Swedish experiences on remediation projects in the Baltic region

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Radioactive waste in Estonia

- Sweden was already 1991/1992 asked by Estonia from support and help within the area radioactive waste.
- *Radioactive waste is found in three places in Estonia:*
- Sillamäe, at Narva by the Finish bay, a depository for residual products after extraction of uranium from radioactive slate.
- Tammiku (Saku), a small depository for radioactive waste from industry and hospitals, about 20 km south of Tallinn.
- Paldiski, a naval plant for training of Russian nuclear submarine crews, situated about 50 km west from Tallinn.

PALDISKI - FORMER SOVIET TRAINING BASE FOR NUCLEAR SUBMARINE CREWS

RETRIEVAL, CONDITIONING, DEMOLITION AND ENVIRONMENTAL RESTORATION

Fig. 1. Map of Estonia.

- About 1.5 million inhabitants
- Tallinn about 480 000 residents
- Area about 45 227 km²
- Tallinn - Paldiski 48 km.

Paldiski - Background and data

- Two nuclear submarine dummies, each with one reactor and auxiliary systems, for training of submarine crews
- Reactor 1, type PWR, of 70 MW in operation April 1968
- Reactor 2, type PWR, of 90 MW in operation February 1983
- Both the reactors was shut off during 1989
- All fuel was transported to Russia in October 1994
- Everything else, active waste included, was left at the site
- Russia handed over the responsibility for Paldiski to Estonia in September 1995.

Paldiski Site 1995

Fig.2. Aerial view of the Paldiski site in year 1995

In the centre is the Main Technological Building with parts of the two submarines. Up in the centre of the picture is the Solid Waste Storage.

- The SWS consists of concrete structure, with L= 28m, W= 12m, H= 4m, divided into 10 compartments adapted for different sorts of waste. Taken in operation 1968. Only three compartments, 1, 4a and 5, was used for storage of radioactive waste
- Al sort of solid waste was dumped. E.g. control rods, steam generators, sources, scrap, plastic, rags etc.
- Characterise, condition and pack the waste from the Solid Waste Storage (SWS) of Paldiski Nuclear Facility in Estonia
- By Russians, the facility was a top secret military object
- All the information about facility, including data about waste arising and disposal, was classified
- No proper records have being kept by Russians concerning waste disposal
- Characterisation of the waste was carried out during 1996

- The store was emptied 1997 – 1998
- The building was surveyed and decontaminated during 1999
- The building was demolished 2000.

Fig.3. The roof of SWS

1995 the geographic position for SWS (building 307) is determined by GPS equipment.

Preparation for investigation of SWS start with two Estonians working to open a slab above cell #1.

Fig.4. Two Estonians open a slab.

- The waste characterisation was done in April 1996 jointly by Estonian (AS ALARA), Swedish (Studsvik RadWaste AB and SKB) and US (DOE Idaho Operations Office) experts.

Fig. 5 Waste characterisation in April 1996

- The aim of the work:
  - Locate the control rods and other highly active items
  - Investigate if spent nuclear fuel was stored in the cells
  - Determinate the gamma and neutron dose rates and the loose surface contamination in the cells
  - Qualify a nuclide content of the waste.
- Only three cells: 1, 4A and 5 were used for the storage of radioactive waste
- 20 control-rods was stored in cell 1 and 5
- 8 steam-generators was found in cell 1
- No spent nuclear fuel was indicated
- Some contamination was detected in cell 5 presumably caused by damaged control rods
- Estimated waste volume is about 200 m3
- Estimated total activity is about 3.7 TBq.

Fig. 6. View inside cell #1

Cell #1 contained among other things 8 steam-generators and 9 control rods from the rebuilding of reactor #1 connected with the refuelling in 1981.

The coloured parts of this picture show the radioactive parts and the level of activity. Indicated activity originates from control rods, more or less shielded by steam generators and other inactive waste.

- No neutrons were detected in SWS
- The dose rate in **cell 4A** did not exceed 20 μSv/h - 137Cs and 60Co was indicated
- The dose rate in **cell 1** was in the range of 5-9 mSv/h. The gamma spectrometric data shows 60Co, 152Eu and 154Eu
- The dose rate in **cell 5** was more than 10 000 mSv/h in the bottom of the cell and 200 mSv/h at the roof level. 60Co, 152Eu and 154Eu were indicated.

Fig. 8. Control rods and sources in cell #5

Cell #5 contained, among lots of other waste, 11 control rods from reactor 1 plus varying sources. A source of significant high radioactivity is marked, ≈ 10 000 mSv/h.

