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Research

A Review of the Decommissioning Plan and Cost Estimate for the Studsvik Rock Facility (AM) for the Storage of Low and Intermediate Level Wastes

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SKI

SKI perspective

Background

The nuclear power utilities must under the so-called Studsvik Act (the complete translation is the Act on the Financing of the Management of Certain Radioactive Waste etc. (1988:1597)) contribute to the Swedish Nuclear Waste Fund 0,15 öre (approximately 0,02 U.S. cents) per kWh produced by nuclear power. This part of the financing system was established by the Swedish parliament to cover future expenses for the decontamination and decommissioning of older Swedish research nuclear reactors and related facilities at the Studsvik site. The task to build up an appropriate capital fund will be based on the sum of individual cost estimates for the decontamination and decommissioning of relevant facilities. It is therefore vital that these cost estimates are reliable and meaningful over the long term, to ensure that there will not be a significant discrepancy between accumulated capital and future obligations. Accordingly, it is of utmost importance that the cost estimate for the Studsvik Rock Facility for the Storage of Low and Intermediate Level Wastes (AM) is scrutinised and validated.

Purpose of the project

The primary aim of this applied study, or review, has been to describe, analyse and determine the reasonableness of the estimate of the future costs for decontamination and decommissioning of the Studsvik Rock Facility for the Storage of Low and Intermediate Level Waste.

A second aim has been to describe how presentation of the cost estimate might be improved, i.e. how to enhance the quality and clarity of the collected and presented data. An important consideration is the development of a systematic approach to improve the preparation, monitoring and understanding of estimates of costs for decontamination and dismantling. Appendix 1 of this report presents a guideline for the format of decommissioning cost estimate reports.

Results

A comparison of the estimated future costs for decontamination and decommissioning of the Studsvik Rock Facility for the Storage of Low and Intermediate Level Waste with benchmark references, indicates that the cost estimate for equipment dismantling seems to be reasonable. It is however concluded that the cost estimate for cleaning and decontamination is somewhat unclear, i.e. the cost estimate is difficult to interpret due to apparently inconsistent statements relating to scope and methodology, which in turn translate into uncertainty on the final cost estimate.

The report shows that it is possible to enhance and extend the present knowledge basis for cost estimates by using feedback of experience, using appropriate benchmarking data. It also provides a comprehensive overview of how the report presentation can be improved in order to facilitate review and comparison with benchmarking references. Overall the presented financial provisions appear to be sufficient, and even might be conservative, i.e. the review indicates a risk that the estimated cost may have been overstated.

This report represents a contribution to active learning, which helps to improve the estimation of decontamination and decommissioning costs with improved confidence levels. The key aspect of the contribution made by the report is that it introduces access to benchmarking comparisons with other relevant decommissioning programs and projects.

Continued work

This study reinforces the message that current limited access to relevant benchmarking information makes it difficult to validate the reliability of decommissioning cost estimates. A proposed way to develop this study is to identify and analyse a similar project that has been decontaminated and dismantled. Since there is no such project in Sweden it will be necessary to look abroad for this possibility.

This study also indicates the need to develop a more comprehensive approach to the presentation of decommissioning cost information data in a clear and efficient manner.

Comparative studies of this type contribute significantly to the validation of cost estimates for the decontamination and decommissioning of specific Swedish facilities. The review of estimates and suggestions as to how they can be more transparent contributes to our understanding of the prerequisites for the development of future cost estimates on a reliable and meaningful basis.

Effects on SKI work

SKI will be able to draw inferences from this study that will assist in the ongoing monitoring of the yearly cost estimates presented by the company AB SVAFO. In particular, this study will give support to the present review process in regard to the estimated decommissioning and dismantling costs of the Studsvik Rock Facility for the Storage of Low and Intermediate Level Wastes (AM).

Project information

At SKI Staffan Lindskog has been responsible to supervise and co-ordinate the project. Geoff Varley from NAC International, England, has accomplished the research task. Monica Bowen-Schrire was responsible for the translation of the background report into English.

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BACKGROUND

The AM facility is a storage facility for packaged wastes that have been conditioned at the Studsvik site. It is located inside a rock mass on the Studsvik industrial site. The task of the facility is to store the wastes on an interim basis before dispatch to a repository. The waste packages sentenced for storage in AM include:

- Low-level waste (LLW) packages that do not need any special protection against ionising radiation
- Intermediate-level waste (ILW) packages that must be handled with a protective shield and using remote controlled equipment.

In all cases the waste packages delivered to AM do not have any surface radioactive contamination. To date no release of contamination has been known to occur.

The AM decommissioning cost estimate prepared for SVAFO addresses a Main Case (all wastes removed) and an Alternate Case (in which the scope of removal of equipment is unclear). The cost estimates for the Main Case and the Alternate case are MSEK 16.8 and MSEK 10.0 respectively. The overall program, comprising preparation, dismantling and concluding work, is projected to take 24 months.

UNCERTAINTIES

There are a number of aspects of the program that are not clear in the AB SVAFO report. For example, the assumed route for the disposition of wastes generated in dismantling process equipment and building materials is unclear. In addition, the detailed schedule of program items (Section A items in cost estimate) is somewhat confusing with the possibility that several cost elements have been omitted.

