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Swedish Radiation Safety Authority

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Allocation of Decommissioning and Waste Liabilities

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Background

A crucial task for the present generations is to ensure that environmental liabilities are identified sufficiently well so that it may be possible to accumulate the corresponding necessary financial assets in the Swedish Nuclear Waste Fund. Adequate funding will provide forthcoming generation's with the financial means to decommission and dismantle older nuclear facilities that are part of the Swedish nuclear waste legacy.

It ought to be stressed that, if sustainability and long term credibility of the financing system shall be met, the necessary contributions to the fund need to be determined with a precision that provides a high degree of confidence that the accumulated total will balance the future environmental liabilities.

SSM undertakes reviews of crucial questions that may have an effect on these provisions. In order to enhance transparency and thereby introduce a spectrum of multi-disciplinary judgement in these areas, analytical studies are made by external and independent scholars.

Purpose of the project

The main objective of this study has been to find a defensible rationale for a methodology that will provide the basis of an equitable and fair allocation of environmental liabilities between two operators at the old uranium mine at the Ranstad site.

The report addresses the following tasks:

- The identification and analysis of potential approaches and concepts for the allocation of future costs for decontamination, dismantling and decommissioning.
- Within the frame of the Study a systematic presentation of advantages and disadvantages of some possible allocation approaches are articulated and commented upon.
- The approaches considered include volume of uranium processed, levels and types of radioactive contamination, space used over time and commercial benefit accrued over time, as well as the incremental cost of marginal contamination caused by one operator that is beyond that created by preceding operations/owners.

Results and Recommendations

The study gives a number of tentative statements:

- The work demonstrates that there are a number of methods available for cost allocation, the pros and cons of which are examined. The study investigates potential proportional and incremental methods in some depth. A recommendation in principle to use the latter methodology is given.
- It is concluded that a "fair assumption" is that the potential allocation of costs for "the RMA Leaching Hall" probably is small, in relation to the total costs, and estimated to be not more than about 175 kSEK, plus any costs associated with decommissioning/disposal of a number of small pieces of equipment added by the current operator.

Direct Benefits for SSM work

SSM can use the study as input for the calculation of an appropriate fee level for RMA according to the Financing Act (activity number 305 00 34-04). SSM also will be able to use the study as support to the yearly review of the cost estimates for the future decommissioning costs of the nuclear facilities that are subject to the Studsvik Act (activity number 305 00 32-00).

In addition, the findings of the report may be used as support to the work on developing terms-of-reference in regard to appropriate ways for licensee holders to assess, calculate and present more accurate cost calculations that are compulsory under the Studsvik Act (activity number 305 00 33-00).

Project information

At SSM Staffan Lindskog has with utmost determination and skill supervised and co-ordinated the project. At NAC International Geoff Varley has performed the research task with the highest standard.
SSM reference: SSM 2011-1337

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This report concerns a study which has been conducted for the Swedish Radiation Safety Authority, SSM. The conclusions and viewpoints presented in the report are those of the author/authors and do not necessarily coincide with those of the SSM.

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1. Introduction

The Ranstad Industricentrum AB (RIC) hosts a number of facilities formerly used mostly for the processing of natural uranium bearing shale. During its history there have been several owners of the site. The facilities are no longer in use and some clean-up activities have taken place. Until recently one of the facilities (the Small Leaching Hall) was used by, Ranstad Mineral AB (RMA), to chemically process wastes generated by nuclear fuel manufacturers and recover uranium (including enriched uranium) from them. RMA also used space in another facility (the Large Leaching Hall) for temporary storage of untreated and processed wastes.

The equitable allocation of decommissioning costs to the respective owners/users of the site and its facilities is the subject of this report. More specifically, the task is to determine a defensible rationale for what portion of the decommissioning and associated waste management costs (hereinafter referred to as D&D costs) should be allocated to RMA and/or RIC.

The usual contemporary approach to the allocation of D&D costs is guided by the Polluter Pays Principle, whereby the organization that caused the pollution pays for the corresponding D&D costs. This may sound simple in principle but, depending on the characteristics of a facility and the operations carried out in it, the basic polluter pays principle reasonably may be interpreted in different ways, including on the basis of proportionality (e.g. in proportion to the operational volumes over time for each owner/operator) or on an incremental basis (i.e. the incremental D&D costs incurred as a result of the operations carried out by the second owner/operator. The equitable allocation of costs may be complicated further when the condition of the site and facilities, and the associated D&D cost, was not established/estimated at the time when the succeeding owners/operators began their operations (as is the case at the Ranstad site).

This report addresses the following:

1. Identification and analysis of potential approaches to the allocation of D&D costs
2. Discussion of the pros and cons of each approach, taking into account reasonable and scientifically sound decision criteria

3. Recommendation of a rationale that is fair and equitable in respect of the portion of Ranstad D&D costs that should be allocated to RMA. The approaches considered and discussed include allocation based on:
    - Volumes of uranium processed
    - Levels of radioactive contamination in materials, surfaces and medias
    - Space used over time
    - NAC's knowledge of approaches used by other entities internationally, including:
        - Commercial benefit accrued over time
        - Incremental cost of extra contamination

2. Executive Summary

The subject of this report is the equitable allocation of D&D costs to the respective owners/users of the Ranstad site in Sweden. More specifically, the task is to determine a logical and defensible rationale for what portion of the decommissioning and associated waste management costs should be allocated to Ranstad Mineral AB (RMA).

POTENTIAL ALLOCATION METHODOLOGIES

It is now generally accepted that fundamental fairness requires that polluters take the steps necessary to abate their own emissions or pay for their cleanup (the polluter pays principle). For sites with multiple owners or operators there are two generic approaches that have been adopted to allocate costs:

- A proportional allocation method and
- An incremental allocation method.

