Belgoprocess

Decontamination and decommissioning of a 2,000 m^3 open storage pond for liquid waste and sludges

1. Introduction

Belgoprocess started the industrial decommissioning of the main process building of the former Eurochemic reprocessing plant in 1990, after completion of a pilot project. Two small storage buildings for final products from reprocessing were dismantled to verify the assumptions made in a previous paper study on decommissioning, to demonstrate and develop dismantling techniques and to train personnel. Both buildings were emptied and decontaminated to background levels. They were demolished and the remaining concrete debris was disposed of as industrial waste and green field conditions restored.

The industrial decommissioning of the main process building of the former Eurochemic reprocessing plant was started in 1990. It is a large rectangular construction of about 80 m long, 27 m wide and 30 m high. The core of the building consists of a large cell block of 40 main cells, containing the chemical process equipment. Access areas and service corridors are located on 7 floor levels.

About 106 individual cell structures have to be dismantled. Some cells have contamination levels up to 125 Bq/cm^2 (beta) and 200 Bq/cm^2 (alpha). Some hot spots give a gamma dose rate of several mSv/h. About 1,500 Mg of metal structures and 12,500 m^3 of concrete with 55,000 m^2 of concrete surfaces have to be removed and/or to be decontaminated. Most of the work involves hands-on operations under protective clothing tailored to each specific task. Tool automation and automatic positioning systems are successfully applied.

In the beginning of April, 1998, the large scale decommissioning of shutdown facilities at the Belgoprocess site BP2 was started. Over the period 1998 to 2008, the project includes the decommissioning of about 15 storage and treatment facilities of different kinds and sizes from the former waste treatment department of the Belgian Nuclear Research Centre (SCK·CEN).

The specific Belgoprocess approach should be highlighted in which decommissioning activities are carried out on an industrial scale with special emphasis on cost minimisation, a commitment to results within an overall planning, and the use of technology on an industrial representative scale. This approach includes specific actions to reduce standby costs. It takes great care to limit radioactive waste management costs, keeping the generation of radioactive waste to a minimum, minimising the spread of radioactivity as much as possible, and optimising the possibilities for recycling and reuse of valuable components from existing and potential waste streams. Extensive use of adequate decontamination techniques is made in order to allow dismantled components and materials to be unconditionally released.

2. History of the 2,000 m^3 open storage pond

The 2,000 m^3 open storage pond on the Belgoprocess site 2, the site of the former waste treatment department from the Belgian Nuclear Research Centre was constructed in the years 1957-1959. It is a large rectangular reservoir of about 42 m long, 20.5 m wide (external dimensions) and 3.5 m high (internal dimension) (see Fig. 1). It has in fact two parts, one with a volume of 200 m^3, the other has a volume of 2,000 m^3. The outer walls of pre-stressed concrete have a thickness of 20 to 33 cm. The floor of the 2,000 m^3 part has two layers of 10 cm thick concrete plates. The joints between the various concrete plates have been filled with bitumen. The second layer of concrete plates is isolated from the first one by means of a bitumen layer and two small layers of sand and concrete. The 200 m^3 part has a one piece 33 cm thick floor plate.

At the inner side of the concrete walls of the 2,000 m^3 part, a 20 cm thick brick wall was erected and the area between the inner wall and the outer pre-stressed concrete was filled with a bitumen layer. The entire inner part (floor and walls) of the 200 m^3 part was covered with tiles. Moreover, the 200 m^3 part was partially covered with wooden plates.

Three sides of the entire open storage pond were supported by 1.5 to 2 m high and 4 to 6 m wide sand shoulders that reached up to about 1.5 m from the top of the side walls. Only the northern wall had no sand shoulder.

On top of the open storage pond an aluminium roller-bridge was installed with 300 kg lifting capacity. It covered the entire width of the reservoir.

In the early years, the open storage pond was used as an overflow reservoir for the various other water tanks on the site and as a storage pond for the safety injection water for the BR2 material testing reactor from the Belgian Nuclear Research Centre in case of a major nuclear accident. In a later phase, the pond was also used as an open cooling reservoir for the scrubber water of an incinerator for low level beta-gamma wastes. This resulted in a deposit of some 126 Mg of radioactive sludges in the pond.