Fig. 9. The high active source in cell #5

Fig. 10. The GammaCam detection head placed on a tripod outside the Tammiku RMI storage

GammaCam data

- *Spectral Range* < 50 keV to > 1.3 MeV
- *Detector* High density terbium-activated scintillating glass
- *Detection Head* Weight: 60 Pounds,
  Size: 19 in. Length,
  10 in. Width,
  15 in. Height,
  Tripod Mountable
- *System Power* 215 Watts, 110 - 240 VAC 50/60 Hz.

Continuation

- Erect a shelter building on top of the SWS
- Design and manufacture special containers for disposing control rods
- Establish remote handling technology to locate, retrieve, cut and pack the waste (especially control rods and unshielded radiation sources).

Fig. 11. The shelter building on top of SWS

To protect from weather and wind and from spreading activity a simple shelter was built above the main part of the SWS.

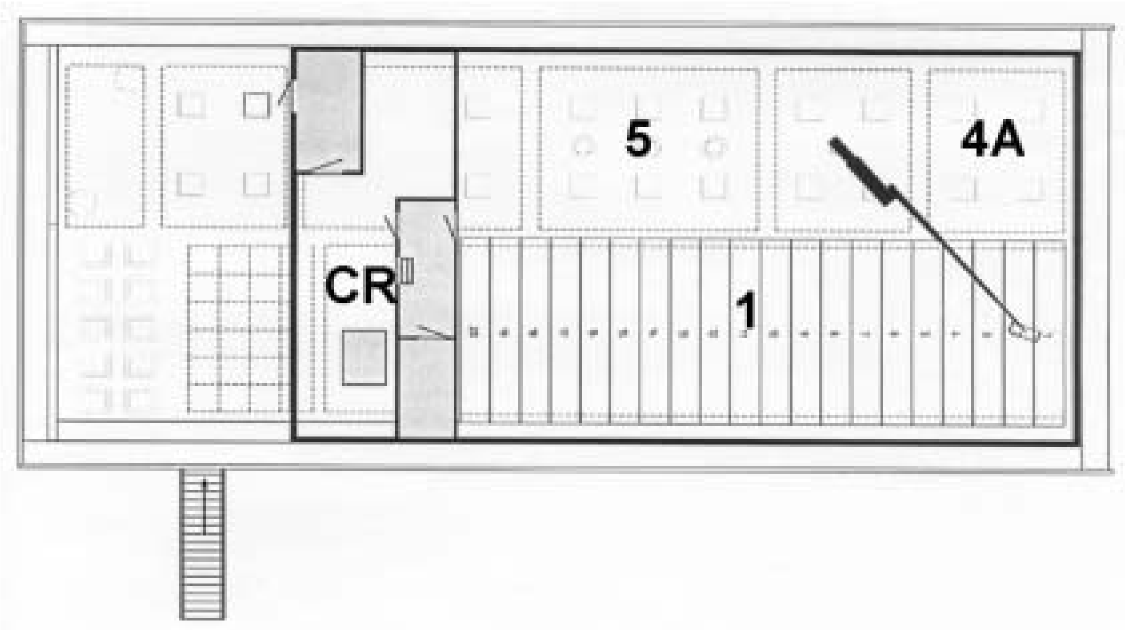

Fig. 12. Layout of the shelter building

Cell 1, 4A, 5 and CR (Control Room) are marked in the figure. Cell 4A contained very low active compactable waste. In cell #1 was mostly steel and wood placed but also some containers with sand to prevent from radiation from the control rods. Control rods and sources were stored in cell #5 together with a huge pile of plastic carpets.

Fig. 13. Compactable waste in cell #4A

The cell #4 is top filled by compactable waste. The dose rate is below 20 µSv/h. The low levelled waste in cell #4A was retrieved by hands of the Estonian personnel. The waste was packed in plastic bags and later placed in 200 litre drums.

Fig. 14. Manual work in cell #4A

The compressible waste from cell #4A, filled in plastic bags, was compacted in an in drum compactor. Compaction rate about 3:1.

Fig. 15. The in drum compactor

Fig. 16. The opening in the ground wall

To bring material in and out to the SWS an opening was sawed in the ground wall. An airlock was arranged inside.

Fig. 17 The concrete saw, mounted vertical, cutting an opening through a wall.

After erection of the shelter building two hydraulic cranes was installed.

