Project Evaluation of the Decommissioning of a Laboratory Plant in Studsvik

H.R. Hedvall, K.H. Stridsman, S.R. Berg, B. Johnsson
AB SVAFO, Studsvik
SE-611 82 Nyköping
Sweden

ABSTRACT

The largest decommissioning project of its kind so far in Sweden has taken seven years. Fourteen thousand square metres have been decommissioned by a small group. In October 2005, a final application was made for free release of the buildings. Demolition of the building is planned for April 2006.

The nuclear laboratory plant was contaminated with Co-60, Cs-137, Sr-90, H-3 and transuranic nuclides. The aim of the project was to clean up the laboratory to release levels, and then final demolition.

Decommissioning has been under way since 1998.[1] The plant was built between 1959 and 1963 for use as a research facility for reprocessing spent fuel, research on plutonium-enriched fuel, material testing and test fabrication of rods with MOX-fuel. The THOR technology with pyrolyses was developed here and is now being used by Studsvik in Erwin, USA.

A thorough final evaluation of the project is presented in this paper.

INTRODUCTION

The decommissioning of the former nuclear Active Chemical Laboratory plant (ACL) and Active Chemical Filter building (ACF) has been under way since 1998. In October 2005, an application was made to the Swedish Radiation Protection Authority (SSI) for free release of the buildings. A thorough final evaluation of the project has been initiated, and this paper will focus on the results and lessons learned from seven years of decontamination and decommissioning work during the project.

The laboratory building has been used for a wide variety of nuclear technology development projects, e.g., reprocessing of fuel, fuel production, fuel cladding and experiments with transuranic elements. From the late seventies and throughout the eighties, the ACL building was used for operations such as material testing in hot cells, production of radiation sources and storage of fissile materials. The ACF building is a filter and ventilation building for radioactive air streams from the ACL laboratory. Prior to decommissioning, the buildings were contaminated, mainly with Co-60, Cs-137, Sr-90, H-3 and transuranic nuclides such as Pu and Am.

The performance part of the project focuses on the lessons learned from the project with regard to planning, organization and management. The advantages and disadvantages of the slimline organization of the project, especially the management, are discussed.

Project costs prior to 1998, for a preliminary project involving the dismantlement of some test equipment and glove boxes, are not included in the cost evaluation. Nor are cost entries such as intermediate and final storage of radioactive waste and demolition of the free released buildings.

The advantages and disadvantages of using manual (hand-held) equipment are discussed, as are the advantages of extended use of *in-situ* gamma spectroscopy.

The cost part of the project includes information on project costs for the following entries:

- Cleaning, dismantlement and decommissioning
- Manual measurements
- *In-situ* gamma spectroscopy measurements and analyses
- Waste treatment (melting, incineration)
- General purchasing
- Consultants (radiological experts)
- Project management and administration

AUTHORITY REGULATIONS

No formal requirements for the management of spent fuel and radioactive waste were established in Sweden until the late 1970s. Decommissioning regulations were developed in the 1990s. SSI has not yet defined any formal nuclide-specific release limitations. New regulations for free release (clearance) are planned from 2007.

The limit for release to unrestricted use for the first Swedish reactor R1, which was decommissioned between 1981–83, was set at 8 kBq/m^2 by the authorities. This limit was specified for that project only. The limit for a small "alpha" lab in 1985 was set at 40 kBq/m^2.

At the start of this project, the authority had no clear directives, and much effort was spent at the beginning of the project to decide what level to use.

More specific decommissioning clearance levels (used for the Studsvik Laboratory Plant, ACL) were not decided until 2001 and shown in Table I.

The conditions stated that the project should:

- Perform reasonable clean-up activities

- Show compliance with EU recommendations RP 113 [2] (surface activity levels for demolition) for the expected nuclides

- Make nuclide-specific measurements of residual activity
- Search for spot activity, if spots exceeding 150 Bq alpha or 1500 Bq beta/gamma are suspected
- Disregard naturally occurring activity that cannot be attributed to the operations performed at the facility
- Take measures against re-contamination of cleaned areas

Table I. Specific Decommissioning Clearance Levels for ACL

Nuclide	Activity (kBq/m^2)
Co-60	10
Cs-134, 137	100
Sr -90	1,000
H-3	100,000
Pu-238, 239, 240,	10
Am-241	10
Pu-241	1,000

After decontamination it was found that more than 99% of the radioactivity in the remaining building, 20 000 tonnes, was natural.

