people from 19 different countries. A series of group discussions were also held following each session to promote learning about current practices, highlight strategic issues related to metals recycling and develop professional networks across the industry. To stimulate discussion, a series of questions were posed at each group and the outcomes captured for inclusion within this report. This report provides a short summary of the various presentations and discussions concentrating on the key messages and outcomes of the sessions.

2 Day 1 – Tuesday April 8th

The symposium was opened after lunch by **Arne Larsson** of Studsvik with a general welcome and the background to the conference development. Following the 2012 forum hosted by Studsvik on characterisation, there was a call from the IAEA for a workshop on metal recycling. Studsvik worked with the IAEA and OECD/NEA to provide a platform for open discussion regarding the issues involved with metal recycling on a national and international scale. **Anders Appelgren** of Studsvik, the symposium coordinator also provided a general overview of the programme and basic housekeeping information.

2.1 Symposium Opening

The Symposium was officially opened by **Michael Mononen**, CEO of Studsvik who welcomed the guests and thanked the IAEA and OECD for their support while developing the programme. Michael highlighted Studsvik's ambition to minimise the environmental impact of decommissioning and highlighted how Studsvik's pedigree has developed to support this ambition. It was identified that the symposium should provide attendees with the networks and tools required to provide solutions to the national and international issues surrounding resource recovery from the nuclear industry. The symposium should also give attendees a consistent overview of what is considered best practice at both a national and international level.

2.1.1 Overview of the IAEA supported decommissioning and waste management activities

Vladimir Michal, Head of Waste Technology at the IAEA provided a useful overview of the work being completed by the IAEA to support decommissioning and waste management in the nuclear industry. This covered more than 60 publications compiled in conjunction with other agencies. The IAEA hosts a Learning From Experience (LFE) platform called 'CONNECT' which comprises a series of networks and working groups including an international decommissioning network and a waste characterisation network. The IAEA also carry out regional technology cooperation projects as well a peer review service. The IAEA have produced several guidance documents which assist the clearance and management of radioactive material from the nuclear industry as well as the management of radioactive materials within the metal recycling industry.

2.1.2 Clearance, Reuse, Recycle and Disposal as VLLW. A role for all of these options in the optimisation of rad waste management in decommissioning–more work needed on optimisation

Claudio Pescatore of the OECD/NEA looked at the options available for treatment and disposal of waste from a decommissioning operation and the national variations with which these options are applied. By comparing three national strategies (France, Sweden, Germany), several conclusions were reached. The key message from the presentation was that a choice of treatment and disposal options is vital to optimising a national waste management strategy, including clearance and VLLW disposal which can also offer cost benefits. Claudio finished with a review of some of the work already completed by the NEA and their future programme of work looking at optimisation of waste management approaches.

2.1.3 Management of Materials from the Decommissioning of Nuclear Reactors

Georg Braehler of the World Nuclear Association (WNA) gave an insightful presentation on what can be done with materials from the decommissioning of nuclear reactors. The presentation showed that, although the volumes of waste generated seem large, they are in fact small compared to the conventional recycling market and should not have much impact on operations. The main issue surrounding the recycling of these materials is acceptance, both from a public and a legal perspective which are needed to promote a sustainable route for the recovered materials. Georg concluded that recycling is the most practical and affordable process to minimise the environmental impact. Several questions were raised following the presentation about the issue of public acceptance in Germany of recycling metal that has been cleared for release. The main reason for the current public acceptance is that nothing has happened to generate distrust. A comment was also raised about the limited scale of materials from the nuclear industry. The small volumes of metal generated could deter the conventional waste market from accepting the perceived risk of recycling cleared metals from the nuclear industry.

2.2 Session A - Regulations and recommendations

Maria Lindberg of Studsvik in Sweden chaired the first session.

2.2.1 Clearance and recycling – how can radiation protection and application of the waste hierarchy be optimised?

Simon Carroll from the Swedish Radiation Safety Authority (SSM) gave a presentation on how radiation protection principles and requirements for safety can be combined with the Waste Hierarchy to safely optimise the management of waste from the decommissioning of nuclear facilities. Simon noteed that clearance is the point at which influence from the regulator is lost, so continued good practice is vital. He showed that clearance is entirely consistent with radiation protection requirements and offers possibilities for sustainable materials management in line with the Waste Hierarchy. In order to fully optimise the minimisation of radioactive waste a number of factors should be considered by the waste producer at an early stage, preferably the pre-planning stage. A question was asked about whether interim storage can play a role in optimisation as the legislation can sometimes prevent this. Simon suggested that some barriers are inescapable but there is normally sufficient scope within the legislation to explore opportunities to optimise the waste management approach and fully understand the benefit that will be delivered. A comment was also raised that public perception can create difficulties in releasing recovered materials back in to the system and whether greater clarity of the process would ease this issue.

2.2.2 Regulatory aspects of clearance and recycling of metallic material forming part of buildings of nuclear facilities in Germany

In order to release metals from buildings to be decommissioned in Germany, clearance regulations for both the building and the metal waste stream need to be met. This raises an issue of how to perform clearance of metals without removing them from the building structure. **Stefan Theirfeldt** of Brenk Systemplanung GmbH, Aachen (Germany) provided an overview of a technique where one type of clearance procedure can be used to provide suitable information to comply with the clearance processes for both the building surfaces and the metal on the surfaces. By converting the

clearance level for buildings to a clearance level for metallic materials, significant savings can be made in time and effort for the overall clearance procedure.

2.2.3 Example of establishing the recycling of scrap metal as a waste management option within German regulations

Johannes Delfs of TÜV NORD SysTec GmbH & Co. KG presented an example of what is required to establish the recycling of cleared metal as a waste management option within German regulations. There are numerous steps in the German process including application and granting of a licence, confirmation that the material conforms to the licence, assessment by independent experts, approval by the supervisory authority and final review and approval by the facilities radiation protection officer. In order to complete this process, the regulatory authority has a series of requirements that the clearance procedure must comply with before approval is given. The experience has shown that, despite additional requirements, metals from a German facility can practicably be sent for treatment by metal recycling in a foreign EU member state. A question was raised as to whether the system was too complex. Although it looks complicated, providing the communication channels are in place and suitably understood and the regulatory requirements are fulfilled then there should not be a problem.

2.2.4 Application of regulation for recycling metals arising from decommissioning of an Italian nuclear facility

An example of how national regulations have been applied in Italy in order to recycle metallic material from the decommissioning of an Italian nuclear facility was presented by **Leonardo Baldassarre of SOGIN**. He described the current regulatory framework in Italy and used two examples to demonstrate the feasibility of unconditional removal of metals from nuclear facilities. The first example covered the removal of a steel tank located in an unclassified zone but within the perimeter of the nuclear installation, and the second related to the removal of metals from a controlled zone.