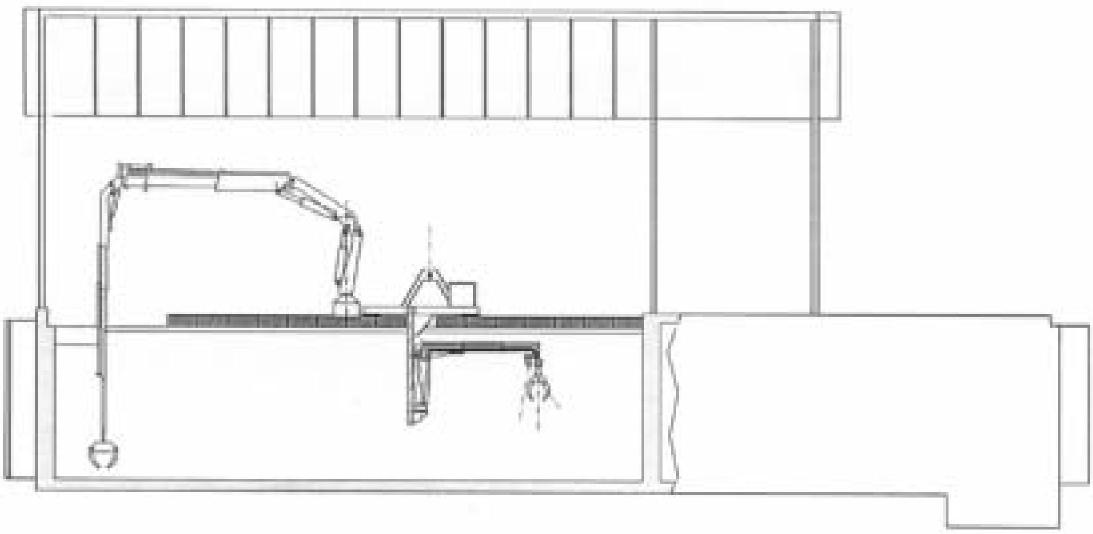

Fig. 18. SWS cross section

Fig. 19. The main crane

Fig. 20. The manipulator crane

Palfinger 2 400

- Capacity: 2.4 ton/meter
- Range: 4.15 m
- Rotation: 360^o
- Power: 18 kW, 3~ 400V

Operated by radio.
Option: 4 hydraulic connections at the end of the beam.

The ERGOGRIP is a hydraulic, modular gripping unit for objects weighing up to about 200kg (400lbs). The design of the unit is shown in the adjacent figure. The tool, which is available in eleven basic versions, is connected to the hydraulic system of a hydraulic crane and requires no additional hydraulic power supply. The gripping jaws are easily replaceable and are matched to suit the object to be handled.

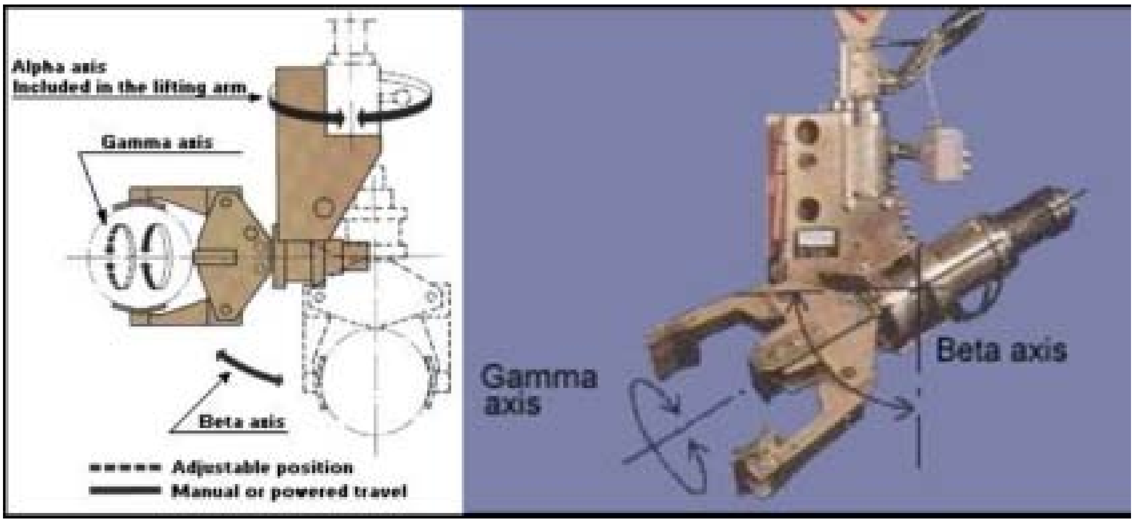

Fig. 21. ERGOGRIP gripping unit

Powered tilting travel of 90° about the beta axis. Gamma axis located off-centre. Powered rotary travel about the gamma axis through angles of 90, 180, 270 and 360°.

