Regulation evolution in Sweden with emphasis on financial aspects of decommissioning

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INTRODUCTION

It is generally agreed that it should be the polluters that pay. A corollary to this principle is that it is those who benefit from e g nuclear electricity generation that should pay all the future costs for decommissioning and waste management. In order for such a corollary to be implemented in practice it is necessary that costs can be estimated, that appropriate funds can be accumulated, and that money can be made available at the time when it is needed.

This is the principle underlying the recent (2006) recommendation of *the European Union Commission* on financial resources for decommissioning.[1] The Commission states that "*a segregated fund with appropriate controls on use is the preferred option for all nuclear installations*", and "*a clear recommendation to this effect is made for new installations*". Furthermore, "*as regards the estimation of decommissioning costs, … the Commission recommends a prudent calculation of costs based on appropriate risk management criteria and external supervision*". The commission finds that *"experience shows that exchange of information between national experts concerning the various approaches to and financial arrangements for decommissioning and waste management is an excellent way of facilitating a common response to safety challenges".*

However, stringent requirements on assessing and securing assets for liabilities have been in force since many years through the various national implementations of *the International Financial Reporting Standards* (IFRS) and *the International Accounting Standards* (IAS). Thus, precise calculations are to be presented each year (except for ongoing court cases), and in case estimation is difficult, various scenarios should be considered and a weighed average presented.

In Sweden, *the Law of Finance* (SFS 2006:647) regulates how the costs for decommissioning and waste management are to be calculated and paid. A fee is levied on the use of nuclear electricity and accumulated in the waste fund. In addition, the nuclear companies are obligated to provide securities for future fees (to cover the eventuality of an early shutdown) as well as for possible underestimations in the assessments.

There is a special fund for old research facilities, and payments to it will discontinue from the year 2010 (SFS 1988:1597). However, no securities apply to this fund as for the nuclear power reactors.

PURPOSE AND SCOPE

According to *Nationmaster*[2], Sweden has the highest per capita nuclear electric energy generation in the world, and ranks among the six pioneering countries on nuclear power production development[3][1]. Since the 1970'ies, *the Swedish Nuclear Fuel and Waste Management Company* (SKB) runs a comprehensive research, development and demonstration programme for management of nuclear waste[4] as well as makes recurrent cost calculations. Allocation of assets to cover future costs has been practiced in Sweden for about 30 years.

Consequently, there is a story to tell and experiences to share. Decommissioning and cost calculations may, however, be treacherous and demanding, and laws and regulations may appear as draconian. Consequently, we are still struggling with establishing pertinent approaches and methodologies. The purpose and scope of the present paper is to communicate this situation.

GENERAL NUCLEAR TECHNOLOGY DEVELOPMENT IN SWEDEN

Nuclear Power

The first Swedish nuclear research reactor was located at *the Royal Institute of Technology* in Stockholm and was commissioned in 1954 [5-6]). It was operated until 1970[6-7], and was decommissioned during 1979-1983.[7-8] The moderator consisted of heavy water from Norway and the natural uranium for the fuel (three tonnes) was "borrowed" from France. Sweden has huge natural resources of uranium. At the time, uranium-bearing

[1] From [3], page 99: "*Only six countries took part in the rush to build the first nuclear power stations – the United States, the United Kingdom, France, the Soviet Union, Canada and Sweden. All other countries were in due course to turn to one or another of these pioneers for assistance with their first power reactors and subsequent nuclear construction programs*."

shale was mined for oil production. An auxiliary mineral in this shale is "*kolm*" the ash of which contains percentage quantities of uranium. Such uranium was beneficiated from 1953 at a capacity of five tonnes per year.

Subsequently[7,9], "*the Swedish strategy*" ("*den svenska linjen*")[10] was established and applied. It consisted of use of heavy water as a moderator and natural uranium, mined and processed domestically. Most of the development work was carried out by *AB Atomenergi* (AE) at their site at *Studsvik* 80 kilometers south of Stockholm. Since the late 1970'ies the successors of AE have changed names several times and today most of the facilities belong to and are operated by subsidiaries in the *Studsvik AB* group.

