# EMPTYING OF THE OLD STORAGE FOR INTERMEDIATE LEVEL WASTE IN STUDSVIK

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## ABSTRACT

The emptying of the storage for solid intermediate level waste (denoted AT) and reconditioning of that waste are reported. The waste was produced in Studsvik in the period of 1960-1984 and the storage was emptied during 15 years, from 1986 to 2001.

The storage was built in the 60-ies and extended in the 70-ies and waste was disposed in the storage until 1986 when the last transport arrived.

In 1986 the emptying of the facility started and went on until 2001 when the last transport of waste left the facility. The waste from the facility was treated in the nearby hot cell building, partly built for handling of the waste from the old intermediate level waste storage.

This paper will give a background to the waste that was originally stored in the in the facility, the planning of the emptying as well as an overview of the actual removal and re-packing of the waste. Lessons learned will also be given. One of the most important lessons learned during the this project was that, when introducing equipment for retrieving waste or for cutting or in other ways handling the waste, don't chose the most sophisticated equipment. Why can one ask and the answer is that it will eventually break and then it will be contaminated and sometime to such degree that can't be repaired, and the invested money wasted. From this project we have first hand knowledge of just such frustrations and like to share our experiences.

## INTRODUCTION

Studsvik is today both the name of the company and the site where it is located. In order to understand the logistics in the project the history is shortly described below.

The Studsvik site was opened in 1955 for what was then called AB Atomenergi, which belonged to the Swedish government. AB Atomenergi was actually formed in 1947 and at that time situated in Stockholm. The Studsvik site is located about 100 km south of Stockholm on the Baltic shore. AB Atomenergi changed its name to Studsvik AB in 1987. Studsvik RadWaste AB is a subsidiary to Studsvik AB.

Studsvik RadWaste AB incinerates waste from nuclear power plants, hospitals and fuel manufacturers since the middle of the 1970-ies. The permit for incineration limits the waste that is allowed to be incinerated to operational waste, i.e. not containing large amounts of □ nuclides. Uranium contaminated waste is a special case, however, which can be treated.
Studsvik RadWaste AB also operates a melting facility for low-level metallic waste. In the facility steel, aluminium, brass and copper is melted and thereafter measured and free released for unconditional use outside the nuclear industry, according to Swedish regulations.

As mentioned above, Studsvik once belonged to the government with the aim to support the development of Swedish nuclear power. According to Swedish law the nuclear plants benefiting from this development pay for the handling of the old waste generated before 1991 and arisen from that development. This is

handled through AB SVAFO, a company that was jointly owned by the Swedish nuclear power plants until May 1, 2003 when it was acquired by Studsvik AB.

AB SVAFO has facilities at the Studsvik site for handling the old waste as well as operational waste. In these facilities intermediate-level waste and the liquid waste from the Studsvik facility are treated. These facilities are operated by Studsvik RadWaste AB.

In Sweden there are two national options for final disposal, SFR (final repository for radioactive operational waste), SFL (deep repository for high-level waste). SFR is presently operating and accepts operational waste from Swedish nuclear installations that meet SFR's acceptance criteria. SFL is not yet built but is aimed to accept all other waste from Swedish nuclear installations, of course within defined acceptance criteria. There are also near-surface disposals, close to each nuclear facility, but that is not possible for the kind of waste discussed in this paper, i.e. long lived or alpha contaminated waste.

## HISTORY OF THE STORAGE AT

The storage AT is still standing and is at the moment used for other purposes than storing waste and is therefore referred to in present tense.

### Timeline for the storage

The storage AT was built in two phases. The first phase was built in1960 and used from1961 and the second built in 1970 and used from1971. In 1982 a decision was taken to modernise the waste handling facilities in Studsvik and this included building a hot cell facility for the re-conditioning of the waste from AT. In 1984 transports of new waste to AT was ended. However, until 1997 special wastes (including in the responsibilities of SVAFO) that had been stored in other places in Studsvik could be transferred to AT for a short period of storage.

### The storage

In Fig. 1 an overview of the storage is shown. The storage consists of two types of storage compartments. One type is the so-called tube-positions and the other type is the open compartments. There are in total 20 sections of which 8 are open compartments and 12 are tube-positions, containing several tubes each immersed in concrete. Two sets of tubes were designed for fissile waste. The open compartments are covered with concrete blocks in which there are openings for the disposal of the incoming waste. The large concrete blocks can be lifted with a crane.