Control Rod Container (CRC)

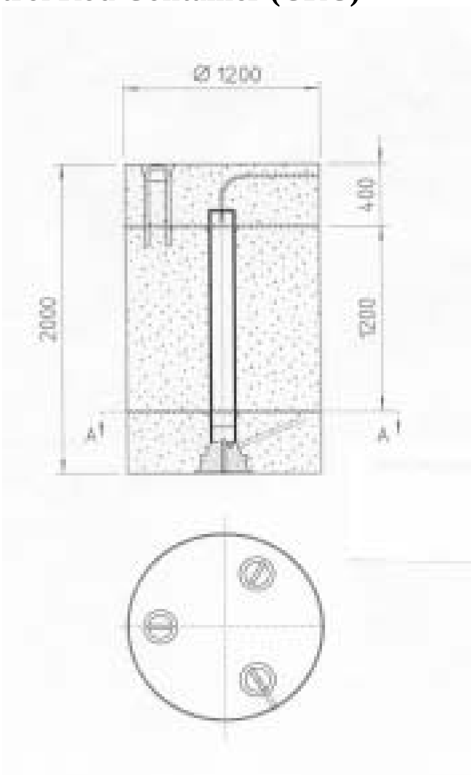

Fig. 22. Sketch of the CRC

The Control Rod Container is a cylindrical tube with the diameter 1200 mm and high 2000 mm. This cylinder is filled with concrete but in the centre, 400 mm from the top and all way to the bottom, is a cylindrical channel, diameter 200 mm. From the top of this inner tube leads two Ø 20 mm tubes in parallel out through the envelope surface. From outside through those smaller pipes are two steel wires connected to an inner tube, Ø 160 mm, with tight bottom (the quiver). Through the roof of a cell a hole is drilled and the CRC is placed above the hole. The inner tube is lowered and hoisted through the hole with the help of the wires.

Fig. 23. Manufacturing of control rod containers

The most active parts from the control rods were placed in three special designed containers, manufactured at the site from pipes for cooling water, outer diameter approximately 1.2 m. In the centre a small pipe with a diameter of about 0, 2 m was placed, the interspace was filled with concrete for radiation shielding.

Fig. 24. The control room

All equipment, booth the cranes, the hydraulic shear, the TV-cameras, lights, dose rate detectors etc. was operated from a shielded control room arranged in one of the empty compartments.

Fig. 25. The main crane with jib and gamma probe

The main crane with jib and gamma probe was used when lifting the concrete planks cowered cell #1.

Hydraulic shear

Fig. 26. The hydraulic shear

The hydraulic shear mounted at the end of a square tube and lowered down into the cells.

Fig. 27. The hydraulic shear in cell #1

Each control rod was cut in length of approximately 1 meter.

Fig. 28. This photo shows the first cut of a control rod

Fig. 29. Loading the quiver

Cut control rods are put into the “quiver” which, after been filled, was hoisted up into the control rod container.

Fig. 30. One CRC waiting for storing

The three CRCs are stored in empty pools in the Main technological Building.

Fig. 31. The new interim store

A new interim store is built in connection to the sarcophagus #2 in the northern end of the Main Building. Concrete containers are remotely placed in the interim store by an overhead crane and a special designed lifting tool.

Fig. 32. Placing containers in the store

The special lifting tool for the waste containers was constructed to fit the old overhead crane in the building. The tool has replaced the hook in the 10 ton crane and is remotely operated by radio.

Fig. 33. The lifting tool gripping a container

In 1997 the SWS and the shelter building was situated in the NE corner of the site. Three years later, year 2000, booth the SWS and the shelter building had been demolished and the area is cleaned.

Fig. 34. The NE corner year 1997 respectively year 2000

- Altogether 20 man.mSv was received by 8 persons from March 1997 to December 1998
- No accidents
- All solid waste was conditioned and stored in the interim storage
- The building is decontaminated and demolished
- The Estonians have learned waste retrieval and conditioning

Fig. 35. Main Technological Building with Annex building

In parallel with retrieving the solid waste the Main Technological Building was renovated and partly modernised. A new office and waste handling area was constructed.

Fig. 36. Portal monitor LEAB

The portal monitor is installed at the entrance to the zoned area in the new annex building and building 302. The laundry in the annex building is equipped with an industrial wash machine and dryer.

Fig.37. Wash machine and dryer in the laundry

The northern part of the annex building is planned for waste handling. This area shall house equipment for nuclide measuring, concrete mixing, tools for segmentation and decontamination etc.

Fig. 38. Waste handling area in the annex building

Building 303 – treatment of liquid waste

- Accomplished a study for demolition as a PHARE project
- A contract for the demolition study was signed in December 1997 and the study continued during 14 month. The final report was delivered to EU in January 1999.
- New construction drawings and isometric drawings from the piping in the building was performed.
- The drawings were performed after checking of dimensions and measurement of all rooms, piping, and components in the rooms.
- Calculation of weights and areas of the contaminated systems was performed by use of the new documentation.