AM normalised unit costs for selected, individual decommissioning activities have been derived and compared with relevant benchmark data from other recent decommissioning cost estimate analyses performed for SKI. Taking into account that there is very good access at AM, the results of these analyses give some comfort that the AM equipment dismantling estimate is in the correct ballpark.

Regarding resources needed for project planning and management, the AM ratio of man-hours to project cost may be high. This conclusion is based on correlation

analysis of data in other Swedish cost estimates for the R2 research reactor and for Ågesta, compared with the AM cost estimate. It may be helpful to perform a broader analysis of other AB SVAFO decommissioning cost estimates and actual decommissioning projects, to see if there is any consistent correlation between planning resource needs and overall project cost, or indeed if an alternative, non-linear correlation might apply.

The assumptions made for worker utilisation and dismantling efficiency may or may not be appropriate for the AM facility estimate. However, the AB SVAFO report provides insufficient information to facilitate further comment on the reasonableness of the assumptions and related methodology.

Dismantling costs were based on information provided by a commercial company, in a non-competitive situation. On one hand there might have been a tendency for the information to introduce conservatism into the AM cost estimate. On the other hand (depending on experience/track record of the company concerning nuclear decommissioning work) it could be either high or low in terms of estimated resources needed.

In any event, the AM cost estimate report is unclear on cleaning and decontamination aspects, not least because statements appear to be inconsistent. In addition, the whole concept of cleaning and decontamination prior to activity mapping might be considered to be an inappropriate approach. If, as is expected, the entire facility will not be contaminated, it is reasonable to ask why the estimate would address an extensive program of cleaning and decontamination.

OVERALL REASONABLENESS OF THE AM FACILITY COST ESTIMATE

Notwithstanding a number of inadequacies of the AM cost estimate report, the general impression is that the indicated financial requirements probably are sufficient and might even be overstated (conservative). This assertion is predicated on the basis that the basic methodologies applied are reasonable, which remains to be demonstrated. The report is ambiguous in its presentation, which makes it difficult to draw firm conclusions in this regard.

A significant problem with the estimate indeed is the uncertainty introduced due to the way in which the information has been presented. Clear unequivocal statements are not present for some of the key elements of the projected decommissioning

program. Important underlying assumptions are not justified/supported and there are apparent contradictions that undermine confidence in the details of the estimate.

Limited benchmark comparisons with other decommissioning programs have been possible. Those comparisons that have been possible have not raised any alarms in regard to the reasonableness of the AM estimate.

COST ESTIMATE REPORT PRESENTATION

In view of the problems associated with the presentational aspects of the AM cost estimate and at the invitation of SKI, this report includes suggestions as to how the presentation of such information might be improved. In particular:

- Decommissioning objectives must be clear and well defined, including how uncertainty is handled in preparing the estimate.
- Concerning facility condition, factors that potentially would affect project implementation and cost must be highlighted.
- Inventories of materials etc., should be characterised with a range of metrics, to make possible comparisons with other benchmark information, in order to validate/support the cost estimate.
- Concerning overall labour resources, the real-time profile of labour requirements throughput the project should be looked at, rather than relying on simple scaling of resources.
- Some explanation to justify the estimate of resources required for the main elements of the planning and approved process should be provided.
- How robust the estimate is should be demonstrated by providing a summary of the main factors that might affect the total estimated cost, with an indication of by how much.
- The reference information used to support specific cost elements should be made visible.
- In order to increase confidence in the estimate, contingency amounts included should be linked to and explained in relation to the assessment of specific uncertainties and sensitivities.

1. Introduction

Statenskärnkraftinspektion (SKI) charged NAC International with the task of conducting a review of the decommissioning cost analyses report SEP 01-319 prepared by Westinghouse Atom AB for AB SVAFO concerning the Studsvik Underground Waste Storage Facility (AM). This report presents the conclusions of a prudence review of the cost estimate, looking at the reasonableness of the cost estimate as well as the completeness of the estimate and related logistics. This report also considers the presentation of information in the cost estimate report and makes recommendations on how the format and content could be improved, in particular with a view to making the conclusions and uncertainties more clear, in terms of principal assumptions and the reasonableness of the sources that underpin those assumptions.

2. Facility Description and Decommissioning Scope

2.1 AM Facility Outline Description

2.1.1 Purpose

The AM facility is a storage facility for packaged wastes that have been conditioned at the Studsvik site. Construction of the AM facility was completed in 1985 and the first waste material was committed to storage in September 1987. The task of the facility is to store the wastes on a interim basis until such time as they can be dispatched for disposal in the SFR or SFL repositories (SFR is the Swedish repository for radioactive operational waste and SFL is the Swedish repository for long-lived radioactive waste).

The design life for AM assumes delivery of wastes to the facility through 2040. During the period through 2040 wastes will be transferred to final disposal in Swedish repositories.