Application of the proportional method might be straightforward if the extent of the residual clean up exercise were in proportion to the throughput of materials in the facility, for example at a non-radioactive chemical facility resulting in a quantity of process wastes and residues (with consistent characteristics) to be disposed of.

For a facility that has processed radioactive materials, adoption of the proportional approach is not necessarily so straightforward. If the additional contamination across a facility was not sufficient to either change the volumes of wastes generated in various categories (affecting disposal costs) and/or the effort required to decommission the facilities, the adoption of a proportional allocation of D&D costs could be seen as wholly unreasonable; i.e. a case could be made that the first owner should bear 100 percent of the D&D costs.

In the incremental approach, the second owner/operator would only be liable for the added (incremental) costs of remediation due to their operations at the facility. Even if a second operator processed a much larger volume of material than the first operator, the incremental impact on D&D cost could be small, or even zero. Application of a proportional approach in such a case could generate a very different allocation of costs compared to the incremental approach.

INTERNATIONAL REFERENCES

A small number of international cases have been identified where the owner or operator of a nuclear facility changed and these examples have been reviewed to determine how

costs were allocated. The nuclear power plant (NPP) sale examples investigated suggest that a principle of proportionality is the starting position for D&D cost allocations. However, such deals are different in nature to the RMA case at Ranstad in respect that they have been sold for use in the original manner intended and as sustainable, revenue and profit generating entities, tending to attract more than one bidder so the sale becomes an auction.

This is very different to the case of the small leaching hall at Ranstad, where the facility probably would have resided in a dormant state had RMA not leased the facility to support a completely different business activity to the one for which the facility originally was built.

One Illustrative Case

The United States uranium enrichment plants were built and operated by the government from the 1950's until the 1990's. Later they were transferred to a government corporation and then privatised. The parties involved in the transfer away from government agreed that the government's operations had contaminated all of the facilities and the future operations of the new corporation would not increase D&D costs for the facilities themselves. The only incremental contribution to cleanup costs would relate to the generation of uranium tails (in the form of UF_6), the disposal liability for which the corporation was required to accept. This an apparent example of the incremental method of allocating costs.

PRINCIPAL ISSUES FOR EVALUATION

There are a number of factors that can affect the most equitable way to allocate D&D costs between multiple site owners and operators. These include applicable law, contract conditions, operational scope and international precedents. Swedish law is designed to assure that remediation costs are paid by a responsible party, not to allocate the costs among the parties. Swedish law therefore is not helpful and does not influence the analysis.

Based on the stated contract terms provided to NAC alone, all costs, or possibly all costs except those that are demonstrably incremental and directly attributable to RMA's operations, would remain with AB Atomenergi and its successors. However, the remit given to NAC was to investigate potential methodologies that would be equitable, or fair, considering all of the facts. NAC's assessment follows.

The main issues to be resolved are:

- Should the D&D cost allocation to RMA in respect of the small leaching hall be based on a proportional or incremental basis?
- If an incremental approach were deemed to be the most appropriate, how should this be assessed given the fact that the condition of the facility and its associated D&D cost was not established prior to the beginning of RMA operations?
- If a proportional approach were deemed to be the most appropriate, what parameters would be relevant to the derivation of equitable cost allocations?

NAC INTERNATIONAL CONCLUSIONS AND RECOMMENDATIONS

It is NAC's opinion that an allocation of D&D costs based on space used over time is not an appropriate basis for allocating D&D costs. Allocation of D&D costs based on the relative economic benefit received during each party's period of operation (such as profits) equally does not seem to be meaningful. Both methods could arrive at extremely inequitable and unfair results.

RMA did install a number of small pieces of equipment that were incremental to the existing facilities. The cost of D&D for these specific pieces of equipment, whatever those costs turn out to be, should be borne by RMA.

In respect of all other aspects of the D&D program, it is NAC's view that, irrespective of the contractual arrangement, the most fair equitable methodology for assessing RMA's contribution would be on an incremental basis whereby RMA as a minimum would pay for any incremental contribution to D&D costs that may apply, subject to being able to assess this with some reasonable degree of confidence. Unfortunately the available base of information is not sufficient to derive a fully defensible cost allocation using this methodology, not least because the facility was not benchmarked at the time when RMA began operations.

NAC nevertheless has developed a simple methodology based on potential incremental contamination of the facility and its impact on D&D cost through extra D&D work as well as extra waste disposal costs. The analysis assumes that radiological mapping of the facility, general tidying of the facility prior to commencing decontamination and conventional demolition, would be unaffected by RMA operations. It is further assumed that the cost of D&D related overhead activities also would be unaffected.

The indicative range of incremental cost using this method (excluding the costs related to new equipment installed by RMA) is in the order of kSEK 54 to kSEK 84, equivalent to between 0.7 and 1.0 percent of the direct D&D costs for the RMA Leaching Hall. NAC believes that this estimate may be an overestimate of the real impact of RMA operations. If evidence-based values for any of the input parameters could be obtained, it would be possible to reduce the uncertainty.

Given the absence of reliable data to support an incremental methodology, it is appropriate to consider also a proportional approach. In fact this is a partial proportional approach since some parts of the D&D activities clearly would not be affected by RMA operations. NAC does not necessarily support the use of a proportional methodology at Ranstad but, if adopted, the recommended surrogate would be the volume and specific activity of uranium processed in the facility by the respective operators, for which recorded data is available. On this basis NAC has derived an estimated cost allocation of approximately kSEK 175, which represents about 2 percent of the direct D&D costs for the RMA Leaching Hall.

Irrespective of the allocation methodology applied, the assessed financial contribution by RMA is small compared to the overall D&D cost for the facility that they have been leasing.

One potential additional consideration to take into account relates to the RMA lease agreement for use of the RMA Leaching Hall and whether or not the payments under this agreement might provide grounds for offsetting the estimated RMA D&D liabilities against payments already made by RMA under the lease.