PROJECT PERFORMANCE

AB SVAFO is running Sweden's largest decommissioning project so far. The project is almost at an end. Fourteen thousand square metres divided into four areas are being decommissioned by a small group. The aim of the ACL and ACF project has been to clean up the laboratory to release levels, and then final demolition. There has been extensive interest in the project, and the international Technical Advisory Group (TAG) of the OECD countries has taken part in the ACL project.[3]

ACL was built between 1959 and 1963 for use as a research facility for reprocessing spent fuel, research on plutonium-enriched fuel, material testing and test fabrication of rods with MOX-fuel. The THOR technology with pyrolyses was developed at ACL and is now being used by Studsvik in Erwin, USA.

The decommissioning of the former nuclear "Active Central Laboratory" (ACL and ACF building) has been under way since 1998, though six laboratories in Area 1 had already been decommissioned and accepted by the authorities as a free released area. The decommissioning work in these six rooms was performed during 1988-1990.

Some preparatory work was carried out in the period between 1992 and 1998. Radiological equipment, more than 70 glove boxes from the plutonium work performed and most of the test facilities were treated and disposed of as waste. Some of the furniture was also treated and disposed of.

The laboratory activities at ACL ended in 1997. The laboratory was acquired by AB SVAFO from Studsvik Nuclear AB in 1998. An application for free release of the buildings will be made to SSI in September 2005. A thorough final evaluation of the project has been initiated, and this paper will focus on the results and the lessons learned from the seven years of decontamination and decommissioning activities during the project.

PROJECT COST

The project organization leadership consisted of a group of four persons: the project leader, the deputy project leader and the leaders for measurements and decontamination staff. The group had at least one regular meeting a week to discuss and plan the current work.

There was another organizational group consisting of representatives for the purchaser, main contractors, expert consultants and leaders of the project. The purpose of this group was to provide information on the continuing work, including measurements and analyses, problems, contacts with the authorities, the timetable and the budget. This group had one regular meeting a month. The group comprised nine persons with different functions: buyer, project leader, radiation protection officer, safety, radiation physicist, measurement technician and assistant, manager of the radiation protection group and manager of the decontamination staff. The radiation protection group and decontamination staff consisted of between two and ten persons depending on the job situation.

Cost calculations for the project, made in 1988 when a decommissioning fund was raised, put the estimated cost of decontaminating the building, excluding security and safety and some administration at MSEK 74 (MUSD 9.25). Ten years later, in 1998, it was decided that decommissioning should take two years, even though the first plan had stated three years. The total cost of the project was set at MSEK 20 (MUSD 2.5). By 2000, the cost had trebled and it had become clear that the project would take even longer. The decontamination and measurements took longer than planned due to a delay in the delivery of the instrumentation and more time spent on tank and pipe measurements. The pace of work also slowed down at the end of the project.

The costs for clearing Area 1, which was cleared between 1988 and 1992, and the preparatory work between 1992 and 1998 were estimated at MSEK 30 (MUSD 3.75).

The cost for the main project, after 1998, was MSEK 70 (MUSD 8.75). The cost split between the different entries is shown in Figure 1.