2.1.2 Location and Physical Description

AM is located inside the Studsvik industrial site, in the rock mass situated in the south eastern part of the site, adjacent to the sea (see Figure 1). Road access is possible via a tunnel, approximately 50m long and 5.5m wide, from the harbour where M/S Sigyn can dock. Restricted access is possible via a ventilation shaft that also provides an emergency exit route through an above ground building on top of the relevant rock mass.

The layout of AM is as shown in Figure 2. The storage part of the facility comprises the Gallery (an area for waste handling and shielded storage) and the Hall (an area for waste that can be handled without shielding). A loading bay is positioned between the two and all three are serviced by a 25 tonnes overhead travelling crane (OHT crane). Other parts of the facility include a waste package area at the end of the main access tunnel and a service area, which includes a control room for remote operation of the OHT crane. Throughout the working areas of AM there is ventilation ducting. Ventilation is forced and the system includes radon filters.

Figure 1 Location of the AM Facility at Studsvik

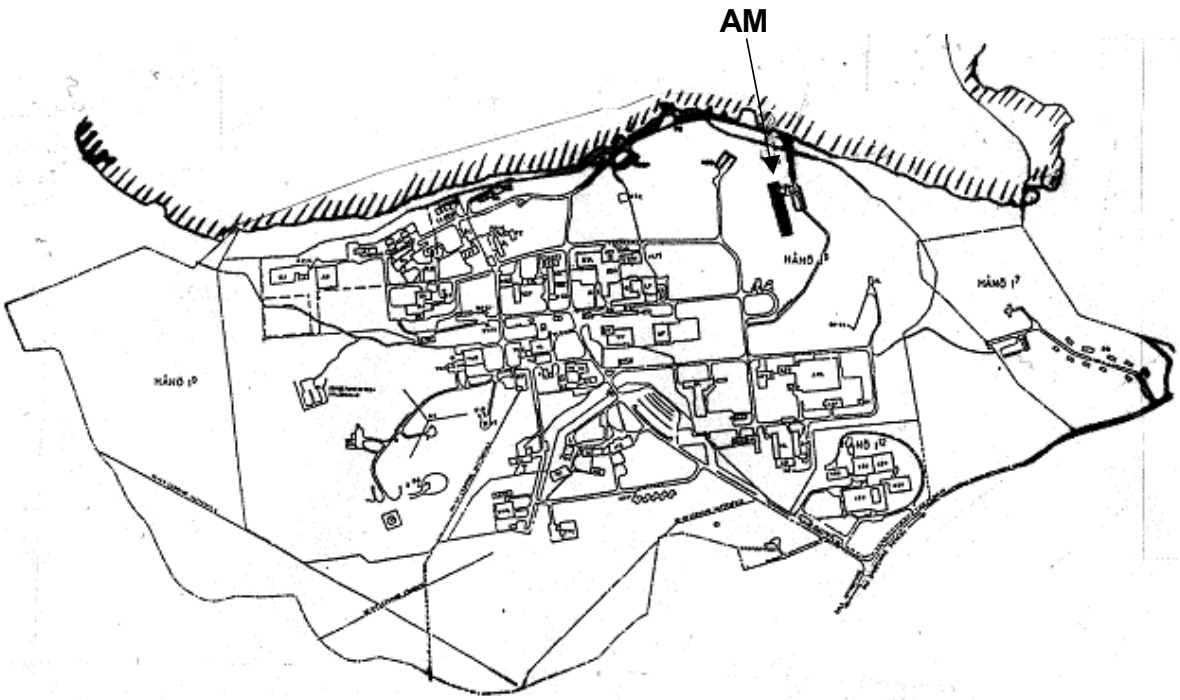
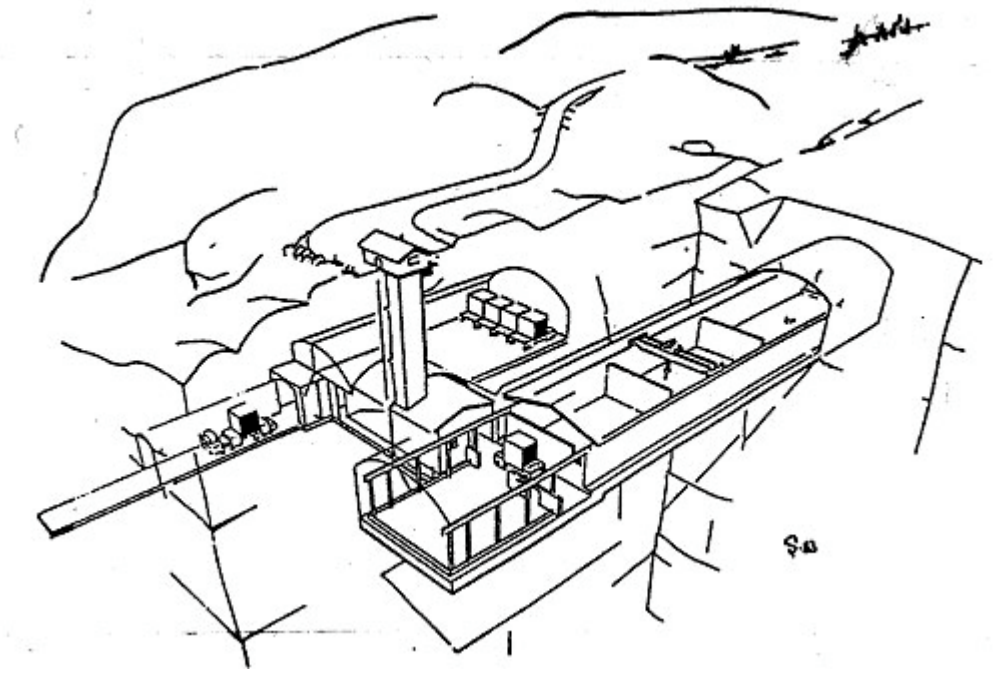