2.2.5 Suspension on release of uncontaminated scrap from DOE radiological areas current status and strategies for management – Replaced by an Overview of ndcon

Unfortunately, the presenter for the original presentation could not make the Sympoisum. As such, **Stefan Berbner** of Studsvik gave a presentation on the background of ndcon, the sponsors of the evening's dinner. Studsvik and Westinghouse have signed a teaming agreement to jointly offer a full range of decommissioning services for Nuclear Power Plants (NPP) in Europe, initially in Germany and Sweden. The cooperation will be marketed under the separate brand name of ndcon, a Nuclear Decommissioning Consortium by Studsvik and Westinghouse.

2.2.6 Group Discussions – Session A – Regulations and Recommendations

Four simultaneous discussion groups were held for each session. The notes from the discussion groups have been reviewed and combined in the summaries recorded in this section.

A) Is harmonisation of clearance regulations a good idea?

Harmonisation of clearance regulations across Europe was seen as wishful thinking, as in some countries there is variation even between federal regions. It was seen as a benefit as it would remove the perceived problem of cross boundary transfer of material that has been cleared in one country but would still be considered within nuclear regulation in another country.

B) Do the present clearance regulations support recycling?

As the regulations differ between countries, a varied response was received. Several countries were seen as having regulation that support recycling (UK, Germany and Sweden) and could even go further if the same standards for the non-nuclear industry were applied. Some countries (France) were identified as having regulations that did not support recycling. It was noted that regulations also reflect public opinion as the regulator's role is to enact the regulations set by the elected government. It was suggested that before the legislation is changed, levels of education surrounding the nuclear industry and radioactive waste should be improved to increase awareness.

C) How detailed should regulations be? Should details be developed by industry and then be approved by regulators?

The detail within the regulations was hard to agree given the varied approaches internationally. It was agreed that the role of the regulator in developing regulations is to apply the law and also reflect public acceptance transferred into law by government. Support from industry was seen as essential in optimising the methods undertaken to apply clearance levels within a set and regulated framework. The level at which clearance of material can be optimised will always be dependent on the nation's public acceptance of allowing this material to be recycled and a lot of the discussion centred around how industry can improve education of the nuclear industry. This, however, was seen as hard to do given the varied nature with which regulators treat radiation levels from other industries or incidents. More work should be done to harmonise the regulations across industries working with radiation to present a coherent message to the public.

D) Do present regulations and practices reflect the associated risks?

The main risk is from radioactive sources in the non-nuclear industry and from countries with poor controls at recycling facilities. As stated above there is a discrepancy between nuclear and other radioactive waste generating industries. The regulations are thought to poorly reflect the scientific and technical risks in various nations but can be said to be representative of the public perception of the risk without considering the final objective. It was noted that in the UK a lot of work has been done to show the benefits gained from clearance and recycling activities, not just in terms of cost but also in terms of environmental impact. This proved very useful when discussing the pros and cons of clearance and recycling of material from the nuclear industry.

2.2.7 Conclusion of the Day

The day was concluded with a buffet dinner served at Horsvik, the conference and hotel facilities adjacent to the Studsvik site. This was used as a superb networking event to allow delegates to discuss the day's proceedings and other industry news in a relaxed atmosphere.

3 Day 2 – Wednesday April 9th

3.1 Session B - Minimising waste amounts taking benefit of characterisation and categorisation

Håkan Lorenz of Barsebäck Kraft AB chaired session B providing an introduction for each presenter.

3.1.1 Clearance of materials, some experience from the UK

Pete Burgess from Nuvia in the UK started the session with an overview of a project designed to clear waste expected to be clean, i.e. there was no reasonable possibility that it could have been contaminated because it came from an area on the outside of a cell which was modern, well designed and where there had been no incidents. The aim was to identify any sample where the count rate generated was 2 sigma or greater than the appropriate reference background. Where this happened (about 1 time in 40), the sample was re-measured. The process allowed the release of the building contents for recycling, with the exception of some areas of the cell line and the actual process pipework, giving a large overall reduction in the cost of demolition, despite the relatively intensive monitoring effort. Following questions, Pete noted that this process resulted in several 1000m^3 of material to be cleared for conventional waste disposal.

3.1.2 Impact of metals recycling on a Swedish BWR decommissioning project

A review of some practical aspects gained by ndcon for recovering metals from a decommissioning project in Sweden was presented by **Arne Larsson**. Arne looked the requirements for implementing the Waste Hierarchy as part of an environmentally sound decommissioning project and presented ndcon's waste management concept flow chart. Arne focussed on four vital elements of the decommissioning project: the initial planning, inventory and characterisation, dismantling and waste treatment to show how focus on these aspects can reduce disposal volumes, and the total Decommissioning and Dismantling (D&D) costs. By giving a real example, Arne showed that the disposal volume of Very Low Level Waste (VLLW) and Low Level Waste (LLW) was reduced from 1800m^3 to 6000m^3. The figures and examples shown suggest that the recycling of metals from decommissioning of nuclear facilities is a proven, cost efficient and sustainable waste management approach but requires significant competence and a robust waste management structure within the project.

3.1.3 Management of metal arising from an Italian Nuclear Facility: techniques for clearance and unconditional release

Leonardo Baldassarre of SOGIN Spa presented an approach used in Italy to decommission an old drainage pipe and characterise the removed segments to allow the disposal of the material without any radiological constraints. A facility was set up on the site to size reduce, clean and characterise segments of the pipe based on a characterisation plan. The results show that 90% of the material is releasable without radiological constraints. The released material will be melted with metallic material from a non-nuclear origin at a ratio of 1 to 10.

3.1.4 Characterisation of contaminated metals using an advanced statistical toolbox

Per Lidar of Studsvik and **Yvon Desnoyers** of Geovariances looked at the role characterisation has to play in recovering contaminated metals from a decommissioning project. The presentation used the

active culvert at the Studsvik facility as a case study to show how combining statistical and geostatistical tools in a toolbox concept allows an improvement in project performance while reducing costs. As parts of the metal pipe network are difficult to access due to non-viable sections, alternative survey methods were required. Geostatistics proved to be an appropriate data processing tool providing better characterisation of contaminated materials and in particular metals. This led to better segregation for clearance, recycling, reuse or waste minimisation. One question was raised about how small objects within the pipe were accounted for as geostatistics does not do this. The project accounted for this through a preliminary check of the structures and a review of all historical documentation relating to the pipeline to identify any leaks that may have occurred.

3.1.5 Group Discussions – Session B – Minimising waste amounts taking benefit of characterisation and categorisation

Four simultaneous discussion groups were held for each session. The notes from the discussion groups have been reviewed and combined in the summaries recorded in this section.

A) What are the main obstacles for minimisation of radioactive waste?