The strategy included reprocessing, and comprehensive research and development work in this area was carried out in collaboration at *the Institute for Atomic Energy* (IFA) in Norway. The pilot plant for reprocessing ("*Uranrensanlegget*") at IFA was commissioned 1962 and taken out of operation in 1968. (In 1980 the IFA changed its name to *Institute for Energy Technology*, IFE.)

The Active Central Laboratory (ACL) was used during 1963 to 1998 to 2006 for laboratory scale reprocessing and preparation of mixed oxide fuel, as well as many other purposes. It had a large main hall intended for a mixed oxide fuel pilot plant, but no such plant was ever built.

The *R2* (50 MW) *light water research reactor* was commissioned in 1961 and shut down in 2005. It was used mainly for materials and fuel testing in conjunction with *the Hot Cell Laboratory* (HCL) which was commissioned in 1960 and is still in operation.

The first reactor for energy generation was *the Ågesta heavy water reactor* (65 MW, 10 MW for electricity generation and 55 MW for district heating) in the southern part of Stockholm. It was commissioned in 1963 and taken out of operation in 1973.

Twelve modern light water reactors for electricity generation were commissioned during 1972 – 1985. Nine of these are boiling water reactors (BWR:s) and three are pressurized water reactors (PWR:s). Two of the (BWR:s) have been shut down for political reasons.

Waste Management

Little has been found in the early Swedish nuclear literature on waste management.

Reference [11] mentions that "*the radioactive waste from the reactors constitutes a serious problem in the long term*".

During the period 1956 to 1977, AE published 517 reports in their open report series, two of which deal with radioactive waste[12-13]. In addition, waste management at the Ågesta nuclear power plant is described in references [14-15] from 1963-1964. The low- and intermediate level waste generated before the year 1969 was dumped in the Atlantic Ocean as a part of an *OECD/NEA* co-operation.[16-17]

In 1972, the Government appointed "*the Delegation for research on nuclear power safety and environment issues*" (*Kärnsäkforsk*) financed jointly by the nuclear utilities.[16-17] The budget for the two years 1973-1975 was M€ 13 at the price level of today.

As a part of the planning process for the modern light water nuclear power programme, a so-called *public investigation* was carried out during 1973-1976.[16-18] It compiled state of the art on nuclear waste, analyzed the needs and proposed to the Government that a programme be inaugurated for management of all residues from nuclear activities. The programme comprised, research and development, building and operation of facilities, and financing.

On proposal by *the AKA investigation*[16-17], the Government appointed a "*Program Council For Radioactive Waste*" (PRAV) in 1975. It financed nuclear waste research and took over the duties from Kärnsäkforsk.

In 1981, the main responsibility for nuclear waste research was taken over by what is now called *the Swedish Nuclear Fuel and Waste Management Company* (SKB) who hold it still today.[4] The responsibilities of SKB also include the building and operation of facilities for waste management and final disposal. Thus, *the Interim storage facility for spent nuclear fuel* (CLAB) was commissioned in 1985, and *the Final repository for radioactive operational waste* (SFR) was commissioned in 1988. One prerequisite for the consent to operate SFR was that the properties of the waste could be properly assessed.[19] Planning for decommissioning of the nuclear power reactors is carried out jointly by SKB and the respective utilities.

The responsibilities for the decommissioning and associated waste management for the older facilities rest with the various respective owners. They are all subsidiaries in the Studsvik Group except for the Ågesta nuclear power reactor which is owned jointly by Studsvik and *Vattenfall*.

In the 1980'ies, while Studsvik was still owned 100 % by the Government, new facilities were erected for treatment, repackaging and interim storage of long lived waste (that had not been subjected to seadumping, cf above).[19-20]

There exists no document for the Studsvik – Vattenfall owned facilities similar to the SKB RD&D Programme[4]. However, there are agreements with SKB that provide for final disposal of the waste in the SKB facilities.

Decommissioning

We have found no report among the 517 published by AE during 1956 – 1977 that deals with decommissioning. Neither have we found any mentioning of it in various domestic literature from before 1975 (this includes references [5,14]). We have found a textbook from 1964 on design of nuclear facilities[21] but no mentioning in it on preparing for decommissioning.