Figure 2 Schematic of AM Facility Layout



In the course of a site visit to AM, it was mentioned that there was no known significant radioactive surface contamination present in AM. If any such contamination is present, which might have an impact on the decommissioning program, it is expected that it will be discovered in conjunction with the next radioactive mapping of the facility. Ground water ingress has occurred but AM was designed to handle this. Such water is collected, monitored and discharged. Asbestos is not present anywhere in the AM facility. Overall the facility is in good condition, relatively clean and with good access to all parts, which will facilitate eventual dismantling.

The original construction cost for AM was approximately MSEK30. Escalating this to 2003 money values, the current equivalent would be approximately MSEK50.

2.1.3 Wastes

The waste packages sentenced for storage in AM include:

- Low-level waste (LLW) packages that do not need any special protection against ionising radiation
- Intermediate-level waste (ILW) packages that must be handled with a protective shield and using remote controlled equipment.

In all cases the waste packages delivered to AM do not have any surface radioactive contamination and dispersal of contamination of the contents should not be possible in any way other than if an accident were to occur causing rupture of a container. To date no such release of contamination has been known to occur. Waste drums with bolted lids are further contained inside concrete boxes, five drums to each box, which also have a bolted lid. These concrete boxes are emplaced inside the concrete storage vaults at AM.

2.2 Outline of Decommissioning Plan Scope

2.2.1 Objectives and Principal Assumptions

MAIN CASE

- No immediate reuse for civil purposes
- All wastes removed
- Installations and building components above and below ground subsequently removed (including cast concrete constructions)
- Radiological clearance assumed, after monitoring, for all equipment and building components to be dismantled
- Cavern not backfilled and storage areas left empty

- All access routes sealed by casting with backfilling of ventilation shaft using some dismantling debris

Resulting wastes from this program are estimated as shown in Table 1:

Table 1 Waste Quantities from Dismantling

	Quantity	Assumed Destiny
Building components for dismantling[1]	225 MT / 242 m^3	95 MT / 38m3 to backfill at AM 130 MT / 204m3 to landfill disposal
Process equipment for dismantling[2]	62.6 MT / 32 m^3 ▪ Mechanical equipment 55 MT ▪ Electrical equipment 7.6 MT	All to landfill disposal

There appears to be some lack of clarity and consistency concerning these quantities. Based on information presented in Section 9 of the AB SVAFO report the volume of material needed for backfill would be 40m^3 (47m^3 x 0.85 packing density) rather than 38m^3, leaving 13m^3 excess for disposal to landfill rather than 15m^3. Furthermore, the summary table on the management of dismantling waste presented in Section 9 of the AB SVAFO report clearly defines the volume of material committed to backfill as 47m^3, equivalent to 100 MT. But the abstract to the report associates 38m^3 of backfill with about 95 MT, which appears to be not consistent.

The extent to which these apparent discrepancies may have had an impact on the final decommissioning cost estimate is not clear. In any event, such presentational inconsistencies undermine confidence in the accuracy of the estimate.

Section 9 of the AB SVAFO report (second main paragraph) states that all process equipment dismantling material has been assumed to be sentenced to landfill. However, it also raises other alternatives within the scope of the main case, relating to the possibility of using this material for filling a cavity or cavern at AM, although exactly which cavity is not clear. The purpose of mentioning these alternatives is not understood, since the cost impact appears not to be estimated. The remarks serve only to confuse.

1. Includes cast building structures above and below ground, access tunnel doors and ventilation grids, room dividers such as platforms, ladders etc., and service systems (ventilation, electrical, sewage, drainage) [1] Includes electrical and control equipment, including cubicles, connection boxes, motors and cables on ladder cable trays or in pipes, plus the OHT crane.

2. Includes electrical and control equipment, including cubicles, connection boxes, motors and cables on ladder cable trays or in pipes, plus the OHT crane.

ALTERNATE CASE

The AB SVAFO report is unclear concerning the alternative approach that might be adopted. Section 3.1 of the report appears to be contradictory, as follows:

Section 3.1, Paragraph 2:

- All wastes removed
- Underground facility left in a serviceable state with all equipment intact

Section 3.1, Paragraph 3:

- Clearance of all equipment and building components

Section 9 reiterates the assumption of all equipment being left intact.