- Time needed to characterise
- Perceived costs as opposed to the whole lifecycle costs (including interim storage and disposal repository design and build)
- Confidence in the characterisation regime
- Availability of technology
- Finding outlets for the characterised material
- Capacity of the supply chain to deal with the volumes generated
- Lack of a national strategy for diverting waste from disposal
- Social and public acceptance issues

B) What can or should be done to manage or eliminate the obstacles?

- Communication is seen as key to reducing the obstacles
- A national strategy such as the UK Nuclear Decommissioning Authority's (NDA) provide focus for the industry and allows a common set of goals to be driven through the industry
- Another tool is a demonstrable and clear option selection process that takes in to account all Political, Environmental, Social, Technical and lastly Economic factors (PESTLE)
- Industry best practice guidelines can provide a standardised approach to improve confidence in the approach used
- Leadership within organisations and nations to drive minimisation as an acceptable approach
- Planning for waste management operations before decommissioning begins
- Opening up opportunities for different types of waste management options to provide a greater "toolbox" for treatment and minimisation. This can be done through an active supply chain and an eagerness to support a culture of minimisation

C) Can waste minimisation lead to negative consequences and how can they be avoided?

The main negative side effects can only occur through poor planning. These were identified as:

- Financial impact as too much characterisation can increase costs for little benefit
- Minimisation can lead to difficult secondary wastes or orphan wastes that have no identified disposal route
- Delays in site clearance compared to a baseline of direct disposal
- Increased radiation dose for the additional effort
- Characterisation allows increased segregation of wastes which results in numerous waste routes that all require organisation

D) How can methods for characterisation and categorisation be used (or developed) in order to facilitate waste minimisation?

- Clear understanding of the waste to be disposed of allows detailed planning and optimisation of waste minimisation.
- Good characterisation also gives robust evidence that the correct waste has been diverted and that it is safe to do so
- By decreasing the radioactive portion of waste to be managed, characterisation can facilitate an increased rate of clearance from site by reducing the protocols required for disposal or treatment
- Characterisation supports good communication with the supply chain to allow waste to be handled safely and minimising contract variations by reducing the risks associated with treatment.

3.2 Session C (parallel) Decontamination and melting of metals for clearance, reuse or volume reduction

Session C was chaired by Gunnar Hedin of Westinghouse.

3.2.1 Technical possibilities to support separation of radioactive elements from metallic waste

Guozhu Ye from Swerea MEFOS AB presented the potential of using metal melting to remove surface contamination from metals due to the nature of certain radionuclides and their tendency towards separation into the melt by-products. Using Thermodynamics, it was shown that Am, U, Pu and Zn are separated during melting. Thermodynamics also explains that Co-60, and all other cobalt radioisotopes, will stay in the molten metal when melted under standard conditions in air. Creating a synthetic slag that specifically attracts these elements in a low concentration solution is not trivial. However, in the non-nuclear metals treatment industry the use of ladle furnaces, synthetic slags and gas bubbling through the metal is widely used. Further research may lead to an opportunity for better separation of elements with radioisotopes during the melting process.

3.2.2 Metallic surfaces decontamination by using LASER light

Fabrice Moggia of Areva presented an overview of research being conducted to use LASER light to decontaminate metal surfaces. The aim of the work was to demonstrate the benefit of such technology as a new tool for the nuclear decontamination industry. To do that, several tests were performed, in both laboratory and industrial conditions, firstly with non-active material in order to validate the process and secondly with nuclear material to determine its efficiency. The results showed a promising efficiency and in many cases, higher than those obtained with conventional techniques. An important advantage is that no secondary wastes, such as abrasives or chemicals, were generated and therefore it can be defined as a "dry" process. The addition of a vacuum system also allows contamination to be captured onto HEPA filters, thus avoiding any cross contamination in the room where the process takes place.

3.2.3 Nuclide distribution in the metal recycling process

Per Lidar of Studsvik gave an overview of the experience gained at Studsvik's metal melt facility from analysis of treated metal since 1987. The purpose of the study was to investigate and understand the real nuclide distribution in the melting process in order to obtain a good characterisation of the inventory, support the clearance process of the ingots, create less conservative nuclide vectors for the secondary waste and give better guidelines to decommissioning projects. The goal is to establish an accepted formula for the nuclide distribution during the melting process. Based upon analysis of the extensive dataset and the experience developed during operation of the facility, it was shown that improved models for the nuclide distribution during the melting process can be developed.

3.2.4 Assessment of radioactivity inventory - a key parameter in the clearance for recycling process

Due to a late cancellation, Klas Lundgren of Studsvik agreed to present a previously prepared presentation on the need to understand the radioactive inventory of a waste management project and how this is essential to allow sufficient planning in order to optimise the waste generating process. A good knowledge of the radioactive inventory also allows the project to demonstrate safe handling, support development of business case where investment is required, allows safe transport and allows appropriate treatment options to be considered. Klas provided some insight in to the terms required to be able to complete an inventory analysis of a reactor core as well as examples of where this has been carried out. Klas concluded that existing models are of a good standard and can be validated from measurements in "easy" areas but that further effort may be required to reduce uncertainties and to validate inventory assessment models.

3.2.5 Group Discussions – Session C - Decontamination and melting of metals for clearance, reuse or volume reduction

Due to a shortage of time, the group discussion for Session C was cancelled.

3.3 Session D (parallel) Sustainability and public acceptance

Britt-Marie Drottz Sjöberg, Norwegian University of Science and Technology, NTNU chaired session D.

3.3.1 The Importance of Recycling

An overview of the conventional waste industry's approach to recycling was given by **Jöns-Petter Svensson**, KAABS Nordic AB. This insight focussed on why recycling in everyday life is essential to minimise the impact of our activities on the environment and to provide a sustainable resource for future generations. Jöns-Petter also showed that recycling instead of mining and processing virgin materials results in a 500 million ton reduction in annual CO_2 emissions. The key enablers to allow recycling to succeed were identified as:

- Matchmaking – identifying a customer for the produced materials
- Analysis – understanding what has been put back in to the system
- Regulations – understanding the regulations that need to be adhered to
- Transportation – minimising this will further save CO_2
- Knowledge – understanding how the recycled materials can be used in a global market for recovered materials

Increasing recycling is the only way forward if we want to minimise our impact on the environment. It is a well-known and well defined process but requires commitment, agreement and leadership to decide to get the job done.

3.3.2 Metal Recycling in the UK - a decade of developments

Joe Robinson from Studsvik gave a summary of metal recycling in the UK. The presentation showed a timeline of developments starting with the crisis situation that the UK's only LLW disposal route was close to full. From this situation Joe showed how the UK has developed to protect the Low Level Waste Repository (LLWR) as a nationally strategic resource by instigating, developing and supporting a waste treatment supply chain that diverts waste away from disposal to waste treatment and minimisation routes. A key factor in the success of this strategy is the formation of the NDA which has a remit to develop and implement a strategy to drive a cultural shift in the industry from operating facilities to correctly managing the waste generated. Joe showed how Studsvik have supported this development from concept testing and analysis to the current situation as a leading supplier of waste treatment services in the UK.