3. Ranstad Site History

The Swedish Atomic Energy Committee was formed in 1945 and one of its functions was to support the investigation of uranium recovery in Sweden. In November 1947 a semi-state owned company, AB Atomenergi, was formed to lead nuclear energy research and development. AB Atomenergi was 57 percent owned by the Swedish state and 43 percent by local government-owned and privately-owned electric power companies and industrial enterprises. The discovery and recovery of uranium from indigenous resources quickly became an important focus for this organization.

In 1958 a decision was made to build an industrial uranium recovery facility at Ranstad. The facility was to be constructed by AB Atomenergi to recover uranium from low-grade, alum shale with a mean concentration of only 0.03 per cent uranium. It was designed to process a large volume of shale (800,000 tonnes per year) corresponding to an annual production of 120 tonnes of uranium. The plant operated from 1965 to 1969 at a level well below the nominal design capacity (about 3/7 of the nominal). Thereafter the production continued at even lower levels. In the latter stages production activities essentially were on a pilot scale until about 1980 when production ceased. As early as 1965 there was an extensive focus on process improvements that were intended to reduce costs. This R&D continued until the mid-1980s when falling uranium market prices made it apparent that production was not likely to be economically viable.

The Swedish state acquired all of the shares of AB Atomenergi in 1969 and its name was eventually changed to Studsvik Energiteknik AB. In 1978 Ranstad Skifferaktiebolag (RSA) assumed ownership and became the operator of the Ranstad site. RSA was owned 60 percent by AB Svensk Alunskifferutveckling (ASA), 20 percent by LKAB and 20 percent by Studsvik Energiteknik AB. RSA continued to own and operate the site until 1987. Also in 1987 Studsvik Energiteknik AB changed its name to Studsvik AB.

AB SVAFO (SVAFO) was established under the Studsvik Act of 1988/1989 to coordinate and manage historical wastes generated primarily from government research activities. Its efforts, including remediation of the Ranstad site, were funded by the Nuclear Waste Fund in accordance with the Studsvik Act. Studsvik acquired SVAFO in 2003 and sold it back in 2009 to OKG and the Ringhals, Forsmark and Barseback nuclear power plants.

In the 1990s shares of Studsvik AB were transferred to the electric generating company Vattenfall. Businesses that were not related to nuclear power were sold or closed and Vattenfall eventually divested its ownership to private investment companies.

Ranstad uranium production during the history of operations by the organizations listed above has been reported[1] as 212.5 tonnes of (natural) uranium. NAC's understanding is that this amount corresponds to pure uranium rather than any other chemical form. Accordingly this has been the basis assumed for the analyses presented in this report. Recovery is estimated to have averaged about 67.7 percent, implying that the shale processed contained approximately 314 tonnes of natural uranium. Almost all of this material was processed during AB Atomenergi's ownership, as production during the RSA ownership period has been reported to have been negligible.

In 1987 RSA was sold and the company was renamed Ranstad Industricentrum AB (RIC). RIC is a 100 percent privately owned company that has maintained its ownership through to the present.

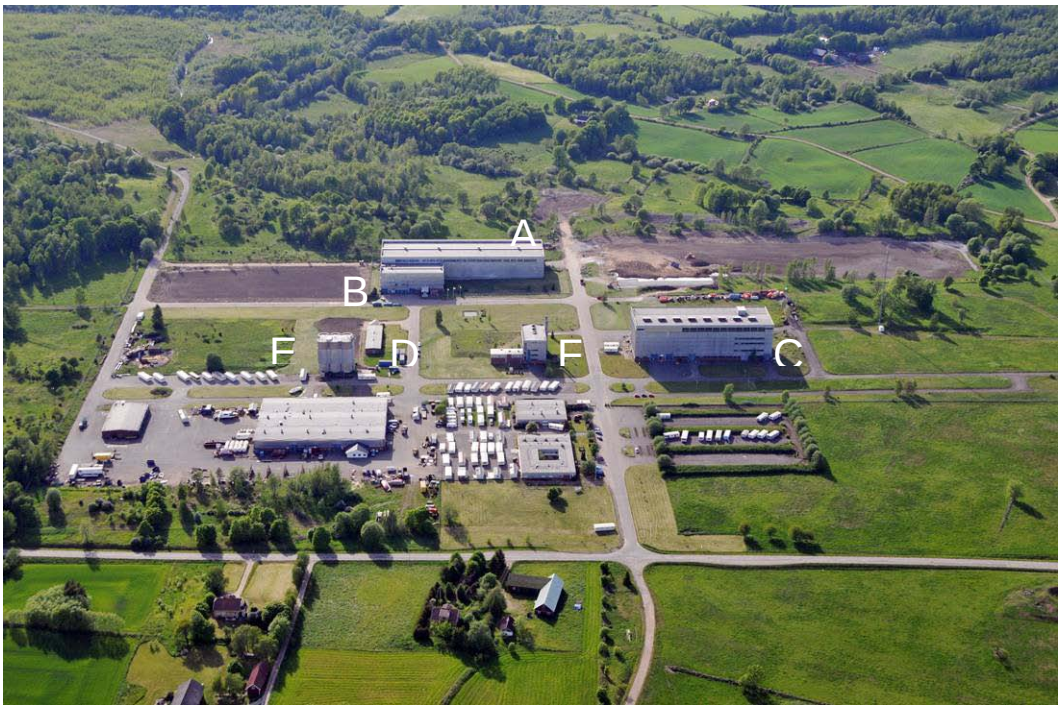
In 1982 RSA received a license that allowed it to process waste from fuel fabrication facilities and it is reported to have recovered 0.3 tonnes of enriched uranium from the wastes through 1984. After the RSA license was terminated in 1984, a new privately-owned company, Ranstad Mineral AB (RMA), was formed to continue this processing. RMA leased a portion of the Ranstad facilities (the Small Leaching Hall, also now referred to as the RMA Leaching Hall) from RSA. This lease was transferred to RIC when RIC assumed ownership of the site from RSA. RMA is reported to have processed about 9.4 tonnes of enriched uranium from 1985 through 2009.