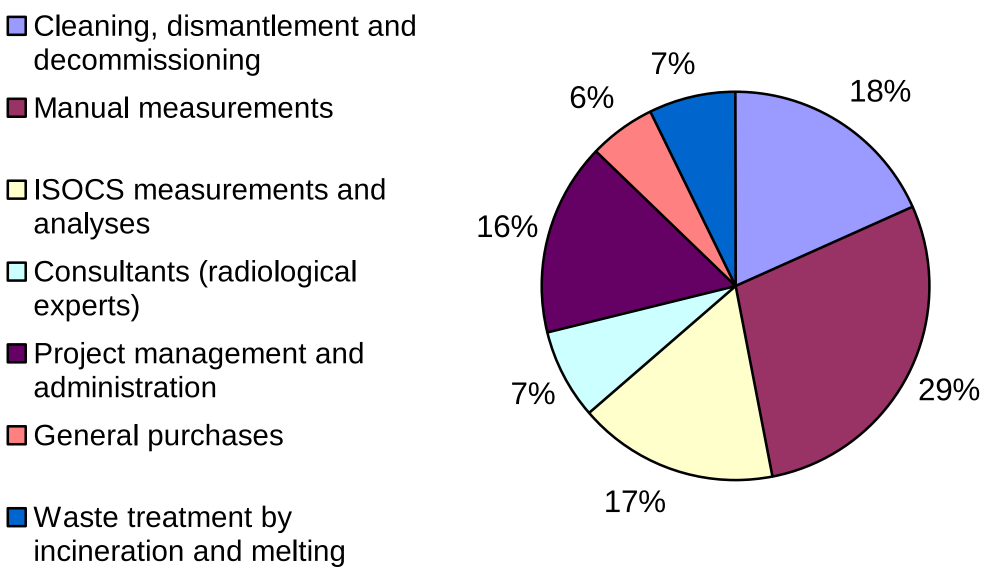

Fig. 1. Decommissioning costs.

TECHNICAL ISSUES

A total of 41,070 smear tests were used on all the surfaces. The number of samples taken at the different areas is specified in Table II. The free release limits used were 4 kBq/m^2 beta/gamma and 0.4 kBq/m^2 alpha. One sample was taken per m^2 of floor and wall up to 2 m. Above this level and on the ceiling, one sample was taken per 4 m^2. Manual hand dose rate measurements with mini 1500 instruments with probe DP6AD were used on all surfaces (38,536 m^2). As a complementary check, 8-hour measurements with an *in-situ* gamma spectrometry technique were used (36,675 m^2).

Table II. Measurements in ACL and ACF for Different Parts of the Buildings

	Smear tests [no]	Manual dose rate check [m^2]	Measured by *in-situ* gamma spec [m^2]	Total surface [m^2]
Area 1	5,740	7,400	5,600	10,600
Area 2	10,112	7,126	8,090	9,962
Area 3	13,764	13,656	12,110	18,441
Area 4	11,454	10,354	10,875	12,536
Total	41,070	38,536	36,675	51,539

Surface contamination after decommissioning is shown in Table III. If zero values are used instead of the MDA figures, the total activity would be 5 MBq and alpha 0.3 MBq. The true value is closer to 5 than 127 MBq.

Table III. Over-Estimated Figures When Using MDA Values

	Average surface contamination, all nuclides [kBq/m^2]	Average surface contamination, alpha nuclides [kBq/m^2]	Total activity [MBq]	Total alpha activity [MBq]
Area 1	2.2	0.4	20	3.5
Area 2	2.3	0.35	22.8	3.5
Area 3	2.9	0.43	53	8
Area 4	2.5	0.38	31	4.6
Summary	2.5	0.4	127	19.6

Of the waste produced, excluding ash and ingots, 30 drums (200 l) of mixed waste will be sent to interim storage. This waste consists of crushed concrete and dust, PVC linoleum, rubber and glass with a total activity of approximately 300 MBq. The final waste after melting and incineration has not been measured.

The radioactive combustible waste, mainly from materials from the cleaning operations, was sent to the incineration facility in Studsvik. The waste after incineration, 41 tonnes, was reduced by 90-95 % of the incoming waste volume.

Scrap metal was sent to the melting facility and consisted mainly of steel and aluminium. Approx 95 % of the metals, 120 tonnes, were free released as ingots after the melting procedure.

Almost 50 tonnes of removed concrete, asbestos and insulation materials were deposited at a community dump.

Compared with the natural activity of the remaining building materials, the contamination was less than 0.07 %.

CONCLUSION AND LESSONS LEARNED

Seven years of work raised the question: what have we learned? The entries below present some items highlighted by the project management and the purchaser.

- Organization

An assistant for the project leader would have made follow-up more efficient. Experts in instrumentation and statistics are also important. Three persons had good knowledge of the building, which was very useful, but better knowledge about practical decisions would have made the project more efficient in terms of time. Interviews and historical facts are important when choosing which nuclides are of most interest for measurements.