Figure 1. Open storage pond in original status

Figure 2. Open storage pond covered with tent construction

When the decision was taken in 1991 to shutdown the incinerator, it was also decided to empty the 2,000 m^3 pond and to prepare the decommissioning activities. For this reason, the pond was covered with a tent construction, i.e., a metal framework spanned with a canvas, and all supply and discharge pipes were disconnected (see Fig. 2 above). Two ventilation groups with pre-filters and absolute filters were installed on both the eastern and the western sides of the pond in order to provide acceptable ventilation and protection of the environment during all future treatment and decommissioning activities.

In September 1993, the removal and treatment of all water and sludges from the open storage pond was started. Sludges were treated in a bituminisation facility, and all activities were finalised in November 1999. After emptying, the inner surfaces of the reservoirs were cleaned with a water spray and all remaining supply and discharge pipes were rinsed and emptied by means of pressurised airflow. The facility was then put in a non-operational standby position.

3. Radiological characterisation of the reservoirs

Sampling and radiological monitoring of the inner surfaces of the storage pond indicated that the main contaminating isotopes in the structure of the reservoir were ^{14}C, ^{55}Fe, ^{60}Co, ^{63}Ni, ^{90}Sr, ^{90}Y, ^{137}Cs, ^{154}Eu, ^{241}Pu. Specific alpha isotopes as ^{226}Ra, ^{235}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{241}Am were also detected, however.

In addition, core samples were taken from the inner brick wall in order to quantify the in depth contamination of the material. After crushing and milling, analyses of these core samples indicated that only a 10 mm surface layer was contaminated with ^{226}Ra, while the remaining inner part showed rather high ^{137}Cs contamination. As a result, it was decided that the entire inner wall had to be considered as radioactive waste, but it was recommended to adapt the technical approach in order to segregate the surface layer from the main part of the inner brick wall. As such, only the material resulting from the removal of the surface layer should be considered as radium contaminated waste.

A sample of a concrete plate from the bottom of the open storage pond was also analysed and a test indicated that it would be feasible to decontaminate these concrete plates by shaving and to achieve unconditional release conditions.

Samples were also taken from the outer pre-stressed concrete wall. They showed no contamination at all, which did not necessarily mean that the entire outer wall should be free of contamination. Indeed, it was seen that the outer wall has some cracks, and there was no guarantee that the layer of bitumen in between the two walls was everywhere still in good shape.

4. Preparation of the decommissioning activities

In order to avoid air contamination during the various decommissioning activities it was decided that after vacuum cleaning of the entire inner surface of the open storage pond:

- All inner surfaces would be painted to avoid the spread of removable contamination;
- All decontamination activities would be carried out in isolated and ventilated areas;
- For dust free decontamination of the brick and concrete surfaces, scabblers and shavers would be integrated into industrial systems that capture dust and debris at the cutting-tool surface, minimising any possible cross contamination.

As a result, two mobile intervention areas were constructed (5 m x 5 m x 3.75 m) in which the decommissioning activities could be organised and which could be moved along the inner wall depending on the progress of work (see Fig. 3). As such, in practice two mobile cell structures were developed, both having their own ventilation system, which should be independent from the main ventilation of the tent construction.

Further activities were carried out in order to prepare the work area:

- The localisation of all underground supply and discharge pipes, as well as electrical connections;
- The removal of remaining sludges in these supply and discharge pipes, as well as the removal of hot spots with doses between 120 µSv/h to 250 µSv/h from three areas in the neighbourhood of these pipes;
- The complete electrical isolation of the storage pond, except for the illumination;
- The complete restoration of the wooden plates on top of the 200 m^3 part of the storage pond in order to create an individual cell structure for this part;
- The construction of two access locks to the 200 m^3 and the 2,000 m^3 parts of the storage pond with additional areas for the dust extraction systems;
- The reorganisation of the ventilation systems, creating adequate air flows to the mobile intervention areas and the 2,000 m^3 pond, independent from the main ventilation of the tent construction.

5. Practical decommissioning work

The work area being prepared, the practical decommissioning activities were started in the second half of the year 2000 with the decontamination and removal of the required part of the inner and outer wall of the 200 m^3 as well as the 2,000 m^3 reservoir in order to create adequate access openings at ground floor level.

Afterwards, in the 200 m^3 part, the tiles were removed and the remaining concrete walls and floor were decontaminated by shaving.