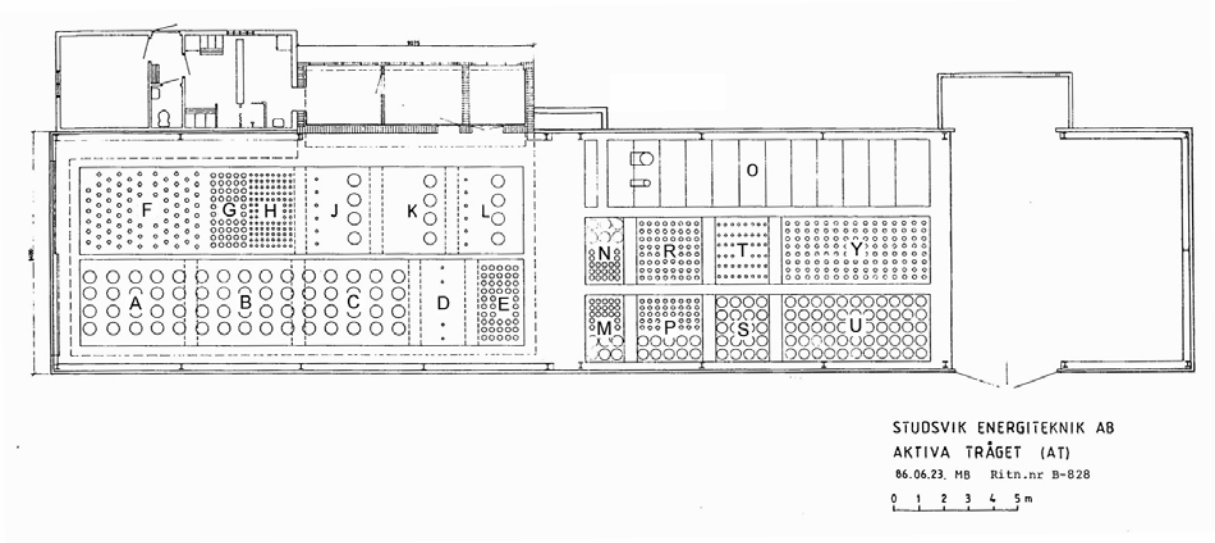


Fig. 1 Drawing of the storage AT

In Fig. 1 the different compartments are shown. The parts denoted A, B, C, D, J, K, L and O are the open compartments and the rest are the tube-positions. The tube positions F and T are the ones for fissile waste which can be seen as the dots representing the tubes are more widespread in the drawing. The different sized dots represent different sized holes, which was the main factor for deciding where the different waste packages were disposed.

**Content in AT**

The principle for depositing waste in AT was:

- Fissile material in designated tube-positions
- High dose rate goods in positions with heavy shielding
- Lower dose rate goods in lighter shielded positions
- Size of goods set the final storage position of the goods
- Some waste types where known to exist in large numbers and were therefore designated to be stored in the same compartment

Most of the wastes that were deposited in AT originated from the R2-reactor (an MTR) and the Hot Cell Laboratory (HCL) in Studsvik. The waste was to a large extent packed in different kinds of metal cans, from 1-litre up to 20-litre cans. A lot of the waste was alpha-contaminated, other wastes had high degree of neutron activation products and therefore a high gamma dose-rate. But not all waste was neatly packed in cans, there were also hydraulic tables, old vacuum cleaners and waste from normal work in hot cells. Ion-exchange resins from R2 cleaning systems were also stored in AT. Apart from waste from the Studsvik site there was also waste from the Swedish army and from industries.

**Documentation**

The documentation regarding the waste are logbooks kept in AT during the time of disposal. In these books each package of waste was entered with:

- Date of disposal
- Transport documentation number
- Material in waste, for example fissile, non-burnable or burnable, fuel
- Transportation packaging
- Activity content
- Disposal position
- Additional information such as more information on the content and what facility that delivered the waste

The transportation documents were saved and can now be found in the archives.

## PERMITS AND COMMUNICATION WITH AUTHORITIES

In 1981-1982 the Swedish government decided that the waste handling facilities had to be modernised and that the packaging system for the waste to be up-graded. This started the building of the new hot cell facilities for handling the old wastes but also newly produced ILW in Studsvik.

From the start of the emptying of AT and reconditioning of the retrieved waste a new permit from the authorities was needed for each compartment that was due for emptying. This was the case until 1994 when a general permit for emptying AT was given. This permit included all compartments and all types of waste with one exception and that was the fissile and fuel-containing wastes. In total the authorities issued 32 permits were issued over the years of emptying the AT.

During the whole emptying the authorities were kept informed of the progress and of the difficulties that occurred during the emptying and repacking.

## THE REAL WORK

All the re-packing of the waste retrieved from AT took place in the near-by hot-cell facility, purposely built for that. All the waste from AT was packed in 80 litre double lid drums (denoted DL-drums) which were packed in 5-position concrete moulds. Any liquids or semi-liquids (mainly ion-exchange resins) were mixed with cement and casted in 200 litre drums or mixed with an absorber or evaporated. The absorbed or evaporated liquids were thereafter packed in DL-drums.