Joe finished with lessons learnt from the delivery of this strategy, showing the environmental and financial benefit this has delivered to the UK tax payer, saving an estimated £10 million to date. By engaging with the community and showing the benefits, the conclusions of the presentation were that policy and strategy supporting the Waste Hierarchy is essential and that demonstration projects can support this by increasing confidence in the available techniques. Furthermore, disposal prices

need to be at least equal to true costs of disposal (whole lifecycle costs) and financial incentivisation of the waste generating sites has provided the biggest impact on metal recycling. A question was asked about the outlets for clean metal in the UK, but this has not been an issue as the UK nuclear industry has sent cleared metals for recycling for a long time and the scrap metal dealers understand that these materials are legally exempt.

3.3.3 Recycling of rare metals from the decommissioning of nuclear facilities

Jan Philipp Dabruck, RWTH Aachen University, Germany gave an overview of a project looking at strategically important rare metals present in nuclear facilities and whether they are economically recoverable. The project aimed to identify and quantify the relevant metals in components, assess the spread of radioactivity across these components to understand how easy it would be to recover these materials and for those that are contaminated, whether they can be decontaminated for recovery. Following this desk study phase, the process for recovery of the metals will be assessed to determine the economic viability of the metal recycling programme. Based on the high degree of public acceptance for recycling in Germany it is also anticipated that there will be strong public acceptance for such a venture. The outcome of the study should be a decision as to whether recycling the rare metals is technically feasible and of economic interest.

3.3.4 Considerations for disposition of dry cask storage system materials at end of storage system life

Robert Howard from Oak Ridge National Laboratory, USA looked at the dry cask storage systems deployed at NPP for Used Nuclear Fuel (UNF) storage. An important consideration arising from the increasing use of these systems is management of the dry cask storage systems' materials after the fuel is disposed of. Based on current designs it is not expected that the casks can be used for disposal and are not adequate for transport. This means that the 1850 canisters already packed and the 200 per year currently planned to be loaded will need to be recycled or disposed of when the fuel is packed into the final containers for disposal. The concrete horizontal storage modules or vertical storage overpacks will need to be reused, repurposed, recycled, or disposed of in some manner. The empty metal storage canister/cask will also have to be decontaminated for possible reuse or recycling, or disposed of as LLW. These material disposition options can have a significant impact on the cost of the overall used fuel management system.

3.3.5 Group Discussions – Session D - Sustainability and public acceptance

Two simultaneous discussion groups were held for session D. The notes from the discussion groups have been reviewed and combined in the summaries recorded in this section.

A) What is the role of international organisations and national regulators in gaining public acceptance for clearance?

The role of governments was seen as more significant than that of international organisations as they are responsible for policy setting and the regulatory regime. International organisations are still important due to the international nature of the metal market. Public acceptance requires education about the industry as well as leadership, incentives and a desire to recycle across the industry at all levels of public engagement.

B) How far should the industry go in demonstrating sustainability and gaining public acceptance?

Industry can play a role in educating the public to improve confidence in the industry that material can be safely managed. Several examples were given of facilities that have opened their doors to the public to allow them to get an appreciation for the processes involved. The primary method industry can use to gain public acceptance is "getting it right." Negative information is known to weigh heavy and stay in the public conscience longer than positive information as this just confirms what people already know. As such a continuous focus on quality and demonstrating the benefits that can be gained from clearance and recycling is required.

C) Does public opinion care about recycling from nuclear industry?

Public opinion does care when it impacts their community. Not In My Back Yard (NIMBY) is used to reference the general stance people take with regard to operations. This can actually have a positive effect; in the UK one of the drivers for recycling is to prevent the need for a second repository as the process to site and develop a new facility is seen as prohibitive. It was also noted that public opinion is represented to some extent within the regulatory framework that recycling is carried out as this is set by an elected government. Furthermore, showing that all PESTLE factors have been considered and that a systematic approach has been used to come to a decision can help show that all considerations have been assessed.

D) Do orphan sources in the scrap market destroy the confidence in recycling material from nuclear industry? Do the public understand the difference?

One negative event can lead to a massive change in public perception. Regardless of how well the national system works, global events will also have an impact on the acceptability of the process. This is where international organisations can play a cross industry role in standardising quality.

3.4 Session E Optimization of waste and materials disposition – policy, strategies, and techniques

As part of the NEA's forward plan of work on the optimisation of waste management approaches, Session E was dedicated to the subject of optimisation. This will support an upcoming project and was intended to drive debate on how waste management within the nuclear industry can be optimised. The session was chaired by Claudio Pescatore, OECD/NEA.

3.4.1 Waste management for decommissioning of nuclear power plants - An EPRI decommissioning project report

Rich McGrath of the Electric Power Research Institute presented an overview of metal disposal options and strategies in the US based on disposal volumes. The decontamination of metal is not typically cost effective in the US due to the large areas available for waste disposal, thus providing a cheap disposal route. For large volumes and components the strategy is limited to transport considerations and whether size reduction is required to enable shipment of an item for disposal. Waste management plans are used to optimise site activities and prevent bottle necks for the site clearance. Metal is recycled in the US when the criteria of no detectable activity is met. Some decontamination techniques have also been used but this is dependent on the cost benefit for the

process. Metal melting was also used in the US but public concern regarding the release of radioactivity into the metal stream has caused the Department of Energy (DOE) to suspend the unrestricted release of all scrap metal from radiological control areas at their facilities, however some metal is reused within the nuclear industry. A question was raised about whether the DOE suspension would be lifted, several attempts have failed due to public pressure.

3.4.2 The legal and policy framework for waste disposition

The Legal and policy framework for LLW treatment and disposal in the UK was reviewed by **Jonathan Leech** of Dentons. Jonathan showed how the Waste Hierarchy is applied to LLW in the UK through the 2007 Policy for the Management of LLW. He also showed how various other regulations combine to ensure the application of the Waste Hierarchy and minimisation of LLW is achieved through consideration of Best Available Techniques (BAT) and the Proximity Principle. Following this, the UK strategy for the Management of LLW from the nuclear industry was developed by the NDA and the policy was implemented by the LLWR. The strategy identified the application of the Waste Hierarchy, preservation of LLW disposal capacity and the development of treatment and disposal routes as being core principles to delivering the policy requirements. Jonathan summarised the issues faced in the UK with international nuclear liabilities conventions and how this has impacted the development of disposal of VLLW to conventional Landfill. The LLWR has had to take charge of the waste in order to assume liability under express contract terms. This prevents future claimants from being able to claim against multiple licenced sites.