An aerial photograph of the Ranstad site is shown in Figure 3.1. In this figure the main facilities are identified as follows:

- Large Leaching Hall (A)
- RMA Leaching Hall (B)
- Old Sorting Facility (C)
- Control Building (D)
- Lime Silos (E)
- Heating Plant (F)

1. SKBArbetsrapport R&D 93-42, "Uranium Recovery in Sweden, History and Perspectives" by A.Hultgren and G.Olsson, August 1993

Figure 3.1 Overview of the Ranstad Site



4. Potential D&D Cost Allocation Methodologies

4.1 Producer Pays Principle

It is now generally accepted that fundamental fairness requires that polluters take the steps necessary to abate their own emissions or pay for their cleanup. This principle requires that specific polluters should incur responsibility for their contribution to a particular pollution problem. In concept the principle is clear and straight forward for a site that has had only one owner or operator. In such instance the owner or operator is expected to pay the entire cost of remediation needed to meet legal and regulatory requirements.

For sites with multiple owners or operators there are two generic approaches that have been adopted to allocate costs. These approaches are the:

- Proportional allocation method and
- Incremental allocation method.

4.1.1 Proportional Allocation Method

For a chemical processing facility that does not involve radioactivity, application of the proportional method might be straightforward if the extent of the residual clean up exercise were in proportion to the throughput of materials in the facility e.g. resulting in a quantity of wastes and residues to be disposed of. For example, if the total cost of remediation is 100 and the first party to operate the site contributed 80 percent of the residual liability then, if there is no appreciable difference in the character of the liability to be dealt with, that party would pay 80 percent of the cleanup costs. The second owner would pay the remaining 20 percent of the costs. Both parties benefitted from the use of the site and both accordingly benefit in respect of cleanup costs from the other party's usage.

In instances where there is an appreciable difference in the character of the residual liability from each party's operations (such that remediation costs are materially affected), this approach would require the assignment of costs based on something other than just volume. The necessary adjustment, for example, could be related to some measure of relative environmental toxic potential, or the remediation cost differences on a unit basis.

For a facility that has processed radioactive materials, adoption of the proportional approach is not necessarily so straightforward. For example, a chemical process vessel might reach an equilibrium level of radioactive contamination after a certain amount of material has been processed through it. Thereafter, if a subsequent operator processes material with similar radioactive characteristics, the cost of D&D for that piece of the facility might not change. More broadly, if the additional contamination across a facility was not sufficient to change the volumes of wastes generated in various categories (affecting disposal costs), or the effort required to decommission the facilities, the adoption of a proportional allocation of D&D costs could be seen as wholly unreasonable.

4.1.2 Incremental Allocation Method

In the incremental approach, the second owner/operator would only be liable for the added (incremental) costs of remediation due to their operations at the facility. The logic for this approach when applied to a radioactive material processing facility would be that the first owner/operator built the site, contaminated the facilities and consequently should be responsible for the full costs of cleaning up the site in the condition when it ended operations. Absent any subsequent owners/operators, the first owner/operator had this obligation and its obligation should not change with subsequent use of the site. Subsequent users should only be responsible for the increased costs of D&D resulting from their operations. Even if a second operator processed a much larger volume of material than the first operator, the incremental impact on D&D cost could be small, or even zero. Application of a proportional approach in such a case could generate a very different allocation of costs compared to the incremental approach.

4.2 International References

A small number of international cases have been identified where the owner or operator of a nuclear facility changed and these examples have been reviewed to determine how costs were allocated. This exercise did not produce a compelling argument for either the proportional or the incremental approach. There are not many examples of facilities with multiple owners or operators and both methods have been used.

4.2.1 Reactor Sales

4.2.1.1 United States

There have been a number of nuclear power plant (NPP) sales, particularly in the United States. In order to obtain or transfer an operating license, the Nuclear Regulatory Commission (NRC) requires that the owner assures the availability of the financial resources to cover the full cost of the D&D of the facility at all times. Typically this starts out as a financial surety such as a letter of credit, parent financial guarantee, or other financial instrument sufficient to cover the full cost. As the reactor operates, the owner periodically transfers cash into a sinking or trust fund and reduces the amount of the financial surety.

When the NPP is being sold, the buyer and seller typically assess the adequacy of the sinking fund to cover the seller's proportional share of estimated D&D costs. If the fund is adequate, the seller transfers it to the buyer and the buyer establishes a financial surety to cover all additional costs.

This is an arrangement between two commercial entities where the negotiated approach is generally to assign D&D costs based on the proportional methodology.

4.2.1.2 Europe

Based on a limited search of the European context, the basic concepts that apply to D&D allocations for NPP ownership transfers in the United States also apply in Europe, albeit that there can be detailed variations from country to country.

SWEDEN

In Sweden the Act on the Financing of Management of Residual Products from Nuclear Activities (2006:647) (Financing Act) establishes how the costs for D&D are to be calculated and paid. The Financing Act originally required that a fee be levied on the generation of nuclear electricity over the first 25 years of NPP operation, sufficient to cover the cost of D&D, disposal of spent fuel and other radioactive waste and the fees must be accumulated in an external fund. In addition the Act required that nuclear operators provided financial security to cover an early shutdown or an under- estimation of costs. If a nuclear plant were to change license holder, the new license holder would be required to continue paying the per kWh fee (to the extent that 25 years of operation had not been reached) and to put financial guarantees in place if still applicable (also the 25 year issue). Later Sweden revised the period for collection of financial contributions to 40

years but this does not change the fundamental situation. The Swedish power reactor approach is another example of a cost allocation methodology that is broadly proportional but, because of the 25/40 year accumulation rule, the end result could be different depending on the age of the reactor at the time of transferring to a new license holder.