The AKA investigation[16-17], however, has a separate section (4.2.3) on decommissioning. The Ågesta nuclear power reactor had been taken out of operation two years before the first AKA report[16-17] was published in 1975. It says that *"In conjunction with the secession of the operation, there was a possibility to make radiological and other surveys with the purpose to gain experience for decommissioning of nuclear power plants. It was assessed, however, that the costs involved would not be justified in relation to the expected value of the results."*

A number of practical actions were taken, however, in order to turn the reactor into a suitable state for maintenance at a low level for possibly many years before final decommissioning. The actions included removal of all the fuel, the heavy water and any readily removable radioactive items. This first stage of decommissioning required 30 man-years at a total cost of M€ 2,2 at the cost level of today.

Two decommissioning projects of appreciable size have subsequently been carried out in Sweden: the R1 reactor in Stockholm and the Active Central Laboratory (ACL) at Studsvik.

The first Swedish nuclear reactor, R1, was located in rock under the Royal Institute of Technology in Stockholm. [5-6] It was fuelled with metallic natural uranium and had heavy water together with a graphite reflector as moderators. It had a maximum thermal power of 1 000 kW. The reactor was commissioned in 1954 and shut down in 1970 after having been used for 65000 hours for various research purposes.

A radiological survey for decommissioning was started in 1979. Work began on site in 1981 and went on during until 1983 when green field conditions had been attained.

The facility had very little conventional equipment and structures and therefore the decommissioning work had to be planned and executed using specially designed tools and other equipment as well as protective shields.

The sampling of the graphite reflector was limited at the planning and cost estimating stage since it gave rise to dose to personnel. It turned out once the reactor tank had been lifted that the dose rate was considerably higher than assessed. This meant a cost increase for this part of the project.

A timber handling machine was modified with a pneumatic hammer and remote controls. This made the work much more efficient and saved dose, and helped in reaching all the targets for the project.

The time schedule was followed and the radiological doses to the staff were under control and kept low. Studsvik was granted a total of MSEK 25 for the demolition of R1, but the outcome was only MSEK 21,7. This corresponds to M€ 9,6 and 8,4, respectively at the price level today. A general description of the decommissioning project can be found in references [7-8]

The Central Active Laboratory (ACL) at Studsvik was part of the early Swedish domestic concept with natural uranium fuel, heavy water moderation, reprocessing and mixed oxide fuel. It was used for laboratory scale reprocessing and preparation of mixed oxide fuel. The main hall was intended for a mixed oxide fuel pilot plant but no such plant was ever built. The facility had had a very varied use, much of which with high alpha to gamma ratios.

The laboratory was built during 1959 to 1963 and was decommissioned during 1998 to 2006. It had a total floor area of 14 200 square meters.

Progress reports and experiences from the decommissioning have been presented in references [22-24]. There are substantial differences between the cost calculations at the different stages, and most of them also deviate considerably from the final outcome. The reasons for this include the high alpha to gamma ratios and the varied use implying that the level of contamination varied substantially between different rooms. We are not aware of any final official figures and reporting.

PERSPECTIVE ON THE EVOLUTION

It is sometimes warranted to deal with the past in order better to shape the future. This is especially pertinent in nuclear technology where long term perspectives apply not only to final storage of waste but also to use of facilities e t c.

Hearsay might be valuable in this respect but caution is warranted since historians recurrently warn against the fallibility of human memory and notoriously look for written sources. This has been the approach also in the present work and the rationale for the abundant old references and citations.

It should also be recognized that all stakeholders – enlightened professionals as well as initiated non-professionals – may be susceptible to trends and emotionally influenced views. Therefore, analyses of events and trends from the perspectives of those who were in them might help us today to prepare ourselves in our work for the future.

An early source from 1950[25] states the following: "*The control of radioactive effluents from nuclear reactors and separation plants, and the disposal of waste material from biological and chemical laboratories are important aspects of radiation protection. … At the present time the quantity of waste is not large, but if, as is anticipated, there is an increased utilization of nuclear fission energy, the amount of effluent to be treated will increase accordingly. Fortunately, research on the development of atomic energy and on the disposal of waste is being carried out simultaneously, so that progress in the latter will undoubtedly keep pace with the former.*"

According to SKB[26], the history of nuclear power in Sweden can be divided into the following three phases:

1945-1972	waste is no real problem
1972-1984	waste is a big political issue; basic model developed
1984-present	development of basic model for waste management

According to [27], the Government spending for development of the Swedish nuclear programme during the years 1955-1975 was G€ 1,55 at the price level of today. As illustrated above, only a small fraction of this was spent on waste management and decommissioning.