Fig. 39. Building 303, Liquid Waste Treatment Building, and Tank farm

The Liquid Waste Treatment Building and the Tank farm are built in direct connection to each other. The building raises six floors high. The exactly position of all larger components is shown on the 3-D X-ray drawing of Building 303 with the tank farm.

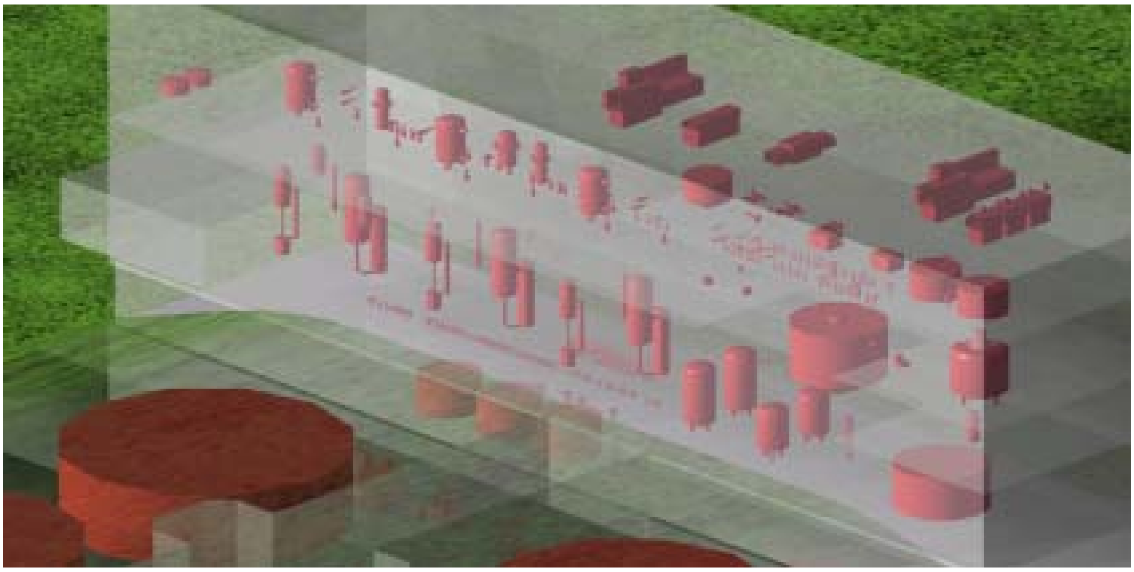

Fig. 40. Building 303, 3D X-ray drawing

The study investigated different alternatives, immediate demolition or wait for up to 50 years. It was recommended an immediate demolition and to decontaminate the contaminated components and piping as good as possible to have those free released.

The cost for removing all installations and demolition of the building was estimated to about 1.5 MUSD. Those works was estimated to be carried out in 5 years but is absolutely dependent on the financing.

Fig. 41. Removal of asbestos

It was a hard and time-consuming work to remove asbestos insulation from a great part of the installations. Luckily there was almost no contaminated asbestos insulation.

Building Decontamination

Fig. 42. Concrete decontamination work

A grid, 1 x 1 meter, was marked on all surfaces. Every square was surveyed and found contamination marked. Using diamond disk or jackhammer connected to an industrial vacuum cleaner all areas were decontaminated step by step. After the decontamination was finished you could find the building ragged and penetrated but clean from radioactivity.