UNITED KINGDOM

The approach being proposed by government for new build in the U.K. is to follow a model not dissimilar to the U.S. model. D&D liabilities would be divided in to one of two categories:

- Non-designated Technical Matters
- Designated Technical Matters

Non-designated technical matters (e.g. costs related to spent fuel management and some operational wastes) would be covered by ongoing payments or accruals, effectively as an operating expense. Cost estimates for designated technical matters (including D&D of the facility) would be scrutinized by the relevant government minister and the appropriate amount of money would have to be assured up-front. The details are still being worked out so this may not be the final position but the principle of having all future liabilities covered financially at all times is likely to remain the guiding principle, as a protection for the U.K. tax payer.

4.2.1.3 Summary of Reactor Sales

The examples described suggest that a principle of proportionality is the starting position for D&D cost allocations related to NPP sales. However, such deals are somewhat different in nature to the RMA case at Ranstad. NPPs that have been sold have been demonstrably viable as sustainable, commercial, revenue and profit generating entities and the NPPs are sold to a second owner for use in the manner intended i.e. electricity generation. NPPs put up for sale have tended to attract more than one bidder so, in the end, the sale becomes an auction and the bidders have to factor into their offers some estimation of the adequacy of the existing D&D fund and the projected return on investment that they are willing to accept.

This is very different to the case of the small leaching hall at Ranstad, where the facility probably would have lain dormant had RMA not leased the facility to support a completely different business activity to the one for which the facility originally was built. In the absence of any competition to utilise this niche facility, it should not be

surprising that the end result of negotiations leading to RMA being able to lease the facility did not place any substantial D&D liability on RMA. This is discussed further in section 5.3.

4.2.2 Enrichment Plant Sale

The United States uranium enrichment plants were built and operated by the government from the 1950's until the 1990's. In the early 1990's the government decided that it wanted to privatize the business. As a first step in this process a government owned corporation was established and this entity leased the production facilities from government. The parties agreed that the D&D costs for all of the facilities would remain with government but the corporation would be responsible for removing any waste materials generated as a result of its operation. Basically the parties agreed that the government's operations had contaminated all of the facilities and the corporation's operation would not increase D&D costs. The only incremental contribution to cleanup costs would relate to the generation of uranium tails (in the form of UF_6), the disposal liability for which the corporation was required to accept. This an apparent example of the incremental method of allocating costs. In fact the story may be a little more complicated in so far as the government, in setting up the corporation, always was planning to sell the business. The eventual selling price could have included some allowance to cover part of the D&D costs but the deal was not transparent in this regard.

5. Analysis of Potential Allocation Approaches at Ranstad

There are a number of factors that can affect the most equitable way to allocate D&D costs between multiple site owners and operators. These include applicable law, contract conditions, operational scope and international precedents. An analysis of these factors for the Ranstad case follows.

5.1 Swedish Law

The Swedish Environmental Code entered into force on January 1, 1999. Part 3, Chapter 10, section 2 states: "*Persons who pursue or have pursued an activity or taken a measure that is a contributory cause of the pollution (operators) shall be liable for the after-treatment of areas, buildings and structures…"* It goes on to state that *"If several operators are liable they shall accept joint and several liability…. An operator who shows that his or her responsibility for the pollution is so insignificant that it does not by itself justify after-treatment shall, however, only be liable to the extent that corresponds to his share of responsibility*."

Unless a particular operator can demonstrate that its actions alone did not contribute sufficient contamination to warrant remediation, Swedish environmental law provides that each operator is 100 percent liable for all site remediation costs. It then becomes the responsibility of the multiple operators to sort out their respective shares.

Swedish law is designed to assure that remediation costs are paid by a responsible party, not to allocate the costs among the parties. Since the objective of this report is to address the equitable allocation of D&D costs to the various site operators, Swedish law is not helpful.

5.2 Contractual Terms

Details of contractual terms related to changes of ownership or operators at Ranstad and to the sale of the pertinent companies and the leasing of facilities to RMA have not been made available, so a detailed review is not possible. However, the following information has been provided:

- According to a report titled "Uranium Recovery in Sweden, History and Perspective", the agreement between Studsvik Energiteknik AB and RSA (that transferred ownership of Ranstad to RSA) contained a clause stating that Studsvik Energiteknik AB

"maintained responsibility for restoration of areas affected by earlier uranium production."

- The contract for the purchase of RSA by RIC reportedly contained a clause stating that obligations for restoring the facilities remained with the original owner and operator of the facility i.e. AB Atomenergi and its successor organization(s) (Studsvik Energiteknik AB, Studsvik Nuclear AB and SVAFO).
- NAC has been advised that the contract for the lease of Ranstad facilities to RMA by RIC does not include any provisions related to D&D costs.

Based on the stated contract terms, it appears that AB Atomenergi contractually agreed to retain responsibility for all Ranstad D&D costs, or at a minimum those costs resulting from its operations. Contractually therefore, all costs, or possibly all costs except those that are demonstrably incremental and directly attributable to RMA's operations, would remain with AB Atomenergi and its successors.

5.3 Potential Allocation Methodologies for RMA

The purpose of this exercise to recommend a rationale to allocate the Ranstad D&D costs between RIC and RMA. The analysis takes into account relevant Swedish law, contractual terms and conditions, international precedents and equity, or fairness. The main issues to be resolved are:

- Should the D&D cost allocation to RMA in respect of the small leaching hall be based on a proportional or incremental basis (full discussion of which has been provided in the preceding sections of this report)?
- If an incremental approach were deemed to be the most appropriate, how should this be assessed given the fact that the condition of the facility and its associated D&D cost was not established prior to the beginning of RMA operations?
- If a proportional approach were deemed to be the most appropriate, what parameters would be relevant to the derivation of equitable cost allocations?