3.4.3 Ensuring robust decisions and deployable solutions in UK LLW management

Matthew Clark from the UK NDA provided an overview of the NDA's role in the management of LLW in the UK. The NDA is a public body that was created in 2004 to ensure that nuclear legacy sites are decommissioned safely, securely, cost effectively and in ways that protect the environment. The diminishing capacity of the LLWR became somewhat of a crisis in the UK and required significant effort to ensure operations could continue safely. In response the NDA developed the Nuclear Industry LLW Strategy and a robust supply chain that protects the remaining disposal void. The core values of the strategy being application of the Waste Hierarchy, making the best use of existing assets and opening and using new routes. The strategy introduced several new treatment and disposal options including metal treatment, incineration and VLLW disposal to landfill. This increased choice requires a greater number of decisions and a set of tools for demonstrating how the selected route was chosen. Key to the decision making is to first work out what you "could" do and then work out what you "should" do. The NDA demonstrate how these decisions are improving the situation using benefit realisation to show how the choices being made are for the better. The LLWR coordinates waste activities in the UK on the NDA's behalf as well as providing guidance and improvement activities to drive a change in culture in the industry. All this has resulted in a 2 ½ year extension to the life of the LLWR so far.

3.4.4 Optimization of waste and materials disposition in France – policy, strategies, and techniques

Michel Dutzer of Andra, France gave an overview of the current situation in France before looking at the challenges to minimise waste for disposal. France has several disposal sites for various radioactive waste streams and utilises the concept of "zoning" to minimise the radioactive waste

generated. Zoning identifies areas that could not be contaminated and allows disposal of the relevant waste by conventional means. Areas that may be contaminated are treated as producing radioactive waste with no free release through clearance. The main challenges in France are the disposal of large components and the need for increased disposal capacity for VLLW.

The Planning Act of June 2006 related to the sustainable management of radioactive materials and waste confirms the implementation of a national plan for the management of radioactive materials and waste. The plan states that disposal should be considered as a rare resource. For VLLW this means several treatment options are preferred including the densification of waste, densification of the disposal facility, re-use of concrete scrap to backfill disposal cells and recycling of metallic wastes. In France, recycling of metal is performed within the nuclear industry with the recovered metal used for radiation protection or in containers for waste disposal. Unfortunately there is limited need for these products so opportunities within nuclear new build are being considered. The major challenge is the cost competition with direct disposal and the sensitivity to constraints derived by the interpretation of the French regulation.

3.4.5 Group Discussion – Session E - Optimization of waste and materials disposition – policy, strategies, and techniques

Four simultaneous discussion groups were held for each session. The notes from the discussion groups have been reviewed and combined in the comments recorded in this section.

A) Recycling to open market is widely adopted in society – should the nuclear industry be an exception? If so, for what reasons?

The two options presented during the session were discussed, to recycle and release without restrictions or to recycle and reuse within the nuclear industry itself. The views of different countries has a big impact on how recycling from the nuclear industry is received. The countries that have a business case to support recycling and release generally accept that it can be implemented. In contrast, once a nation has adopted the position that material cannot be released from nuclear sites for unrestricted useit is very difficult to reverse this decision, as seen in the US and France. Recycling is only one of a range of options that the Waste Hierarchy proposes with prevention seen as the preferred option. The differing requirements and views of countries on the release of materials from nuclear sites means this is a difficult question to resolve.

B) Can regulations be simplified to increase metals recycling from the nuclear industry? How?

In order to simplify regulations, it was suggested that they should first be made consistent across the industries producing radioactive wastes. The focus should be on safety, but there was a long discussion on setting safe limits and particularly what can be considered as safe, i.e. industry levels vs. dose levels received by airline personnel. It was also noted that the regulations are merely an extension of the law and therefore this should be considered before trying to simplify regulations.

C) What should be the right decision making framework and evaluation criteria between recycling and disposal? Cost, environmental concerns, social burden, etc.?

There was a short discussion around what criteria to use when making a decision to recycle. In several countries the decision making appeared to be a balance of cost vs. dose or cost vs. an overall risk. Wider criteria were identified that incorporate the societal aspects and environmental considerations. These should all be considered when determining the best approach to dealing with the waste.

3.4.6 Conclusion of the Day

The day was concluded with the Symposium dinner at Nyköping Castle.

4 Day 3 – Thursday April 10th

4.1 Session F Best practice in management of metals for clearance and recycling

Arne Larsson of Studsvik chaired the final session of the symposium.

4.1.1 Utilization of external capacities as an integral component of concepts for residues and dismantling using the example of the CARLA plant

The session was opened with a presentation from **Thomas Kluth** of Siempelkamp Nukleartechnik GmbH, Krefeld, Germany on the capabilities of the CARLA plant to treat metals as part of a range of options to support the expected increase in D&D projects in Germany. Thomas gave an overview of the facility acceptance conditions and the capabilities offered at the facility to recycle metals from the nuclear industry. Roughly half of the metal treated in Germany has been used to manufacture items for use in the nuclear industry with the majority of the remaining metal re-used outside the nuclear industry after satisfying release criteria. The use of this type of facility provides benefits to both the D&D project by increasing flexibility and the environment by minimising the volume of waste for disposal. Several questions were asked about the operations and the strategies employed. It was noted that decay storage was used for suitable nuclide fingerprints and where there was sufficient volume to make the storage time worthwhile. It was also noted that they have had no issues with public acceptance and maintain good stakeholder relations.

4.1.2 Gained experiences concerning the treatment of radioactive metal scrap from German NPP's

Boris Westerwinter from Gesellschaft für Nuklear-Service mbH (GNS) gave an insightful presentation on some of the experiences and lessons learned from the treatment of radioactive metal from Germany's NPPs. GNS's objective is to maximise the recovery of recyclable material while minimising the amount of radioactive waste. It achieves this through various support activities for waste producers that help reduce processing time and costs. Their experiences highlighted how materials that are poorly prepared can result in additional waste and delays to projects from non-conformances. Appropriately prepared materials can also be transported with less risk and in correct packages. Boris showed the benefits of metal melting, clearance and other volume reducing treatment techniques to decommissioning programmes, concluding that the metal melting process represents a highly efficient and future-oriented means of treating radioactive metals. Following questions, it was mentioned that with the changing German market the need for a range of waste

minimisation options is crucial and that the demand for metal melting will only increase as more D&D projects come online.

4.1.3 Treatment of Berkeley boilers in Studsvik – Project description and experiences

An overview of the Berkeley boilers transport and treatment project was provided by **Björn Amcoff** of Studsvik. This flagship project in the UK required the transport of fifteen decommissioned boilers from the Berkeley nuclear licensed site in the UK to Studsvik's facility in Sweden for metal treatment and recycling. A key objective of the project was to remove boilers from site by 31st March, allowing just five months to complete all permissions, design, preparatory, lifting and transport activities. The first five boilers were processed in 2012 and seven of the second batch of ten have now been completed. The project has faced many challenges including a very tight time schedule and both have been successfully delivered to cost and ahead of the baseline programme. Some of the key lessons shared were the need for early evaluation and engagement with the preferred waste management provider in order to minimise issues during transport and treatment. By having this early engagement, key decisions were made that allowed the project to be delivered in a very tight time schedule without any issues or incidents. A question was raised about whether asbestos had been an issue but due to the early involvement, it was a known issue and therefore was easily dealt with using standard asbestos stripping practices.