According to SKB (see www.skb.se), "research and administration" of the Swedish nuclear waste programme will amount to a total of G€ 1,90 at the price level of today. One of the underlying assumptions is that the ten reactors in operation today will remain so for a total of 50 to 60 years. The SKB research is financed through our Government controlled fund system. The amount of publicly financed nuclear research outside the areas of safety, waste management and decommissioning has been small, in comparison, for many years.

Obviously, the prediction from 1950 above on a coherent progress in nuclear technology did not materialize at all in the case of Sweden.

What is then the rationale for the difference? Did people not understand the waste problem before 1972? If they understood the problem, why did they not attend to it?

In 1956, Rolf Sievert (who gave name to the radiological unit) wrote: "*Today, we see the waste issue (disregarding radioactive warfare) as the most serious of the radiation protection questions …* ".[28] The year after, he sent his employee, Bo Lindell, to the United States and Canada to learn about nuclear waste management, and the records from this tour[29-30] are the best source we have found with contemporary insight on this matter. (Bo Lindell later became amongst other things Professor and Director General for *the Swedish Radiation Protection Authority*).

The study tour was arranged under the auspices of *the United Nations World Health Organization* (WHO), who afterwards received an 80 pages long comprehensive trip report.

Bo Lindell conclusions were as follows[29]: "*By now I have heard all kinds of views on the hazard of atoms. Of course waste should be sunk into the sea. It is infantile even to consider releasing waste into the sea. The waste problem will have a decisive impact on the profitability of nuclear energy. There is no problem with the waste. We can inflict damages for generations to come. Our present practice is fully adequate. E t c … When I now {i e in 2003} look through my report {i e [30]} again I am surprised by how much was actually known about the waste problems almost 50 years ago.*"

Actually, much of the research in the United States at the time was focussed on attempting to use the waste (mainly high level waste from reprocessing) as radiation sources although simple considerations would have unveiled the lack of realism of this approach.[29]

Further illumination of the issue of awareness might be obtained from the fifth semiannual report[31] of *the US Atomic Energy Commission* (USAEC) as quoted by Hines[32]:

"*Over the many decades during which physicians have used X-rays and radium for the treatment of disease, they have become familiar with the harmful effects of overdoses of radiation. Biologists have assisted by studying how radiation affects plants and animals. ... By the time that atomic energy was developed, therefore, science was already familiar with the biological effects of most types of radiations.*

What was new to the biologist and the physician in the development of atomic energy was the massive quantity of radioactive materials created and the greater potentialities of these materials for both good and ill. The Atomic Energy Commission has the obligation to investigate these potentialities and to encourage and assist others to do so. It must explore the many benefits in prospect ... and it must learn how to forestall the dangers to human, plant, and animal life."

Obviously, the USAEC as well as Hines were well aware of the problem. Hines studied the radiological effects of nuclear bomb tests in the Pacific[32] and also generated one of the first comprehensive risk assessment for a major nuclear power reactor accident.

Perhaps it is easier to fully respond to issues that are close in time and space. Waste research caught on speed after the experiences had been made with the design, construction and operation of the Ågesta reactor, and when the reactors of the modern generation were being built and the associated waste was soon to be generated.

No such strong connection exists for decommissioning and it can therefore be expected that the topic will receive sub-optimally low attention unless compensation is made by sufficient application of scientifically and technically sound imagination. Lack of such a balanced perspective will result in a misleading basis for decisions, discrepancy between forecasts and outcome and associated loss of trust, as well as collection of insufficient financial resources in the monetary funds.

The topic of decommissioning has received a very substantially increased attention internationally during the past 10-15 years. A significant part of this development is the issuing of various recommendations and other reports by IAEA and OECD/NEA. Recently, as mentioned above, the EU has issued its recommendation "*on the management of financial resources for the decommissioning of nuclear installations , spent fuel and radioactive waste*".[1]

Furthermore, conversations at international meetings reveal that deviations between projected and incurred costs are frequent as are disagreements between different independent estimates for the same facility.