In the 2,000 m^3 part, a wooden staircase was removed as well as some pipes and the rail system on top of the side walls. The aluminium roller-bridge was also removed and decontaminated. The remaining part of the walls and floor of the 2,000 m^3 part was painted in order to avoid the spread of removable contamination.

Following the removal of all equipment, the decontamination and removal of the inner brick walls of the 2,000 m^3 pond could be started. In a first of the two mobile intervention areas, an adapted milling cutter fit on a conventional fork-lift truck, was used as a very effective semi-automatic tool to remove about 1 cm from the wall surfaces. The radium contaminated dust was collected in special 200 l-drums and removed.

After the removal of this surface layer, additional samples were taken from the remaining part of the brick walls in order to confirm that this part was free of radium contamination. As a result, the second mobile intervention area was used to remove the remaining brick structure, which was cut by means of a conventional electro-hydraulic hammering unit. The material was evacuated in 200 l-drums as standard beta-gamma waste.

As a next step, the bitumen layer between the inner brick walls and the outer pre-stressed concrete walls of the 2,000 m^3 pond was removed (see Fig. 4). An adapted milling cutter was used which was fit to the same fork-lift truck, giving effective results similar as to the removal of the brick layer. A thin layer of concrete was removed as well from the inner part of the outer walls in order to remove any remaining activity.

Figure 3. Organisation of decommissioning areas

Figure 4. Removal of bitumen layer

In parallel to these activities, all sand shoulders around the entire open storage pond were removed. Contaminated soil was segregated and evacuated. The remaining part was removed to a temporary storage area, waiting to be monitored for unconditional release.

After removal of the sand shoulders, the outer part of the pre-stressed concrete walls could be monitored for any remaining contamination. Some contamination was found on the top of the walls and in cracks where contaminated liquid material had penetrated through damaged areas in the bitumen layer. It was removed by manual shaving or by means of an electro-hydraulic hammering unit.

Decontamination of the concrete plates from the floor of the 2,000 m^3 pond was also started using the available floor shaving systems. In several steps a surface layer of about 6 mm was removed in order to segregate the radium contaminated part from the concrete blocks. In a second phase, a single concrete block was removed to check the area below this first layer of concrete panels. The underlying bitumen layer seemed to be in a rather good shape and it was decided to continue the removal of all blocks for decontamination in a separated facility, before removing the bitumen layer in order to avoid contamination of the lower concrete structures. Therefore, the bitumen layers in between the various concrete plates were cut out by means of a circular saw blade. The remaining part of the concrete plates from the first layer are further removed and decontaminated for unconditional release after measurement and sampling in a dedicated concrete crushing and sampling that was specifically developed for such purposes.

The bitumen layer under the first concrete plates will then be removed and will probably have to be treated as radioactive waste. Based on samples taken from the lower layers, it is expected, however that these materials may be removed and unconditionally released after adequate monitoring.

Further tasks will be a total monitoring of the remaining structures of the former open storage pond and the removal and decontamination, if necessary, of the tent construction. Afterwards, the remaining parts of the walls and floor layers will also be removed to the dedicated concrete crushing and sampling installation in view of characterisation for unconditional release. The area below the structure will further be monitored and remediated as required. This means that contaminated soil, if detected, will be segregated and evacuated, and green field conditions restored. It is expected that all these activities might be finalised in the middle of the year 2002.

6. Discussion and cost evaluation

The decommissioning of this open storage pond for cooling water and sludges from the incinerator for low level beta-gamma wastes was a specific problem relating to the remediation of the site of the former waste treatment department of the Belgian Nuclear Research Centre. In the current state of progress, it is considered that the activities were rather successful with respect to the applied methodologies and techniques, as well as with respect to the protection of personnel and the environment. Mainly commonly used and proven industrial techniques where applied that offered adequate solutions to the problems that were encountered.

If the activities can be continued as scheduled, it is expected that the total costs for the decommissioning and the decontamination of the former open storage pond will amount up to about 9,000,000 €, which is about 30 % of the original estimate made in 1989. The dismantling costs are currently estimated to be about 3,200,000 €, including a 30 % contingency, while the costs for waste treatment, interim storage and final disposal will be about 5,800,000 €.

The technical approach for the decommissioning activities and the extensive efforts in decontamination and segregation of the resulting decommissioning materials have contributed to this significant reduction of the total costs, while the impact on the personnel and the environment will have been limited to a level as low as reasonably possible.