4.1.4 Some impacts of melting scrap for the decommissioning of nuclear power plant Stade

Georg Bacmeister from E.ON Kernkraft GmbH, gave a presentation looking at the lessons learnt from recycling metal from a decommissioning project in Germany. The NPP Stade was shut down in 2003 and so far has produced 13,000t of material, of which one third has been sent for metal melting. From examining the project several criteria have been identified that determined the treatment or disposal method of the material being generated. These were:

- Acceptance criteria of the desired service facility
- Expected decontamination result of the desired treatment
- Geometric properties of the scrap – smaller articles that could not be cleared directly were sent for melting
- Availability of the desired service facility
- Process reliability and stability
- Long-term aspects – chemically inert secondary waste suitable for long term storage prior to disposal
- On-site or off-site treatment
- Cost and efficiency of the process

The above criteria have influenced the waste management options for Stade NPP. Two questions were asked regarding whether facilities were available on-site for pre-treatment. Georg stated that there are a set of installations on-site for cutting, grit and water blasting but compaction and incineration are completed off-site. Georg was also asked if he would have done anything different in hindsight. He responded by saying that the main aspects of the project would remain the same but certain details regarding the implementation of new processes on-site would have changed.

4.1.5 Panel discussion

Following completion of the sessions, a panel discussion was held where the audience could ask questions they may have from the entirety of the symposium to some of the presenter's from the various sessions. The panel was made up of:

- Vladimir Michal, Head of Waste Technology at the IAEA
- Claudio Pescatore, Principal Administrator for Radioactive Waste and Decommissioning at the OECD/NEA
- Jonathan Leech of Dentons Law Firm
- Oliver Karschnick, Ministry of Energy, Agriculture, the Environment and Rural Areas of Schleswig-Holstein (MELUR)
- Stefan Berbner President of Consultancy Services, Studsvik
- Michel Dutzer of ANDRA

A summary of the questions and answers is presented below.

Q1) What has changed in the industry since the last symposium in 2012?

It is obvious that the decommissioning market is growing with more demand for safe technologies that offer both cost and disposal volume savings. Metal melting is seen as one of the safe and financially viable options that can play an important role in the clearance process. The markets have also changed to focus more on recycling. Different countries have taken different approaches (examples given were the UK's centralisation of the waste treatment market to support growth of a supply chain and France's approach to recovering metals for use within the nuclear industry) but all have sought to embed recycling as a tool for the minimisation of radioactive material produced. Another major change has been the way in which waste management options are assessed and selected as more countries look to take all considerations (political, environmental, social and technical) into account as well as considering whole life costs, not just direct comparison with disposal. Post-Fukushima, some of the major changes are still occurring, especially in Germany where one of the main changes is seen as the need to provide greater explanation and substantiation of the treatment process and plant is required in order to maintain public acceptance of the treatment route.

Q2) When our Grandchildren look back, will they be proud of what we are doing?

One panel member hoped that our grandchildren thought we were crazy, certainly from a German perspective where the public perception of the nuclear industry has shifted so quickly due to the Fukushima incident. Another panel member hoped the opposite but also expected they would ask why we accepted so many inconsistencies across the industry. It was thought they may laugh at what we did with our "primitive" technology but it was certainly hoped that what we do now will help them in the future and reduce the issues they have to contend with.

A comment was made from the audience that the UK's approach of Care and Maintenance of the Magnox fleet of NPP's for 70 years to then expect out grandchildren to clean up our waste is ethically unacceptable especially as other countries are showing it can be done now.

Q3) Do we need more melting capacity?

Frances perspective was yes even though they already have one. The UK's perspective was that as there was no melt facility in the UK, the key challenge of the industry is sufficient planning and clear understanding a when the material will arise in order to make the best use of the available facilities. The difficulty is generating a business case for the development of new facilities without the visibility of future demands. However it was expected that commercial pressures would compel market providers to provide additional capacity.

Q4) How will the Basic Safety Standards (BSS) develop in the future for clearance levels?

This was seen as a very tricky question as there is no way of knowing how these will be translated into legislation but it is hoped that, in each country, sufficient involvement of all interested parties will ensure the legislation developed is suitable. Transparency and consistency will be required across all industries, not just the nuclear industry as steel from other industries is never considered as a risk but has the same potential to be contaminated.

Q5) When considering recycling within the nuclear sector (metals used for new nuclear industry products), is there sufficient capacity for the use of this material or is an open market required?

This is a real challenge. It is very difficult to find outlets within the nuclear industry and will still remain an issue for future generations to deal with. However, if there are not enough outlets does recycling within the conventional scrap metal industry create a problem for the general market? It was suggested that we could inadvertently distort public opinion by not releasing material that has satisfied the free release criteria.

Q6) When will we have harmonised clearance levels in Europe?

A short answer of "Never" was given. The BSS is seen as a start for allowing all countries to set their own limits. A lot of discussion is needed before the BSS are set though as no consideration as no consideration has been given to how different limits across Europe will affect the metal market. This is also an opportunity for regulators to discuss this at a national level and try to agree an approach. The main issue is that when metal enters the market, it is free to be transported across borders so a different approach may be needed.

4.2 Summing up of sessions and group discussions Symposium closing

Following the Panel Discussions, a summing up session was presented. Each of the chairs from the various sections was asked to return to the panel to provide an overview of the session and provide any conclusions or comments drawn from the symposium. Following this, Arne Larsson reviewed the aims of the Symposium: Learn, Share, Build networks and Enjoy concluding that all 4 objectives had been met. Arne then thanked all the presenters and the team responsible for organising such a well run event. Following the close of the symposium, attendees were invited to take a tour of the

Studsvik facility to see some of the treatment solutions that had been discussed over the course of the symposium in action.

5 Poster Session Summaries

Throughout the Symposium, a number of posters were displayed in the lobby of the lecture hall. The posters are summarised below.

From non-disposable to disposable, treatment of pyrophoric or gas forming waste forms for disposal
Carl Österberg, Maria Lindberg, Studsvik
In order to dispose of waste in either a deep geological disposal or in a shallower repository there are several demands that the waste and its package must fulfil, one is that it is not to react with oxygen or the waste package or backfill in the repository, i.e. concrete or grout. The poster looked at treatment of materials in order to meet these criteria.