- Contracts with incentives

In order to adhere to the timetable and maintain the quality of the work performed, contracts with incentives have been discussed. Does a contract with incentives affect the quality of the work performed when, for example, you have manual hand-held dose rate measurements where each measurement takes a long time (monotonous work)? Contracts with incentives must make it very clear that it is not only the time factor but also the quality of the work that is important. The purchaser must be aware of and have some kind of check routines in place if contracts with incentives are used.

- Partnership purchaser-contractor

“It is not a question about *if*, rather *when*, something unplanned arises in a decommissioning project.” This statement says a lot about the kind of project we are dealing with. One lesson learned from this is that when a contract is under negotiation, both the purchaser and the contractor must be aware of the risks. The contractor must specify as much as possible in detail and also take care of the unexpected that will arise. There shall be no discussion on how such situations will be carried out. A strong partnership between purchaser-contractor is of great importance to a successful project.

- Staff turnover

Sweden is a small country. One challenge the project has faced is that of staff turnover for the free releasing and decontamination work. In Sweden, it is difficult to replace staff on a short-term basis. Not many persons in the nuclear business in Sweden have the right background and education (health physics) together with experience of decommissioning projects. An action plan is needed on how to solve these kinds of situations.

- Key cost entries – a strategy for cost evaluation

Different kinds of key costs are required to evaluate and compare projects. This was planned for from the beginning of the project, but there were no discussions between the project management and the purchaser on what such a strategy should look like. From a purchaser’s point of view, demands for a strategy on cost evaluation must be a high priority.

- Communication plan – authorities and the media

During the project, there has been an open dialogue with the authorities, with questions discussed in advance. To hold an open dialogue with the authorities, the purchaser and the project management need a communication plan that deals with questions like: Who will provide the information? What information will be given? When will the information be given?

- Documentation

Updated blueprints are essential to project planning. The most important of these are drawings for ventilation, water and drainage. It is also essential to know about concrete type, system changes and rebuilding. The daily documentation is important should there be a request for a summary or an exchange of experiences.

- Exchange of experiences

Cooperation is important. Meetings with the international TAG of the OECD countries made it possible to see other decommissioning projects. This was very useful.

- Instrumentation

The choice of instrumentation has an effect on efficiency. Using hand-held instruments is time-consuming and demands a high degree of patience from the staff. It is also clear that detectors with a large detector area are more efficient than those with a smaller area. *In-situ* gamma spectrometry was not used from the beginning but is a good complement and should have been used from the start, as well as during pre-studies. Technical problems at the beginning, together with late deliveries, slowed down the project.

The gamma *in-situ* spectroscopy had several benefits:

- Discovery of sub-surface contamination not detectable with hand-held equipment.

- An efficient way of specifying the total amount of activity left behind (within the free release conditions).

- It is important to optimize the specific area for each measurement in the project (with regard to the actual nuclides, demands for detection limits, contamination dominated by hot spots or further spread of contamination).

- An important tool for quick radiological mapping – are there high contamination levels in a specific room?

- It is important to have a plan before starting any measurements. The plan should describe different "measurement levels/programmes" (the accuracy of measurements) with regard to, for example, control measurements in a non-radiological area compared with thorough measurements in a highly contaminated laboratory. (What measurement level/programme is used after facing activities where they are not expected, perhaps in a non-radiological restriction area?)

- It is important to have a statistical approach to the measurement programme and the different scenarios in the measurement plan.

- It is important to try to shape the measurement programme in a specific room/part based on the background information (and to try to extract historical/background information).

No internal or external radiation doses were received during the seven-year decommissioning project.

REFERENCES

1. Decommissioning of the ACL and ACF plants in Studsvik, Sweden. WM 04 Conference, February 29 - March 4, 2004, Tucson, AZ, USA
2. Recommended radiological protection criteria for the clearance of buildings and building rubble from the dismantling of nuclear installations, Radiation Protection No. 113, Luxembourg, 2000, ISBN 92-828-9172-0
3. Decommissioning activities at the ACL and ACF plant in Studsvik. 39th Meeting of the Technical Advisory Group, 3-7 October 2005, Cadarache, Marcoule and Creys Malville, France