The first transport left AT on May 20, 1987, that waste originated from the Hot Cell Laboratory at Studsvik Nuclear.

**The tube-positions**

The work on emptying of AT started with the tube-positions. The reason for that was that the only thing deposited in the tubes was cans in different sizes stacked on top of each other. These packages seemed to be the easiest thing to start with in order to get some experience before taking on the open compartments where waste had been more or less just thrown in.

The first approach to retrieve cans from the tube-positions was to use an automated robot and then transfer the cans to an intermediate special storage with revolving cells. This so-called carousel was designed with 24 positions. Unfortunately these very complicated tools were not very flexible and the waste that was to be lifted did not always correspond to the log-book or the transport documentation. One explanation could be that sometimes there were two or more types of packaging corresponding to the same numerical code.

Since the fancy equipment did not work well and was really difficult to handle, the persons that actually worked with the emptying solved the problem by suggesting a new and really simple method of retrieving the waste. The method is schematically shown in Fig. 2 below.

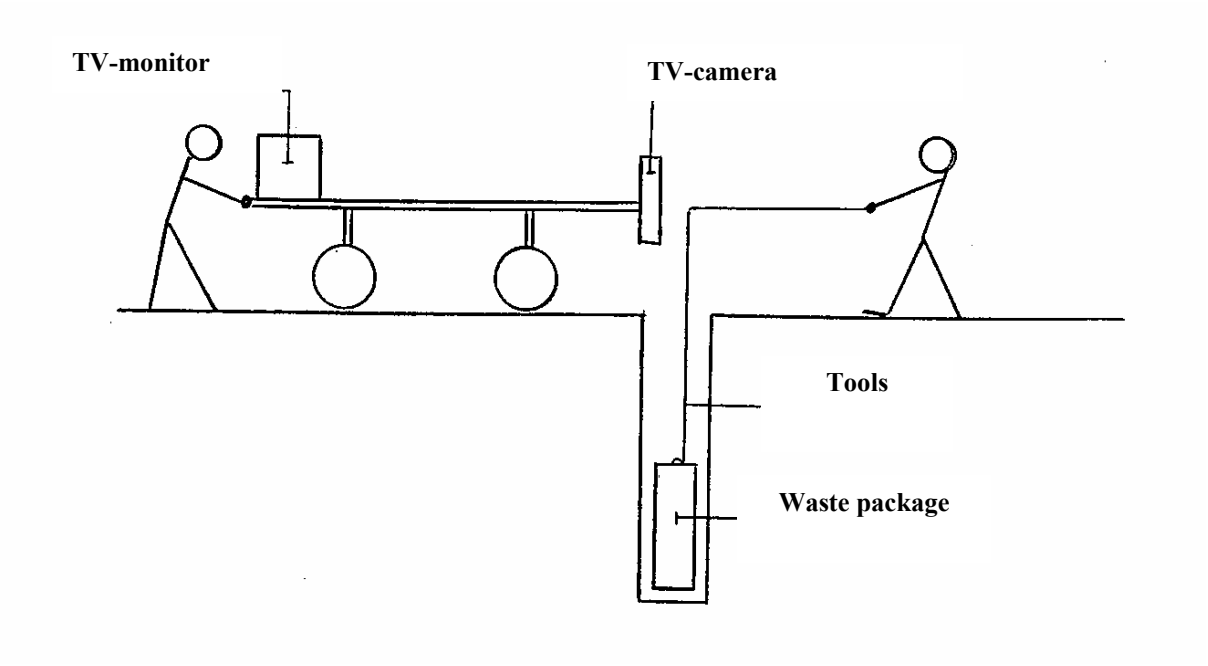


Fig. 2 The simplified method of retrieving waste from tube positions

The prerequisites for retrieving cans with this method were:

- that a line, connected to the handle, was used when disposing of the can, by lowering it into the tube
- that the handle and the line was still in good condition when the can should be retrieved

The figure above is simplified, the line retrieving the waste really went through a transport flask and the waste was directly moved into that when coming up.

**The open compartments**

The open compartments are in total 8, of which one is divided into 12 smaller compartments.

In the beginning of the emptying and in order to minimise the cost for disposal, an attempt to sort the waste into SFR and SFL waste was done. Since the conditions for the SFR waste were not fixed when this started the waste was later re-designated to SFL waste. Another factor for not sorting was the risk for cross contamination during packing in the hot-cell as well as the cross contamination in the compartments due to corroded and broken packages.

The method used for emptying the open compartments was in principle the same as for the tube-positions. A hook was lowered into the compartment and a package was caught and taken up.

In order to refine the method and the tools needed the compartments with the lowest dose rates were emptied first. If, however, there were some very large components in the compartment it was left for later. The important part in this first phase of emptying the open compartments was to take out as much radioactivity as possible before approaching the more difficult objects and compartments with the higher dose rates.