Actually, there are two sides of this coin. One is the expectations and requirements from the financing side, and the other is what is reasonably achievable in terms of precision considering the state of technology and cost estimation methodology.

Accordingly, the subsequent sections will deal with development of the Swedish system of finance, and with the prerequisites for accurate and reliable cost calculations. Finally, examples will be given on practical approaches.

DEVELOPMENT OF THE SYSTEM OF FINANCE TOGETHER WITH ASSOCIATED REGULATIONS

An overview of the development of the Swedish system of finance was presented by Olof Söderberg (then chairman of the Swedish nuclear waste fund) at a meeting of what is now called *the Swedish National Council for Nuclear Waste* (formerly KASAM).[33] Some highlights from this article are given in the following.

It was presupposed in the AKA public investigation[17-18] in 1976 that all costs for waste management and decommissioning, including research, should be carried by the nuclear power utilities. It was proposed that funds should either be set aside in the accounts of the companies, or accumulated by the Government. Based on preliminary considerations, AKA proposed, that the fee should be € 0,24 per kWh at the price level of today (at present the fee is € 0,10 – 0,16 per kWh).

In 1977, the Government concluded that generally accepted auditing standards in Sweden imply that decommissioning of nuclear power plants as well as future costs for waste management should be recognized as liabilities in the financial statements (annual reports) of the companies and that corresponding financial assets should be accumulated. This Government also found it reasonable that such allocations of assets should not generate taxation. The Government proposition became law in 1978, and as a result, a total of M€ 651 were accumulated during 1978-81.

In 1978, the Government commissioned a public investigation on a system of finance, and this eventually led to a law (1981:669) in 1981.

The basic principles of this law are as follows:

- The costs for the management of the spent nuclear fuel and for decommissioning e t c is to be covered by fees on the production from the nuclear power plants.
- Fees are to be paid and low risk assets are to be accumulated in Government controlled external funds.
- The owners of the facilities in question are responsible for actually carrying out the various tasks and actions needed.
- The Government has the long term responsibility for the waste (presumably after closure of the disposal facilities).

In 1981, the Government also instituted a new agency, *the Committee For Spent Nuclear Fuel* (NAK) with the objective to manage the system of finance. A couple of years later, NAK was reorganized and changed names to *the National Board for Spent Nuclear Fuel* (SKN). In 1992, the tasks of SKN were taken over by *the Swedish Nuclear Power Inspectorate* (SKI) which in turn will merge with *the Swedish Radiation Protection Authority* (SSI) on July 1st this year (2008).

Today, it is the duty of SKI to review cost calculations submitted by the nuclear utilities and their jointly owned daughter company *the Swedish Nuclear Fuel and Waste Management Company* (SKB) as well as Studsvik, and to propose the level of the fee to the Government. SKI also oversees the disbursements from the funds when they are used for the intended purposes.

The administration of the financial assets has been carried out separately, and presently this is the duty of *the Swedish Nuclear Waste Fund*.

The financing of the management of the waste and decommissioning of the facilities for the Swedish nuclear technology development programme was not included in the initial law of finance (1981:669). Instead, this was covered in a law in 1988 (1988:1597) on financing of certain radioactive waste e t c (the so-called *Studsvik law*). It was reasoned, that the research carried out in these facilities was a prerequisite for the design and construction of the modern nuclear power plants. The costs for waste management and decommissioning should therefore also be carried by the users of electricity from the nuclear power plants.

The Studsvik law was passed while Studsvik AB was still owned to 100 % by the Government. In the early 1980'ies, Studsvik was transferred into a publicly trades stock company, and this is the situation still today.

The Studsvik law (1988:1597) will be revoked by the end of the year 2009. The new law on finance (2006:647) states that the funds accumulated to cover environmental liabilities for old nuclear research facilities can only be used for what is intended in the Studsvik law (1988:1597) and that any superfluous assets will be assumed by the Government. Furthermore, since no fees will enter this fund after the year 2009, it can be concluded that any insufficiencies will have to be covered by the owners of the old research facilities.