Management of zirconium rod claddings with the process of electrochemical breakdown
Yury Pokhitonov, V. G. Khlopin Radium Institute
One of the waste types formed during reprocessing of irradiated nuclear power plant fuel is fuel element claddings. The most commonly-used method of isolating spent fuel claddings is to encapsulate them in concrete and inter them in metal containers. The poster investigates the process of electrochemical dissolution of fuel rod claddings in nitric acid solutions. A successful outcome to this task would enable zirconium separated from claddings to be utilised during encapsulation of high-level waste in a matrix based on zirconium dioxide with a high level of chemical stability.

Treatment and conditioning of metallic intermediate level waste
Per Lidar, Tommi Huutoniemi, Eva Blank, Studsvik, Mattias Elfwing, SKB
In 2011 SKB started an R&D program for evaluating different disposal concepts for Long Lived – Low and Intermediate Level Waste (LL-LILW). The purpose was to develop alternative repository concepts and conditioning methods for LL-LILW and to evaluate and compare them from a range of parameters. Studsvik was assigned to investigate whether melting of metallic LL-LILW is technically feasible and, if so, what the requirements are to build and operate such a facility.

RPV in-situ segmentation combined with off-site treatment for volume reduction and recycling
Arne Larsson, Per Lidar, Studsvik, Per Segerud, Gunnar Hedin, Westinghouse Electric Sweden AB
Decommissioning of NPPs generates large volumes of radioactive or potentially radioactive waste. Proper management of the large components and the dismantling waste are key success factors in a decommissioning project. This case study uses proven technology and shows that

- RPV in-situ segmentation combined with off-site treatment will open up for clearance and recycling
- Disposal volume can be reduced with at least 90%
- More than 70% of the metal can be subject for clearance and recycling

Setup for electrochemical decontamination of metal surfaces
A Belozub, D Shafikov, A Klyushkin, V Suzdalev, Mikhal Alyapyshev, V. G. Khlopin Radium Institute
This poster looks at the use of electrochemical decontamination by dissolution of a thin layer of the metal surface. The main goal of the work is to develop new equipment that offers a higher efficiency of electrochemical decontamination.

Foam decontamination of metals
D Shafikov, A Belozub, A Klyushkin, A Shafikova, V. G. Khlopin Radium Institute
Foam decontamination has been used to decontaminate radioactively contaminated surfaces. The foam offers a large volume of decontaminating medium while forming relatively small volumes of secondary liquid waste. This poster presents the results of two types of foam medium based on easily degradable surfactants.

Proven concepts for LLW metals - Treatment for waste minimization and recycling
Björn Amcoff, Bo Wirendal, Studsvik
The poster presents an overview of Studsvik's operations in Sweden. For the main stream waste treated at the facility in Sweden, Studsvik expect to free-release at least 95 % of incoming weight and return a maximum of 5 % of residual secondary waste.

Metals Characterisation by Facility Characterisation in support of Site Remediation and Decommissioning Projects
Gemma Laurie, Megan Carroll, Sellafield Ltd
The poster gave an overview of the facility characterisation programme on going at Sellafield. Facility Characterisation have delivered approximately 500 Characterisation Projects since 2010 supporting decommissioning planning, waste routing and disposal across all Operational, Infrastructure and Decommissioning areas of the Sellafield Site.

Beneficial Re-Use of Metal from Decommissioning of Power Reactors
Troy Eshleman, Graham Raw, Barry Moloney, EnergySolutions
The poster showed the beneficial re-use of metal from decommissioning of power reactors offers potential cost savings compared to disposal for lightly activated or contaminated metal and also eliminates the risk of future increases in cost for alternative disposal or recycling procedures.

6 Appendix A – Symposium Programme

Program

Recycling of Metals arising from Operation and Decommissioning of Nuclear Facilities

Studsvik, Nyköping, Sweden, April 8th-10th 2014

Tuesday April 8th

	Arrival
10.30 – 12.00	Registration Horsvik
11.00 – 12.15	Lunch Horsvik
12.30 – 13.00	**Symposium opening** **Studsvik auditorium**
12.30 – 12.35	*Welcome* Arne Larsson, Studsvik Nuclear AB
12.35 – 12-45	*Opening* Michael Mononen, CEO Studsvik AB
12.45 – 13.00	*Symposium information* Anders Appelgren, Studsvik Nuclear AB
13.00 – 14.00	**Invited presentations** **Studsvik auditorium**
13.00 – 13.20	*Overview of the IAEA supported decommissioning and waste management activities* Vladimir Michal (presenter), Vladan Ljubenov, International Atomic Energy Agency (IAEA)
13.20 – 13.40	*Clearance, reuse, recycle, disposal as VLLW* Claudio Pescatore, OECD Nuclear Energy Agency (OECD/NEA)
13.40 – 14.00	*Management of Materials from the Decommissioning of Nuclear Reactors* Georg Braehler, World Nuclear Association (WNA)
14.00 – 14.30	Coffee break Entrance hall

Tuesday April 8th (continuation)

14.30 – 18.00	**Session A** **Regulations and recommendations** **Studsvik Auditorium** **Session chair Maria Lindberg, Studsvik Nuclear AB**
14.30 – 15.00	*Clearance and recycling – how can radiation protection and application of the waste hierarchy be optimised?* Henrik Efraimsson, Anders Wiebert, Simon Carroll (presenter), Swedish Radiation Safety Authority (SSM)
15.00 – 15.30	*Regulatory Aspects of Clearance and Recycling of Metallic Material forming Part of Buildings of Nuclear Facilities in Germany* Stefan Thierfeldt (presenter), Stefan Wörlen, Philip Harding, Brenk Systemplanung GmbH
15.30 – 16.00	*Example of establishing the recycling of scrap metal as a waste management option within German regulations* Matthias Bodenstein, Johannes Delfs, TÜV NORD SysTec GmbH & Co KG Oliver Karschnick, Ministry of Energy, Agriculture, the Environment and Rural Areas of Schleswig-Holstein (MELUR)
16.00 – 16.30	*Application of Regulation for recycling metals arising from Decommissioning of an Italian Nuclear Facility* Giovanni Varasano, Leonardo Baldassarre (presenter), Edoardo Petagna, Sogin Spa
16.30 – 17.00	*Suspension on Release of Uncontaminated Scrap from DOE Radiological Areas Current Status and Strategies for Management* Richard Meehan, Xavier Ascano, U.S. Department of Energy (DOE) ☒ Presentation cancelled
17.00 – 18.00	Group discussions Rooms at Horsvik
18.30 – 22.00	Dinner buffet Horsvik