3. Overall Work Program

3.1 Outline Program

The assumed decommissioning program, covering in total 24 months, may be subdivided into the following principal phases:

PREPARATORY PHASE (MONTHS 1-5)

- Preparation of licensing documents
- Project planning
- Procurement of external services and equipment
- Site Preparation

DISMANTLING OF PROCESS EQUIPMENT (MONTHS 5-14)

- Project planning and equipment installation
- Equipment cleaning
- Radiological survey
- Installation of temporary service supplies
- Actual dismantling

DISMANTLING OF BUILDING COMPONENTS (MONTHS 13-21)

- Actual dismantling including ventilation and drainage equipment
- Cleanup after dismantling
- Final inspection and closure of dismantling operations

CONCLUDING WORK (MONTHS 21-24)

- Final Cleanup and Inspection
- Final Report

3.2 Disposition of Materials from Dismantling

The assumed route for the disposition of wastes generated in dismantling process equipment and building materials is unclear. In section 5.1.2 of the AB SVAFO report the aim of clearance for as much material as possible is stated but reference also is made to the fact that dismantling material with a higher degree of contamination will be sent to one of the Swedish repositories (SFR or SFL), with a cost of SEK 20,000/m^3 for short-lived waste and SEK 100,000/m^3 for long-lived waste. However in the summary of costs, section 8.2.2 under item A14, the costs

identified refer only to transport and landfill costs. This is consistent with the statement in Section 4.1 of the AB SVAFO report that, providing incidents do not occur in the remaining lifetime of the facility, it can be assumed that the building surfaces can be given clearance. It is also consistent with section 3.4 , which states that it is assumed for the AB SVAFO study that all equipment can be given clearance.

There is a 20 per cent contingency included in respect of unplanned work connected with the items declared to be A1-A20, which in part could relate to possible repository disposal but this is far from clear. If all of it were attributed to this possibility, the contingency of MSEK 0.874 would equate to the repository costs for about 3 per cent of dismantling wastes if long-lived ($8.74m^3$), or about 16 per cent if short-lived ($43.7m^3$). Since section 8.2.4 declares that the cost for building surface decontamination is "very uncertain", clearly not all of the contingency could be attributed to possible additional disposal costs. This means that, if the cost estimate is to be valid, there is little or no margin for dismantling material to not be given clearance.

The schedule of items under section 8.2.2 anyway is somewhat confusing since items A1-A5 are summarised as A1-A9, items A6-A9 are not listed, items A10-14 are summarised as items A10-A19 and finally there is a combination for items A1-A20. The individual cost numbers do add up to the given total but the presentation is not clear. One interpretation would be that several cost elements have been omitted, so some uncertainty must be attributed to these costs based on the AB SVAFO report as presented.

In a similar vain, section 8.2.3 of the AB SVAFO report refers, in confusing fashion, to individual items R1 and R3 but a total for R1-R4 (R2 and R4 not defined) that equals the sum of R1 plus R3.

3.3 Activity Metrics and Costs

3.3.1 Overview

The estimated costs for the two cases considered – full dismantling and removal, or clearance and all equipment left intact – are summarised in Table 2.

Table 2 AB SVAFO Decommissioning Cost Estimates

		COST MSEK	
Identifier	Scope	Main Case	Alternative Case
A	Preparation, follow-up and concluding work for project management	6.3	5.0
B	Project management activities and external costs	5.3	5.0
C	Dismantling work	5.2	----
Total Cost		**16.8**	**10.0**

The corresponding man-hours associated with each phase of work, the volumes/weights of materials involved in the dismantling phase and the costs associated with external services have been estimated as shown in Table 3.

Table 3 Estimated Resources for AM Decommissioning

Identifier	Man Months	Man-hours Cost (MSEK)	Volumes/ Weights	External Costs (MSEK)	% Contingency/ Total Cost (MSEK)
A	40.5[1]	4.86	----	----	30[2] / 6.32
B	47.7[3]	3.64	----	0.73	20 / 5.24
	62.3[5]	4.36	274 m^3 / 288 MT	----	20 / 5.23
	(14)	(0.96)	(62.6 MT)	----	----
C	(13)	(0.94)	(36 MT)	----	----
Totals	**150.5**	**12.86**	**274 m^3 / 288 MT**	**0.73**	**23.5 avg. / 16.79**

The data in parentheses under item C are subsets of the dismantling work. The first line is for 62.6 MT of mechanical and electrical equipment. The second line is for 36 MT of ventilation pipework dismantled as part of the building dismantling phase.

3.3.2 *Normalised Activity Costs*

PROJECT PLANNING AND PROJECT MANAGEMENT

The total time estimated for AM planning and management is approximately 13,600 hours for a project with an overall cost of MSEK16.79 (2003 money values). The

1. Assumes 1850 man-hours per year
2. NB. Section 8.2.1 of AB SVAFO report quotes a 20 per cent contingency but the monetary total clearly corresponds to a 30 per cent contingency.
3. NAC estimate assuming quoted average rate of SEK 70,000 per man-month for this type of work (AB SVAFO report section 8.2.2)

ratio of hours to project cost therefore is 810 hrs/MSEK (see section 3.4 for further discussion).