This arrangement presupposes that the associated cost calculations can be carried out with a high precision even at early stages since otherwise either unintended taxation will occur, or the financial burden on the present owner might become unreasonable or even unbearable. The prerequisites for such calculations are therefore described and analysed in the subsequent section.

ANALYSIS OF COST ESTIMATION PREREQUISITES

Cost calculation methodology for chemical plants and similar

According to standard textbooks e g [34], several stages can be identified in the successive cost calculations typically made for a large chemical plant or similar. The first stage is an order of magnitude (ratio estimate) based on similar previous cost data, and it provides probable accuracy of estimate of not less than ± 30 percent. The last stage is a detailed estimate (contractor's estimate) based on complete engineering drawings, specifications, and site surveys, and the probable accuracy is within ± 5 percent.

Cost calculations for special cases

Larger errors can be expected in a number of cases, however. This has been analysed for non-nuclear facilities by Esbjörn Segelod who also gave a presentation[35] at a seminar held by the Swedish National Council for Nuclear Waste (formerly KASAM), and his conclusions were as follows:

1. Cost overruns are more common than the opposite.
2. Cost overruns are higher for odd and unusual projects.
3. Cost overruns are higher in percent for small projects.
4. Cost overruns are higher for longer times between decision on budget and incurred cost.
5. There is a positive correlation between cost overruns and other types of deviations from plans (e g delays).
6. Cost overruns are higher for new and advanced technology.
7. Estimators, and especially entrepreneurs, tend to underestimate costs and schedules.
8. Projects for which the costs are underestimated have a higher probability of being conducted than those for which the costs are not underestimated.
9. Cost overruns are more common in certain organizations than others.
10. Cost overruns are not always smaller today than 50 – 100 years ago.

Cost calculations for decommissioning of nuclear research facilities

Several of the above ten points apply to nuclear research facilities, and thus higher uncertainties and systematic underestimations can be expected in comparison to an "ordinary" chemical plant.

Moreover, most of the overruns in decommissioning are related to the fact that facilities are nuclear in character. Consequently, the Swedish Nuclear Power Inspectorate, partly in co-operation with other organizations in the Nordic countries, has conducted various information search and research activities to find the most important reasons for this together with their remedies.[7-8,36-43] The following factors have been found to be among the most important ones for a successful planning and reliable cost estimates:

- Follow IAEA and OECD/NEA recommendations and similar
- Find information from other similar facilities
- Carry out radiological characterization for the purpose of decommissioning (usually substantially more extensive than that which is required for operation)
- Carry out an appropriate technology selection with preparedness and flexibility to change methods when warranted
- Carry out a risk identification / risk assessment type of analysis to find and evaluate "cost raisers"

Guidance for the latter can be found in an ASTM standard for estimation of environmental liabilities in general.[44]

The conclusions of the work carried out[7-8,36-43] include the following:

- Nuclear research facilities are very different from nuclear power plants and cannot be dealt with in the same manner.
- Costs for decommissioning of nuclear research facilities are among the most difficult ones to estimate
- If great care is taken (cf above), a precision of ± 15 percent might, nonetheless, be attainable in many cases even at early stages.
- More or less concealed circumstances may easily increase this uncertainty a few or even several times.
- Comparison with incurred costs for similar facilities is essential.
- The characterization (radiological and otherwise) must be carried out in sufficient detail in order for data on incurred costs for similar facilities to be fully utilized.

EXAMPLES OF RECENT AND ONGOING ACTIVITIES

The Swedish Nuclear Power Inspectorate (SKI) carries out various research activities in support of its task to oversee the system of finance. For many years, this has comprised work financed solely by SKI. It was realized in the course of this work that also three of the other Nordic countries (Denmark, Norway and Finland) had had ambitious nuclear technology development programs and therefore also have the associated need for planning for decommissioning, including financial planning. Moreover, since these Nordic countries have a substantial number of old facilities among us – at various stages of decommissioning – the basis for comparison would be much greater in a collaboration.