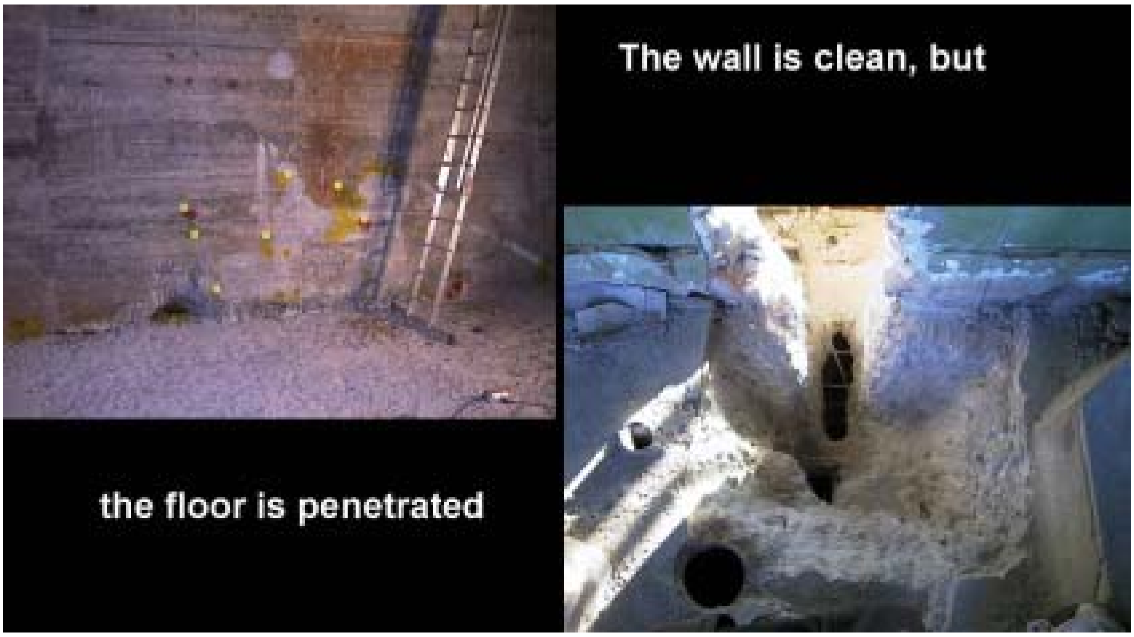

Fig. 43. The result of the decontamination

BOLERO is a robot for decontamination and free release.

Fig. 44. Decontamination robot, BOLERO, from Studsvik *SINA*

Building 303 and the tank farm are demolished. Remaining is only a small house containing pipe connections and valves.

Fig. 45. Cleaned area from building 303

Fig. 46. Piles of crushed concrete.

Crushed concrete from the demolition of buildings are piled in different fractions to be used at road constructions.

Fig. 47. A BROKK demolition robot

The BROKK-family offers several efficient and robust demolition robots. The smallest is small enough to pass through a normal door opening; the biggest one has the highest capacity, of demolition robots, in the world.

The decontamination will require large resources and long time why an interim store of contaminated scrap in 20-feet ISO-containers is recommended.

Fig. 48. Temporary container storage

Building 306

- Storage for liquid stated waste
- 6 tanks
- 400 m³ each
- 4 tanks contained liquid was emptied 1995
- Installed a concrete mixing station for grouting of the content in the tanks
- 2 tanks containing slurry and ion exchange resins was emptied year 2000
- Sand-filters on the bottom of the tanks was taken care of in year 2001

Fig. 49. Cement mixer

In building 306 a cement mixer, complete with fittings for emptying the storage tanks and grouting the waste in containers, was installed. The containers were placed on a vibrating roller conveyor for the best filling up of cement around the waste in the containers.

Ignalina NPP

Fig. 50. Buildings 157 and 157/1

Waste storage buildings 157 & 157/1 with the portal crane covering the whole storage.

Fig. 51. Strengthening of building 157 SE corner

Outside the SE corner of building 157 the walls are completed with extra shielding because of the Group 3 waste high radiation. The storage building for bituminised waste is divided into 12 compartments to where the bituminised waste is pumped.

Fig. 52. Storage for bituminised waste

NE of building 155 lots of waste is dumped, just like a landfill repository.

Fig. 53. Waste stored at the ground

The Group 1 waste is unsorted dumped in different cells in the SWS building.

Fig. 54. Group 1 waste at INPP

Fig. 55. Hedberg compactor and a compacted bale

A compactor, Hedberg HDx50; vas earlier delivered as a gift from Sweden. The compaction rate for the waste classified as compactable is about 3:1. The bales are wrapped in plastic. A wrapping machine is planed to be installed.