MECHANICAL AND ELECTRICAL EQUIPMENT DISMANTLING

It is not ideal to mix dismantling of electrical and mechanical equipment but the available data does not allow a more sophisticated approach. AM is projected to have 55 MT of mechanical equipment and 7.6 MT of electrical equipment, which together will need approximately 2,160 man-hours and MSEK 0.96 for dismantling, for a unit resource need of about 35 hours/MT.

VENTILATION PIPEWORK DISMANTLING

Dismantling of 36 MT of ventilation pipework is projected to need approximately 2,000 man-hours and MSEK 0.94 for a unit resource need of about 56 hours/MT.

3.4 Comparison of AM Normalised Costs with Benchmark References

DISMANTLING

The relevant benchmark data from recent analyses performed for SKI include:

- Primary circuit pipework dismantling at WTR (ref 1)
- Primary pipework dismantling at BR3 (ref 2)

The WTR benchmark reference is 750 hours/MT but this includes decontamination activities (see ref 1). At BR3, including estimates for all preparation work, a similar figure of 740 hours/MT was derived. Both of these derived benchmarks are far in excess of the pipework and mechanical dismantling activities described above for AM. However, excluding the preparation phase for the BR3 example the unit resource need reduces to 122 hours/MT, or a fixed set-up investment of 458 hours plus a variable requirement of 51 hours/MT.

At AM there is very good access to the ventilation pipework and a majority of mechanical equipment, so it would be expected that the resources needed would be comparable to no more than the basic actual dismantling activities at BR3, or WTR. The estimated 35 to 56 hours/MT at AM indeed is in the region of the stripped-out dismantling cost for BR3 pipework of 51 hours/MT. This is not a highly rigorous analyses but gives some comfort that the AM equipment dismantling estimate is in the correct ballpark.

PROJECT PLANNING AND PROJECT MANAGEMENT

In the WTR analysis performed for SKI (ref 1), project planning and management needed approximately 133,000 man hours for a project with an overall cost of MSEK274 (2001 money value equivalent), for a ratio of hours to project cost of 484 hrs/MSEK. This compares with the AM ratio of 810 hours/MSEK. The latter would be expected to be higher since such activities typically include a significant fixed element, plus a variable element in proportion to the magnitude of the project.

Analysis of data in the Swedish cost estimates for the R2 research reactor and for Ågesta, compared with the AM cost estimate, implies that for the pure planning phases of work, i.e. items P1 through P7 in the standard AB SVAFO cost estimate reports, the fixed resource requirement is in the region of 20 to 25 man months and the variable requirement approximately 0.25 man months per MSEK of total project cost. Given the significant differences in the type of projects to which the estimates apply it may be dangerous to draw any rigid benchmarking conclusion in this way. However, it would be interesting to perform a broader analysis of other AB SVAFO decommissioning cost estimates to see if there is any consistency based on this possible correlation between planning resource needs and overall project cost, or indeed if an alternative, non-linear correlation might apply.

4. Review of Reference Assumptions and Uncertainties

4.1 References [1] and [2] from AM Cost Estimate

The AM cost estimate relies on the quoted references [1] and [2] in the AB SVAFO report in respect of:

- Worker utilisation
- Dismantling efficiency

It is further stated that the methodology applied in these references was applied to the AM estimate. The assumptions made may or may not be appropriate for the AM facility estimate. In any event the key assumptions should be stated in the AM report in order that they can be evaluated in a stand-alone manner, without the need for reference back to historical reports. In the absence of such information it is not possible to comment further on the reasonableness of the assumptions and related methodology.

4.2 Hifab AB Dismantling Costs

Section 3.4 of the AM cost estimate states that information provided by Hifab Byggprojektledaren AB in Västerås was used in estimating dismantling costs. It appears that reference [5] in the AM cost estimate, dating from 1999, was used as a basis for resources needed and then Hifab was consulted in 2003 to obtain up-to-date prices related to such resources.

Hifab AB is a commercial company involved in a range of activities, including construction. The reasonableness of the Hifab information cannot be judged. *Inter alia*, the company's track record in dismantling and specifically working within the regulated environment of the nuclear industry, is not stated. By way of caution, it may be suggested that it is not beyond the realms of reality to imagine that estimates provided by a commercial company, in a non-competitive situation, might be somewhat favourable towards their commercial interests. This could apply to the basic information on resources needed and also the prices quoted. On the one hand therefore there might be a tendency for the Hifab information to introduce conservatism into the AM cost estimate. On the other hand (depending on experience/track record concerning nuclear decommissioning work) it could be either high or low in terms of resources needed.