SKI thus took initiative to a co-operative project and this work has been in progress for more than three years. The results of the work have recently been presented internationally[7] and are briefly as follows:

- A compilation of best practice with emphasis on radiological characterization, method selection, financial risk analysis and calculation methodology.
- A compilation of examples of decommissioning projects, one from each of the participating countries.
- A compilation of a knowledge base from the various pieces of information that have been submitted for sharing.
- Plant visits.
- Networking to facilitate informal contacts.

The work for the next few years includes comparisons with plants of similar types outside the Nordic countries.

SKI is also compiling old written material that illuminates how the various nuclear research facilities were used. It is expected that such knowledge will be helpful when the various facilities are to become decommissioned. Unfortunately, Sweden does not have comprehensive compilations of the history of the research activities and facilities the excellent way that Norway[45] and Denmark[46] do.

DISCUSSION AND CONCLUSIONS

General decelopment

In the international literature, the Swedish system of finance is frequently put forward as a good example of how the polluter pays principle can be robustly implemented in practice.[47-48]

Indeed, there appears to be a general consensus around the system of finance and also a satisfaction with the way in which it has functioned so far, especially in conjunction with the financing of new facilities.

Actually, since Sweden was very early internationally to implement segregated fund systems, it might reasonably be expected that there would be a number of lessons learned to share. In a general perspective, the experience is very positive, however.

Nonetheless, we do see challenges for the future, for different reasons, some of which relate to experiences made.

The merger between SKI and SSI implies that the way in which the various tasks of oversight are carried out is being reviewed, and thus any such challenges are being included in that process.

New requirements as well as improved and stricter enforcements of existing ones are materializing as a result of the ongoing rapid international development (cf above).

Data on incurred costs for decommissioning of nuclear facilities are being accumulated in continuously improved forms for comparison. Methodologies for calculation and comparison are being extended from large modern facilities to small odd old research facilities, and this can be expected to lead to sharply improved methodologies for such types.

The general development in the area of environmental liabilities, including implementation of rules and standards for accounting, can also be expected to give rise to improved methodologies together with sharpened requirements.

The research carried out and financed by SKI clearly indicates that efficient means to meet these expectations and requirements include active learning processes with information exchange and openness.

The closing of the Studsvik fund

The challenges for the future also include those associated with the fact that Sweden probably is the first country to face in the near future the finalization of the accumulation of fees to a fund.

Being first requires special caution since there has been no-one around earlier to discover any pitfalls.

A first question in this regard would therefore be if the precision of the historical cost calculations have corresponded to the assumptions underlying the closing of a fund. The answer to this question might be that a small number of specific items have had an unexpectedly high influence on the total cost for old research facilities.

A second question is whether the uncertainty margin of the present estimates is in concordance with the closing. This issue is under development, as is described above for the work financed by SKI. Of course Studsvik AB and its subsidiaries, and especially Svafo AB, are also aware of the situation and have strengthened their capacity for planning significantly during the last several years. The annually submitted cost calculations have also improved substantially e g regarding error margins but do not yet in all respects[41-43] correspond in to the level defined by the new ASTM standard.[44].

It was mentioned above that any superfluous assets in the Studsvik fund will be assumed by the Government while any insufficiency will have to be covered by Studsvik and its subsidiaries, and perhaps also Vattenfall.

Certainly, the intent from all sides is for the assets in the fund to precisely balance the needs. However, the state of the matter is that the nuclear utilities collecting the fees might be reluctant to debit anything that might become redundant since such assets will be assumed by the Government. Conversely, all parties, and especially SKI and Studsvik are anxious that the funding will be sufficient so that the solutions will implemented in a timely manner and in a way that is appropriate from a health and environment point of view.

It is possible that any lack of correspondence between calculated and incurred costs will evidence itself only after a few decades. The present plans call for the disposal of the long-lived waste from Studsvik during 2040-50. It can be expected, however, that any such mismatch will only be more difficult to resolve with time.

It is therefore important that the practical limits for the reliability of cost calculations be explored and that the results be on one hand utilized in the present cost calculations and on the other hand related to the present legislation and its underlying assumptions.

In the planning and execution of this work it is important to take advantage of the lesson of the past on the importance of using ones imagination in combination with good science and technology in order to manage that which may be somewhat remote in space and time.

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