As stated, Swedish law makes all operators liable for all costs. There are international examples where both proportional and incremental methodologies have applied. The contractual agreements relating to Ranstad appear to support either no allocation, or at most an incremental allocation to RMA. In other words there is some support for every conceivable approach but not a strong direction to support a definitive selection. In any

event, the remit given to NAC was to investigate potential methodologies that would be equitable, or fair, considering all of the facts. NAC's assessment follows.

5.3.1 Context

The Ranstad site was built for the benefit of and contaminated by the operations of AB Atomenergi. Consequently AB Atomenergi should be responsible for the full costs of cleaning up the site based on the site conditions when its operations ended. RMA negotiated the option to use an already contaminated facility at the site (a facility without any other apparent use) to establish a new business for economic gain.

RMA entered into a lease agreement with RSA, later assigned to RIC, that has provided some revenue to RSA and RIC that otherwise would not have been accrued. NAC is not aware of any competition to the offer by RMA, so this probably represented an acceptable deal for RSA/RIC as long as RMA did not increase the D&D liability significantly as a result of its new business operations. Irrespective of the contractual arrangement, a fair and equitable basis would be for RMA as a minimum to pay for any incremental contribution to D&D costs that may apply, subject to being able to assess this with some reasonable degree of confidence.

5.3.2 Incremental Approach

Adoption of an incremental approach raises the issue of how to determine RMA's incremental impact on D&D costs. Since the site was not surveyed to determine its condition prior to the commencement of RMA operations, there is no clear reference basis from which it might be possible to determine what additional remediation costs might apply. In addition, the current condition of the facility is not characterized in full. Accordingly there is no reliable basis to assert that RMA has added to the D&D liability. Equally RMA has no basis to prove that it has not.

Notwithstanding the fact that the necessary hard facts are not available, NAC has developed a simple incremental analysis based on potential incremental contamination of the facility and its impact on D&D cost.

5.3.2.1 Incremental Contamination Analysis

NAC is not aware of any information that would make it possible to determine the level of care exercised by the operators of the small leaching hall. This analysis therefore assumes equal care, focuses on changes in key parameters and estimates the impact on D&D costs. This parametric approach does not have a rigorous basis in fact. The

objective is to use subjective judgments to derive a plausible upper bound for the incremental impact of RMA operations on the D&D cost.

The analysis assumes that radiological mapping of the facility, general tidying of the facility prior to commencing decontamination and conventional demolition, would be unaffected by RMA operations. All overhead activities are assumed to be unaffected. The direct D&D activities considered to assess potential incremental cost are:

- Decontamination
- Dismantling
- Waste removal and disposal

DECONTAMINATION

NAC has discussed with OV Konsult the relationship between relevant cost items in the KB2010 Ranstad D&D cost estimate and specific decontamination activities to be carried out.

The decontamination cost estimate is understood to include the removal of a portion of contaminated building surfaces. In the KB2010 cost estimate the reported assumptions were as follows:

- Walls and ceilings had 10 percent of their surface area contaminated to a depth of 3 mm
- 50 percent of floor areas were contaminated to a depth of 1 cm.
- The relevant contaminated surface areas were listed as 1,615m^2 for floors (38%) and 2,653 m^2 for walls and ceilings (62%).

Removal of the contaminated floor surfaces will be more demanding than the removal of wall and ceiling surfaces, mainly because of the greater depth of contamination and potentially because of higher radiation levels. However, the radiation aspect is unlikely to be too onerous because it is virtually all related to low level radiation from uranium. Having to remove a greater depth of concrete would require some extra physical effort but the impact on cost would not be in proportion to the increase in depth.

The KB2010 total cost for these building surface grinding-off activities (kSEK 191) is reported to be broken down as follows:

- Floors: kSEK 101
- Ceilings: kSEK 19
- Walls: kSEK 71

In the KB2010 estimate it was foreseen that the materials removed in this way would be cleaned in tumbling equipment prior to ultimate disposal. The associated cost was kSEK99, of which kSEK97 was for the floor material removed. In the KB2011 estimate the tumbling stage has been removed.

After removal of the surface material, a process to support free release of wastes was included in the KB2010 estimate. Part of this is a cost category called ‘decontamination’. The actual activity relates to the cleanup after grinding-off material surfaces i.e. removal of any loose particles/dust. This would have to be done no matter what depth of surface material would be ground-off. The second part of the process is the monitoring of the residual surfaces to confirm that they can be cleared for free release. This activity also would be the same no matter what the depth of surface material removal occurs.

Based on these assumptions, the only cost that potentially would be affected by RMA operations would be the kSEK 191 of surface removal activities.

Illustrative Calculations

If it is assumed that the impact of RMA operations has resulted in a requirement to decontaminate the floors to double the depth that would have applied in the absence of RMA operations, increasing this part of the costs by 50 percent, the related impact of RMA operations on this part of the D&D cost would be about one third of the floor grinding-off cost, or about kSEK 34.

The assumption of double the depth of contamination was selected only for the purpose of illustrating the calculation methodology. Taking in to consideration the duration of RMA operations relative to prior operations (roughly 50:50), this would appear to be a plausible first order estimate but factors other than time may be relevant. The assumption is not based on any specific evidence from the facility.

If it were assumed that all contaminated surfaces were affected (walls, ceilings and floors) with an increment of 50 percent on the decontamination cost caused by RMA operations, the impact on the D&D cost would be about kSEK 64.