4.3 Cleaning and Decontamination

The AM cost estimate is unclear on the cleaning and decontamination aspects of the work program and this filters through into uncertainty on the final cost. The AM cost estimate includes the following information:

Section 5.1	"2. Cleaning (e.g. high-pressure jets) of equipment and building surfaces."
Section 5.1.1	"Routine cleaning/decontamination of floors and floor surfaces will be conducted within the framework of normal operation."
Section 5.1.2	"Clearance – as long as this can be achieved with a simple decontamination process, namely flushing, simple washing etc. A more complex treatment is not considered to be cost efficient in this case."
Section 8.2.2	"A5 Chemical cleaning of premises, 6 man months – MSEK 0.42"
	"A13 Decontamination and activity measurement of construction surfaces – MSEK 2.25."
Section 8.2.3	"A13 The cost of the decontamination of building surfaces has been based on a cost of SEK 3,000/m^2. The cost is very uncertain."
Section 4.2	"Any water from floor surfaces in the storage part and the service part will be collected by the system for controlled drainage ….."

Section 5.1 refers to high-pressure cleaning of building surfaces but the cost information in section 8.2.2 refers to chemical cleaning of the premises. Furthermore, Section 5.1.2 clearly suggests a simple cleaning technique, which may be a contradiction to section 8.2.2. Section 4.2 makes a reference to how surface water would be dealt with but no reference has been found relating to what would be done with chemical solutions, should such a method be employed. If the unit cost of SEK 3,000/m^2 given in section 8.2.3 were applied conservatively to the whole of the MSEK2.25 cost of decontamination and subsequent activity measurement (item A13 in section 8.2.2), the corresponding surface area for decontamination would be about 750 m^2 i.e. an area of 27 m x 27m only. Given the size of the AM facility this appears to be very low. Section 5.1.1 suggests that cleaning and decontamination anyway will be taken care of during normal operations at AM. If this is the case, then the inclusion of such work in the decommissioning cost estimate is somewhat ambiguous.

This part of the AM cost estimate is difficult to understand because the various statements appear to be inconsistent. In addition, the whole concept of cleaning and decontamination prior to activity measurements might be considered to be an inappropriate approach. If, as is expected, the entire facility will not be contaminated, it is reasonable to ask why an extensive program of cleaning and decontamination

would be required. Monitoring would appear to be the first logical step, with cleaning/decontamination principally afterwards on an as-needed basis.

4.4 Other Uncertainties

4.4.1 Planning and Project Management

The AM cost estimate includes a numerically quoted 30 per cent contingency in respect of planning and project management activities. The basis for this level of uncertainty being higher than for the other categories is not stated. Indeed the uncertainty quoted in words is only 20 per cent, so it may be just a reporting error.

4.4.2 Preparation, Support and Concluding Measures

As stated in section 3.2 of this report, the AM cost estimate is at best incorrectly presented and at worst potentially incomplete in regard to the nominal 20 items (A1 – A20) referred to in section 8.2.2 of the report.

Secondly, depending on the ultimate destiny of wastes from dismantling, the estimate may not be making an adequate provision or contingency for quantities that might have to be sent to one of the Swedish repositories. Before reaching a more helpful conclusion on this, it would be necessary to obtain clarification on how the estimate has been structured in this regard.

5. Overall Reasonableness of the AM Facility Cost Estimate

Notwithstanding a number of inadequacies of the AM cost estimate report, the general impression is that the indicated financial requirements probably are sufficient and might even be overstated (conservative). This assertion is predicated on the basis that the basic methodologies applied (e.g. worker efficiency) are reasonable, which remains to be demonstrated. Beyond that issue, the estimated costs for planning, preparation and project management appear to be large in the context of this project. Also the indicated needs for cleaning and decontamination may be overstated, although this is difficult to determine due to the ambiguity of presentation in the report.

A significant problem with the estimate indeed is the uncertainty introduced due to the way in which the information has been presented. Clear unequivocal statements are not present for some of the key elements of the projected decommissioning program. Important underlying assumptions are not justified/supported and there are apparent contradictions that undermine confidence in the details of the estimate.

Limited benchmark comparisons with other decommissioning programs have been possible. However, those comparisons that have been possible have not raised any alarms in regard to the reasonableness of the AM estimate.

In view of the problems associated with the presentational aspects of the AM cost estimate and at the invitation of SKI, the remainder of this report is devoted to suggestions as to how the presentation of such information might be improved.

6. Report Presentation

6.1 Introductory Remarks

The decommissioning cost estimate reports published by AB SVAFO include a lot of detailed information that no doubt is backed-up by a lot of careful calculation, using methodologies that have been thought about carefully and applied in good faith. That said, if the presentation of the information leaves the average reader unsure in any way about the scope and objectives of the program and/or unconvinced about the validity of the methodologies and key assumptions and/or not having full confidence in the results, then it has not succeeded in its job.

To succeed such a report should exhibit the following principal qualities:

- Clarity, including convenient summaries where appropriate
- Absence of ambiguity
- Consistency
- Stand alone status i.e. with sufficient information to support assertions and assumptions so that extensive reference to other documents is not necessary
- Based on up-to-date information for key inputs
- Absence of unnecessary repetition
- Absence of statements on issues that are not relevant

6.2 Detailed Format

There is no unique, correct way in which to write any kind of report. However, the current format used by AB SVAFO generally tends not to meet all of the criteria suggested in the preceding section. A possible format for consideration in future reporting would be as presented in Appendix 1. Depending on the specific project being considered this might be varied a little but the main building blocks in any event should be considered for all projects. Following are comments on some of the sections proposed in Appendix 1.