Maišiagala

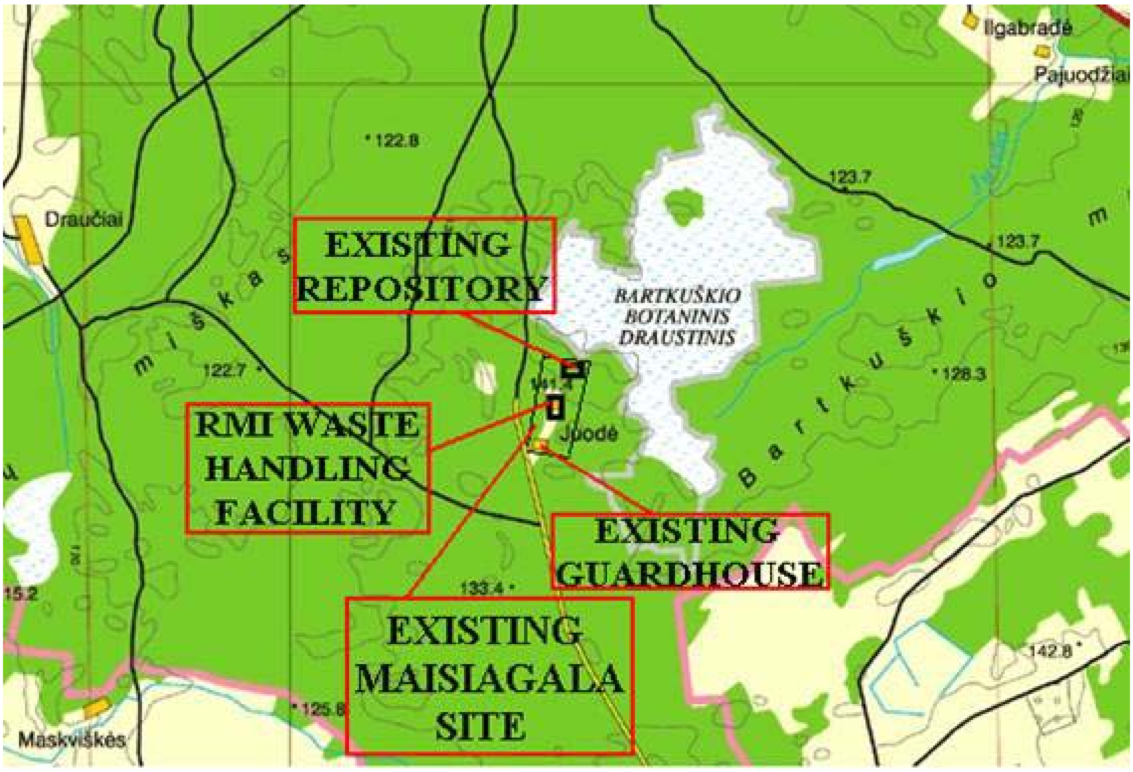

Fig. 56. Location of the Maišiagala site

This map shows the location of the Maišiagala site about 25 km NE from Vilnius. A pre-feasibility study and a feasibility study is performed to find out how to deal with the Lithuanian RMI waste placed in the Maišiagala repository and produced in the future.

Fig. 57. Maišiagala repository

The repository consists of a grouted concrete trough divided by wooden planks in three cells. The waste is placed in the cells and grouted around by concrete.

Fig. 58. Spent Sealed Sources

At the Institute of Physics we found Spend Sealed Sources stored in a stairwell. Other SSS was on the floor in a small room in the cellar.

The condition of the buildings at the Maišiagala site is poor. New building(s) must construct to have modern and qualified areas approved for the handling and storing of the RMI waste.

Fig. 59. Old buildings at Maišiagala

The SKB Feasibility Study to establish a facility for handling of radioactive waste at Maišiagala presented a new building for handling of radioactive waste produced at ”small users”.

This 3-D drawing shows the exterior of the Waste Handling Building.

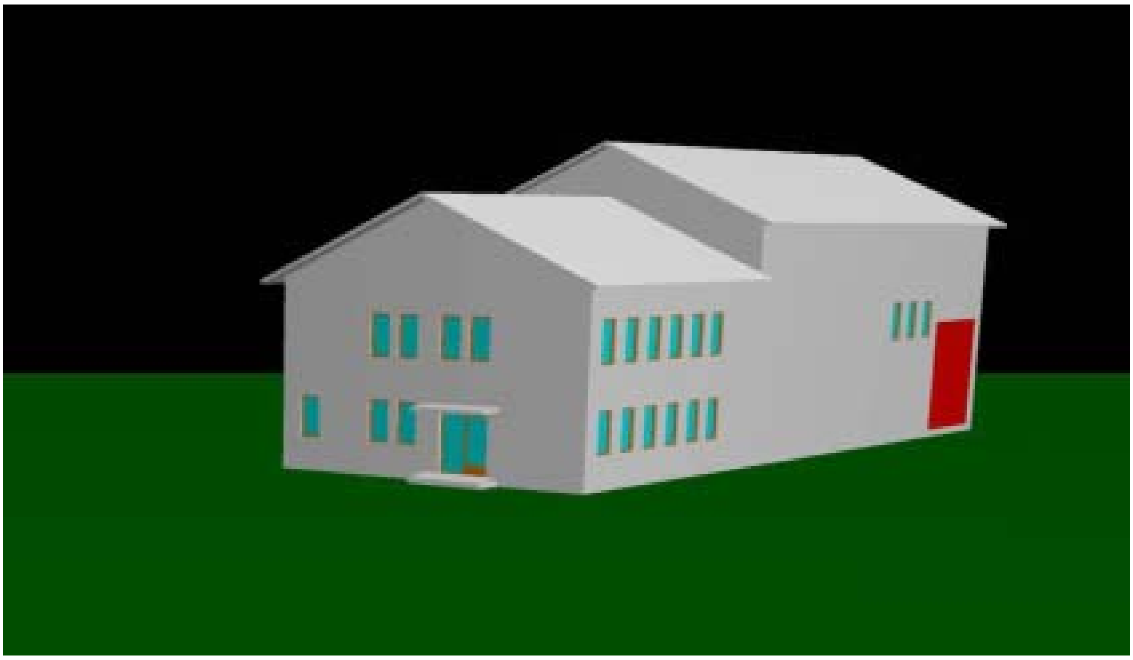

Fig. 60. Exterior of proposed new Waste Handling Facility

Next drawing shows the longitudinal section of the WHF.