In the compartments where the dose rates were high the main content was radiation sources. In this case the objects that were to be retrieved were small and without handles or other things to put a hook through. The dose rates were also so high that the compartments needed to be closed during emptying, which made retrieval impossible with the method described above. Therefore, yet another new equipment was designed. This equipment was the hand and eyes that were needed to take the sources and other objects out of the compartments and were denoted "The crane".

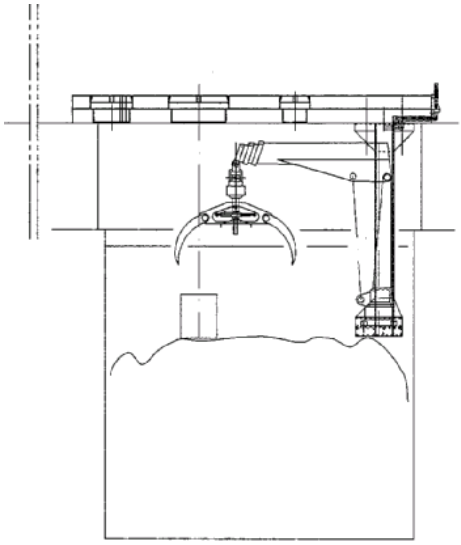

Fig. 3 The Crane

The crane was mounted underneath a radiation shielding block and worked remotely with a joy-stick and with a camera as the eyes so that each waste package could be identified and retrieved in the order that was decided by the operators and the crew in the hot cell facility.

The small objects were put into an 80 litre drum that was then elevated into a transport shield and taken to the hot cell for packaging of its content. The drum was then returned to AT and filled again until the compartment was empty.

**Large components**

Larger components were left in the open compartments to be cut there in pieces large enough to be transported to the cell. In the cell these pieces were then cut in pieces small enough to be economically packed into the DL-drums. These large components were hydraulic tables, filters among other things. The packing took place in the hot cell facility as all the other packing.

The cutting of the large components was done with a so-called Tiger saw. This is a simple and not very expensive equipment which worked really well.

**The last pieces of waste in AT**

The last pieces of waste to be taken out were the ion-exchange resins from the R2-reactor in Studsvik, can that had been stuck in the tube positions, the fissile material and a lid from the decommissioned R1-reactor.

Fig. 4 Lifting cans from tube position

Actually the final transport was of an ion-exchange cartridge on November 13, 2001, 14½ years after the first transport of the emptying of AT.

The resins were put into concrete and that resulted in 6 drums of 200 litres each. The fissile material was packed in the same way as all other waste but with respect taken to its fissile nature.

The R1-lid was cut into pieces with an oxygen lance and packed in boxes, in total 3 boxes and 2 drums (200 litres) with secondary waste. The lid also had cadmium and aluminium inner lids that were packed in DL-drums.

**Closing up**

When the open compartments had been emptied of their content the last thing that had to be done was to vacuum clean all of the compartments, so that they could be used for other projects. One project that has been performed in AT was the "high dose rate drums" reported at WM'03.

## RADIATION PROTECTION

Since the AT was constructed to receive waste and not for retrieving that waste all the routines for radiation protection had to be re-written, during the work the instructions were continuously up-graded.

During the first 9 years of the emptying the workforce in AT was the same. Their external full body yearly dose during the first 9 years varied between 1 and 3 mSv/year. They were also measured for internal contamination and these results varied from below MDA up to 400 Bq Cs-137. This levels with other radiological workers at the Studsvik site

Measurement in the building AT, when all the concrete lids were on and holes were closed revealed dose rates of 2-10 □Sv/h at a height of 1 meter. Measurements at floor-level in opened holes in compartments were the crane was used, gave dose rates up to 200 mSv/h. Other measurements at 1.5 m above an opened hole gave dose-rates about 3 mSv/h.

## LESSONS LEARNED

- Any material or equipment that is used for handling this kind of waste will be waste it self, sooner or later
- Any equipment used should be functional but not too exclusive since such equipment might be very expensive and very difficult to repair or buy spare parts to
- All kinds of documentation are useful, from when the waste was deposited to who did it
- Documenting the processes during operation is also important, especially when reporting to authorities
- Be very careful about loose contamination when different packages have been in the same compartment. Plastics and papers become very brittle due to radiation and time.
- Trying to sort waste into different categories due to final disposal can be difficult. If that is something to aim for, a statement from the disposal owner about the rules are recommended.

**SUMMARY**

- The total numbers of transports from AT were about 3 700
- The total amount of re-conditioned waste was about 100 $m^3$, about the same volume as the waste originally occupied in AT
- The total number of DL-drums packed were about 1200-1300, packed in over 260 moulds
- All the waste is today classified for the SFL (deep repository for high-level waste), due to both the alpha content and the radioactivity level in the moulds and drums