3.b Statement of decommissioning objectives:

This must be clear and well defined, including any variants considered to a main case. If uncertainty exists at the stage of preparing the estimate, for example due to lack of knowledge about the radiological condition of the facility and hence uncertainty over the methods to be employed and characteristics of wastes to be generated, this should be stated, including how

the uncertainty is to be handled in preparing the estimate.

3.c. Statement on facility condition:

The main issue here is to identify factors that potentially would affect project implementation and cost, such as:

- Radiological condition
- Ease of access
- Key existing equipment
- Special factors e.g. presence of asbestos

3.d Inventories of materials etc./Equipment and Building components to be dismantled/Surface areas for decontamination/cutting

Depending on the nature of the equipment or building component to be decontaminated and/or dismantled, variously dimensions, weights and volumes would be appropriate to the preparation of a cost estimate. For example, surface area might be the appropriate measure related to manual surface decontamination and cutting up, whereas volume might be a more appropriate measure in terms of volumes of liquid waste generated from some other decontamination procedure. Size can impact costs, for instance affecting methodology in terms of cut-up and then remove, or remove and then cut-up. Economies of scale sometimes apply as well. Armed with a range of metrics it is possible to make comparisons with other benchmark information, in order to validate/support the cost estimate. I general therefore it is a good idea, wherever possible, to quote quantities in volumes and weights and any other relevant measure, rather than just using one or the other without any consistency.

4.c Proposed program of work/Labour resources required

Overall labour resources of course are an important element of any decommissioning cost estimate, so clarity regarding the required composition of decommissioning teams is important. Furthermore, overall resources when scaled can result in erroneous results. In reality teams of workers cannot shrink and expand at will on a short-term basis, unless entirely hired on a contract basis, and even then there are limitations. So the spend profile over the project and, more importantly, the profile of labour requirements throughput the project should always be looked at. A period of low activity between two

periods of higher activity in reality would not necessarily save anything on the size of the team employed, so such issues should be looked at to ensure that the estimate is not being too optimistic in regard to worker utilisation.

4.d Worker efficiencies and productivity ratios

The relevant assumptions here relate to the ratio of productive time to total time (due to radiological entry/exit control procedures for example) and secondly the productivity for relevant activities such as decontamination and dismantling.

5. Planning and institutional requirements

It would be helpful, *inter alia*, to provide an outline explanation of the main elements of the planning and approval process, with some justification/validation given for the estimated resources required.

7. Key issues and sensitivities

Any estimate of course is just that i.e. an estimate with associated uncertainty. It is therefore important to understand how robust the estimate is. A summary of the main factors that might affect the total estimated cost, with an indication of by how much, would be helpful.

8. Cost estimate/Detailed breakdowns as appropriate

The reference information used to support specific cost elements should be stated. It is always preferable to create a report that stands alone i.e. without the need to refer extensively to other reports that may or may not be readily available and may or may not present the relevant information in a clear and convenient fashion.

9.c Uncertainties/Assessment of prudent contingency provision

It tends to be common practice to add a percentage of the assessed base cost as a contingency. In order to increase confidence in the estimate, contingency amounts included should be linked to and explained in relation to the assessment of uncertainties and sensitivities as described under item 7.

Appendix 1: A Possible Report Format

1. Report Scope
2. Executive Summary
3. Facility Description
    a. Overview of facility
    b. Statement of decommissioning objectives
    c. Statement on facility condition
    d. Inventories of materials etc.
        - Operational wastes
        - Fissile materials
        - Equipment to be dismantled, by category as appropriate, including dimensions, weights and volumes where relevant to the estimate
        - Building components to be dismantled, by category as appropriate, including dimensions, weights and volumes where relevant to the estimate
        - Surface areas for decontamination and/or dismantling (e.g. for cutting)
4. Proposed Program of Work
    a. Main activities, including specific techniques to be applied
    b. Any special equipment needs
    c. Calendar time required
    d. Labour resources required, including make-up of teams needed and associated costs and variations with time over the project
    e. Assumed worker efficiencies and productivity ratios
    f. Work to be done in-house
    g. Work to be contracted out
    h. What is included/excluded in the estimate
5. Description in Outline of the Planning and Institutional Requirements
6. Decommissioning/Dismantling Wastes to be Dealt With
    a. Quantities and categorisation
    b. Destiny
    c. Associated costs
7. Key issues and Sensitivities
8. Cost Estimate
    a. Overview summary
    b. Detailed breakdowns as appropriate

9. Uncertainties
    a. Qualitative descriptions
    b. Potential impact on the cost estimate
    c. Assessment of prudent contingency provision
10. Summary of Key Information and Results

References

1. SKI report 02: 2 – R2.R0-WTR Decommissioning Cost Comparison and Benchmarking Analysis, G.Varley and C.Rusch, October 2001

2. SKI report 2003:11- Ågesta-BR3 Decommissioning Cost Comparison and Benchmarking Analysis, G.Varley, November 2002