DISMANTLING

Dismantling and removal is unlikely to be affected anything like as much as decontamination. It reasonably can be argued that all of the vessel internals, pipe work and other pieces of equipment, which see a large flux of chemical solvents, are likely to have reached an equilibrium level of contamination. Even if this were not the case, the

marginal impact of RMA would be expected to be no more than a few percent, based on relative radiological throughput (see section 1.1.1 for further details). This small impact most probably would not have any impact on the method of dismantling, or the associated costs to perform the work.

WASTE DISPOSAL

Based on the preceding analyses, an extreme position on wastes might be to assume that RMA caused the volume for disposal resulting from surface grinding activities to double. Assuming that the wastes for disposal would have the same characteristics i.e. that RMA operations did not move volumes from one category in to a higher category that required a more expensive disposal solution, this would double the cost of the corresponding waste management. OV Konsult has advised that the relevant cost number included in the KB2010 estimate for disposal of these wastes (kSEK 39.2) was broken down as follows:

- Transportation: kSEK 2.7
- Containers: kSEK 28
- Repository charges: kSEK 8.5

With reference to these cost estimates, the related impact on D&D cost would be about 50 percent of the total, or about kSEK 20.

TOTAL OF EXTRA D&D COSTS USING AN INCREMENTAL METHODOLOGY

Adding together the estimates of extra costs potentially associated with wastes and decontamination gives a total of between approximately kSEK 54 and kSEK 84. This is not a rigorous estimate but indicates a potential order of magnitude based on incremental methodology. The results show that, even making some significant adverse assumptions as to RMA's impact, the incremental costs are not large (in the order of 0.02 to 0.04 percent of the total D&D cost for the Ranstad site and something like 0.7 to 1.0 percent of the latest estimated direct D&D costs for the RMA Leaching Hall (MSEK 7.949).

5.3.3 Proportional Analyses

5.3.3.1 Processed Volume of Uranium

A plausible basis for a proportional allocation of D&D costs would be to consider contamination of the facility during the different phases of operation. Actual contamination data attributable to specific operators is not available, so it is necessary to find a surrogate for contamination. NAC believes that a rational parameter to consider in this regard is the product of the amount and specific activity of the uranium that was

processed in the facility, which in turn may correlate to D&D costs, to some extent at least. This approach inherently assumes that there is no difference in the level of care exercised by the parties during each party's period of operation.

The detailed assumptions used in NAC's analysis are as follows:

- Pre-RMA operations produced 212.5 tonnes of natural uranium. at a recovery rate of 67.7%. Therefore the gross natural uranium throughput was approximately 314 tonnes uranium (MTU). In addition RSA processed about 0.3 MTU of enriched uranium recovered from the processing of fuel fabrication wastes.
- RMA operations recovering 8.9 MTU of enriched uranium, in addition to which plant throughput included an additional 0.5 MTU of enriched uranium that remained in wastes for disposal, giving a total processed of 9.4 MTU.
- The U^{235} enrichment of the enriched uranium is not known. A large portion is understood to have come from the Hanau fuel fabrication plant in Germany. Since this plant operated from 1969 to 1995, the average U^{235} enrichment in wastes processed at Ranstad would have been from operations potentially relating to the same time period. NAC estimates that the average enrichment probably was not more than about 3percent U^{235}.
- U^{238} specific activity = 12.2 kBq per g
- U^{235} specific activity = 77.7 kBq per g
- U^{234} specific activity = 229.4 MBq per g
- U^{238} therefore has a specific activity that is 15.7 percent of that for U^{235}
- U^{234} therefore has a specific activity that is 2,950 times that for U^{235}

Using the specific activity of U^{235} as a reference measure, a unit of natural uranium will have a specific activity that will be proportional to:

$(0.71 \times 1) + (99.284 \times 0.157) + (0.0056 \times 2{,}950) = 32.82$

For a unit of enriched uranium product (EUP) at 3percent U^{235} the specific activity will be proportional to:

$(3 \times 1) + (96.972 \times 0.157) + (0.0284^{2} \times 2{,}950) = 102$

The ratio of EUP to natural uranium on this basis is 3.1. In other words, EUP has about a three times higher radiological significance than natural uranium. U^{238}, U^{235} and U^{234}

[2] Assumes U^{234} enrichment factor is 20 percent higher than for U^{235} i.e. (3/0.71)x 1.2 x 0.0056

primary radioactive decays are by alpha particle emission, all with energy in the range of 4 to 5 MeV, so a ratio between the specific activities has a rational scientific basis. This simple analysis does not take into account the subsequent radioactive decay chains, which include some short half-life beta decays. However, it is believed that these are unlikely to affect the analysis in any significant way. Applying the ratio of 3.1 to the volume figures, RMA's contribution to the contamination may be calculated as:

(9.4 x 3.1) / (314 + [0.3x3.1]) = 9.25 percent.

The latest Ranstad D&D cost estimate, KB2011, includes a breakdown of direct costs (i.e. excluding overhead costs – planning, licensing end suchlike) by specific facility. The breakdown of these direct costs for the small leaching hall (also referred to as the RMA Leaching Hall) is presented in Table 5.1.

Table 5.1 KB2011 Breakdown of Direct D&D Costs for the RMA Leaching Hall

Activity	kSEK	Remarks
Radiological mapping	1,636	Anyway required
Clean-up before demolition	151	General tidying
Dismantling or removal & inspection	*1,050*	
Decontamination	*503*	
Clearing	1,019	General tidying
Waste management (includes packaging, transport, disposal and, for any waste to go to a geological repository, 30 yrs of interim storage).	*336*	
Conventional demolition	3,254	A result of original construction
Total	**7,949**	

1. **Line items in *italic* text are activities where RMA operations may have incurred incremental D&D costs.**

With reference to this breakdown, several of the cost items would be expected to be unaffected by the level of contamination in the plant and therefore would be unaffected by RMA operations. The three line items in *italic* text in Table 5.1 might incur costs that, absent RMA operations, would have been lower. Applying the proportionality ratio derived above to the sum of the estimated costs for the decontamination, dismantling and waste removal and disposal costs form Table 5.1arrives at an estimate of about kSEK 175 for the impact on Ranstad D&D costs.