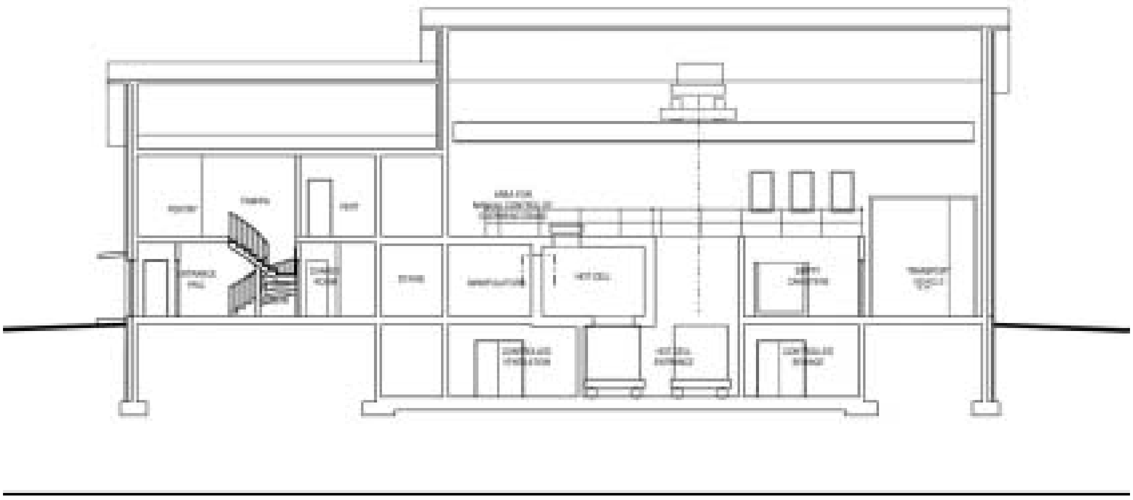

Fig. 61. WHF longitudinal section

The building consists of tree different areas:

- Space for the guard
- Entrance and office area
- Zoned area

and as option a storage, connected to the building, for the waste produced during a period of 30 years.

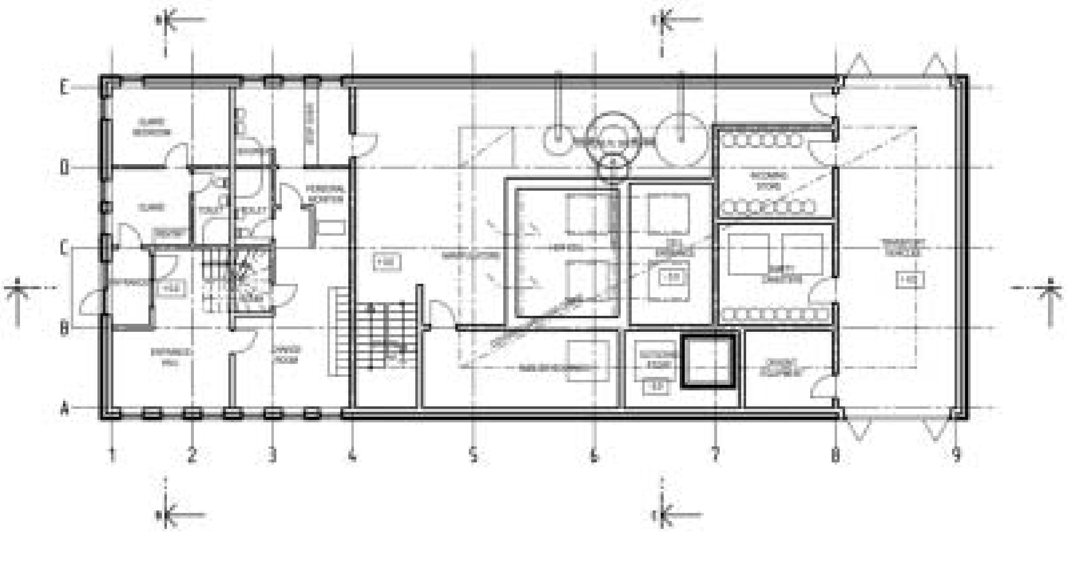

Fig. 62. WHF layout drawing, ground floor

The layout drawing of the Ground floor with the office area to the left. The entrance for waste is to the right and in the middle is the waste handling area. The optioned storage will be connected to the right of the building wit an overhead crane covering area extended over storage.