Wednesday April 9th

08.15 – 11.15	**Session B** **Minimising waste amounts taking benefit of characterisation and categorisation** **Studsvik auditorium** **Session chair Håkan Lorenz, Barsebäck Kraft AB**
08.15 – 08.40	*Clearance of materials, some experience from the UK* Pete Burgess, Nuvia Ltd Alan Fisher, RSRL Ltd
08.40 – 09.05	*Impact of metals recycling on a Swedish BWR decommissioning project* Arne Larsson (presenter), Per Lidar, Gunnar Hedin, Niklas Bergh, ndcon
09.05 – 09.30	*Management of metal arising from an Italian Nuclear Facility: techniques for clearance and unconditional release* Leonardo Baldassarre (presenter), Giovanni Varasano, Salvatore Gaetano Bruno, Sogin Spa
09.30 – 09.50	Coffee break Entrance hall
09.50 – 10.15	*Characterisation of contaminated metals using an advanced statistical toolbox* Per Lidar (presenter), Arne Larsson, Studsvik Nuclear AB Yvon Desnoyers (presenter), Geovariances
10.15 – 11.15	Group discussions Rooms at Horsvik
11.15 – 12.15	Lunch Horsvik

Wednesday April 9th (continuation)

12.15 – 15.15	**Session C (parallel)** **Decontamination and melting of metals for clearance, reuse or volume reduction** **Studsvik auditorium** **Session chair Gunnar Hedin, Westinghouse**
12.15 – 12.45	*Technical possibilities to support separation of radioactive elements from metallic waste* Johan Björkvall, Guozho Ye (presenter), Swerea MEFOS AB Maria Lindberg, Studsvik Nuclear AB
12.45 – 13.15	*Laser decontamination of metallic* Fabrice Moggia (presenter), L Objois, V Toulemonde, AREVA
13.15 – 13.45	*Nuclide distribution in the metal recycling process* Per Lidar (presenter), Maria Lindberg, Patrik Konnéus, Arne Larsson, Studsvik Nuclear AB
13.45 – 14.15	*Assessment of radioactivity inventory - a key parameter in the clearance for recycling process* Klas Lundgren (presenter), Arne Larsson, Studsvik Nuclear AB
14.15 – 15.15	Group discussions including coffee Rooms at Horsvik
12.15 – 15.15	**Session D (parallel)** **Sustainability and public acceptance** **Horsvik** **Session chair Britt-Marie Drottz Sjöberg, Norwegian University of Science and Technology, NTNU**
12.15 – 12.45	*The importance of recycling* Jöns-Petter Svensson, KAABS Nordic AB
12.45 – 13.15	*Metal Recycling in the UK - a decade of developments* Joe Robinson, Studsvik UK
13.15 – 13.45	*Recycling of rare metals from the decommissioning of nuclear facilities* Frank Charlier (presenter), Jan Philipp Dabruck, Aachen University
13.45 – 14.15	*Considerations for Disposition of Dry Cask Storage System Materials at End of Storage System Life* Rob Howard (presenter), Bret van den Akker, Oak Ridge National Laboratory
14.15 – 15.15	Group discussions including coffee Rooms at Horsvik

Wednesday April 9th (continuation)

15.15 – 18.00	**Session E** **Optimization of Waste and Materials Disposition – Policy, Strategies and Techniques** **Studsvik auditorium** **Session chair Claudio Pescatore, OECD/NEA**
15.15 – 15.40	*Waste management for decommissioning of nuclear power plants - An EPRI decommissioning project report* Richard McGrath (presenter), Richard Reid Electric Power Research Institute (EPRI)
15.40 – 16.05	*The Legal and Policy Framework for Waste Disposition The Legal and Policy Framework for Waste Disposition* Jonathan Leech, Dentons UKMEA LLP
16.05 – 16.30	*Ensuring robust decisions and deployable solutions in UK LLW management* Matthew Clarke, Nuclear Decommissioning Authority (NDA)
16.30 – 16.55	*Optimization of Waste and Materials Disposition in France – Policy, Strategies, and Techniques* Michel Dutzer, Andra
16.55 – 18.00	Group discussions Rooms at Horsvik
19.30 – 22.30	**Dinner reception** **Nyköping castle**

Thursday April 10th

08.15 – 11.00	**Session F** **Best practice in management of metals for clearance and recycling** **Studsvik auditorium** **Session chair Arne Larsson, Studsvik Nuclear AB**
08.15 – 08.40	*Utilization of External Capacities as an Integral Component of Concepts for Residues and Dismantling Using the Example of the CARLA Plant* Thomas Kluth, Siempelkamp Nukleartechnik GmbH
08.40 – 09.05	*Gained experiences concerning the treatment of radioactive metal scrap from German NPP's* Boris Westerwinter (presenter), Niemma Buckanie, Gesellschaft für Nuklearservice mbH (GNS)
09.05 – 09.30	*Treatment of Berkeley boilers in Studsvik – Project description and experiences* Dave Saul, Gavin Davidson, Studsvik UK Bo Wirendal, Björn Amcoff (presenter), Studsvik Nuclear AB
09.30 – 09.50	Coffee break Entrance hall
09.50 – 10.15	*Some Impact of Melting Scrap for the Decommissioning of Nuclear Power Plant Stade* Georg Bacmeister, E.ON
10.15 – 11.00	Panel discussion Auditorium
11.00 – 12.00	**Summing up of sessions and group discussions** **Symposium closing** **Studsvik auditorium**
12.00 – 13.00	Lunch Horsvik
13.00 – 17.00	**Guided tours on Studsvik site** Coffee available in Entrance hall

Poster session
Available throughout the whole symposium
Entrance hall

From non-disposable to disposable, treatment of pyrophoric or gas forming waste forms for disposal

Carl Österberg, Maria Lindberg, Studsvik Nuclear AB

Management of zirconium rod claddings with the process of electrochemical breakdown

Yury Pokhitonov, V. G. Khlopin Radium Institute

Treatment and conditioning of metallic intermediate level waste

Per Lidar, Tommi Huutoniemi, Eva Blank, Studsvik Nuclear AB
Mattias Elfwing, SKB

RPV in-situ segmentation combined with off-site treatment for volume reduction and recycling

Arne Larsson, Per Lidar, Studsvik Nuclear AB
Per Segerud, Gunnar Hedin, Westinghouse Electric Sweden AB

Setup for electrochemical decontamination of metal surfaces

A Belozub, D Shafikov, A Klyushkin, V Suzdalev, Mikhal Alyapyshev,
V. G. Khlopin Radium Institute

Foam decontamination of metals

D Shafikov, A Belozub, A Klyushkin, A Shafikova, V. G. Khlopin Radium Institute

Segmentation and packaging reactor vessels internals

Joseph Boucau, Westinghouse Electric Belgium SA

☒ Poster cancelled

Decontamination with wet blasting of components in nuclear power station for service or free release

Per Fagerström, Fagerström Industrikonsult AB

Poster session (continuation)

Proven concepts for LLW metals - Treatment for waste minimization and recycling

Björn Amcoff, Bo Wirendal, Studsvik Nuclear AB

Metals Characterisation by Facility Characterisation in support of Site Remediation and Decommissioning Projects

Gemma Laurie, Megan Carroll, Sellafield Ltd

Beneficial Re-Use of Metal from Decommissioning of Power Reactors

Troy Eshleman, Graham Raw, Barry Moloney, EnergySolutions