1.1.1.1 Space Used Over Time

It is NAC's opinion that an allocation of D&D costs based on space used over time does not have any relevance (at least no obvious meaningful correlation) to the impact that each of the parties had on the physical condition of the facility. Space over time accordingly is considered to not be an appropriate basis for allocating D&D costs.

1.1.1.2 Commercial Benefit Accrued Over Time

Allocation of D&D costs based on the relative economic benefit received during each party's period of operation (such as profits) equally does not seem to be meaningful. Under such an approach a hypothetical organization that made no profit but built the facility and contributed 99 percent of the contamination, would be responsible for none of the remediation costs. A second organization that operated the site profitably during a subsequent period but contributed only 1 percent of the contamination would be responsible for all of the remediation costs.

There may be instances where this approach would be equitable but it is NAC's view that it would not be appropriate in the case of Ranstad and the RMA Leaching Hall. The party that built the RMA Leaching Hall (AB Atomenergi) and which is estimated to have contributed more than 95 percent of the contamination, but made no profit (according to information provided to NAC) should not be free of responsibility for the remediation costs. If RMA produced any profits, this allocation approach would require RMA to pay 100 percent of remediation costs. Consequently this approach is not considered to be equitable.

1.2 Summary of Allocation Analyses and NAC Recommendation

RMA did install a number of small pieces of equipment that were incremental to the existing facilities. The cost of D&D for these specific pieces of equipment, whatever those costs turn out to be, should be borne by RMA.

In respect of all other aspects of the D&D program, it is NAC's view that the most equitable methodology for assessing RMA's contribution would be on an incremental basis, as described in section 5.3.2.1; i.e. based on the increment of extra D&D cost that RMA operations will have caused. There is not however a basis of information that can be used to derive a fully defensible cost allocation using this methodology, not least because the facility was not benchmarked at the time when RMA began operations.

The indicative range of incremental cost using this method (excluding the costs related to new equipment mentioned above), as presented in section 5.3.2, is in the order of kSEK54 to kSEK84, equivalent to between 0.7 and 1.0 percent of the direct D&D costs for the RMA Leaching Hall. NAC believes that this estimate may be an overestimate of the real impact of RMA operations. The input parameters to this methodology were used to provide a broad indication of the cost impact that might apply. Irrespective of the specific data used, the methodology remains.

If evidence-based values for any of the input parameters could be obtained, it would be possible to improve on the uncertainty. For example, if measurements were made at the plant and they indicated that penetration of radioactive contamination into the floors was only fractionally deeper than assumed in the Ranstad cost estimate calculations, rather than the subjective double depth assumption used in this report for illustrative purposes, the estimated incremental decontamination costs and the estimated incremental waste removal and disposal costs would reduce.

Given the absence of reliable data to support an incremental methodology, it is appropriate to consider also a proportional approach, which has some parallels internationally in other sectors of the nuclear industry, as described in section 4.2. In fact this is a partial proportional approach since some parts of the D&D activities clearly would not be affected by RMA operations. NAC does not necessarily support the use of a proportional methodology at Ranstad but, if adopted, the recommended surrogate would be the volume and specific activity of uranium processed in the facility by the respective

operators, for which recorded data is available. On this basis NAC has derived an estimated cost allocation of approximately kSEK 175, which represents about 2.2 percent of the direct D&D costs for the RMA Leaching Hall.

Irrespective of the allocation methodology applied, the assessed financial contribution by RMA is small compared to the overall D&D cost for the facility that they have been leasing.

One potential additional consideration to take into account relates to the RMA lease agreement for use of the RMA Leaching Hall. NAC has been informed that it is a simple rental agreement with no specific conditions stipulated in regard to the eventual condition of the plant at termination of the lease. In other words the agreement is silent on the matter of D&D costs.

At the time the original lease was entered into, the polluter pays principle was not developed and generally adopted into national legislations. Had it been in place at the time, it now might be possible to argue that the lease agreement implicitly was accepting that the rental payments have covered all liabilities, since the original owner would have been aware of the polluter pays principle, yet did not stipulate any related condition in the terms of the lease. Even after the polluter pays principle became generally adopted, no such modifications were made to the lease agreement, as far as NAC is aware. Accordingly it could be determined that the rental payments included a contribution to any incremental D&D costs incurred due to RMA operations.

This is a side issue that is outside the main scope of this report but it is mentioned for completeness, to raise the issue that there might be some grounds for offsetting the estimated RMA liabilities against payments already made by RMA under the lease agreement for the RMA Leaching Hall facility.

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The Swedish Radiation Safety Authority has a comprehensive responsibility to ensure that society is safe from the effects of radiation. The Authority works to achieve radiation safety in a number of areas: nuclear power, medical care as well as commercial products and services. The Authority also works to achieve protection from natural radiation and to increase the level of radiation safety internationally.

The Swedish Radiation Safety Authority works proactively and preventively to protect people and the environment from the harmful effects of radiation, now and in the future. The Authority issues regulations and supervises compliance, while also supporting research, providing training and information, and issuing advice. Often, activities involving radiation require licences issued by the Authority. The Swedish Radiation Safety Authority maintains emergency preparedness around the clock with the aim of limiting the aftermath of radiation accidents and the unintentional spreading of radioactive substances. The Authority participates in international co-operation in order to promote radiation safety and finances projects aiming to raise the level of radiation safety in certain Eastern European countries.

The Authority reports to the Ministry of the Environment and has around 270 employees with competencies in the fields of engineering, natural and behavioural sciences, law, economics and communications. We have received quality, environmental and working environment certification.

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