THE DECONTAMINATION AND DECOMMISSIONING OF THE GRAPHITE SILOS AT VANDELLÓS 1

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Abstract. The 500 MWe gas graphite reactor Vandellós 1 is being decommissioned to a Stage 2 status. The Stage 2 in this particular case involves the dismantling of almost all structures and components outside the reactor vessel. The vessel itself will remain, after removal of fuel, with its internals, until the end of the dormancy period. By achieving Stage 2, about 80% of the site will be released. During the operation of the plant, the graphite fuel sleeves were stored in three concrete silos on site which included about 1000 tonnes of graphite and activated metal pieces. ENRESA started the decommissioning of the graphite silos in 2000. Decommissioning involves the dismantling and removal of equipment from each cell, the decontamination for the cell walls, ceilings and floors and the dismantling of the ventilation system. These activities were followed by a complete radiological monitoring in order to obtain the release of the remaining structures and proceed with its demolition. This paper provides an overview of the decontamination and decommissioning activities related to the graphite silos at Vandellós 1 and describes the efforts made to improve safety through the use of innovative technologies. In addition, the strategy to be followed for the safe management of the graphite waste is also described.

INTRODUCTION

The Vandellós 1 nuclear power plant (497 MW, graphite-gas reactor) is located in the province of Tarragona and is the only natural uranium-graphite-gas nuclear power plant in Spain. The plant was shutdown in 1990, after 17 years of operation, following a fire in the turbine-generators.

ENRESA* was commissioned to undertake the decommissioning of the plant and took responsibility over the site in 1998. The chosen decommissioning alternative was to achieve an IAEA level 2, which involves the dismantling of almost all structures and components outside the reactor vessel. The vessel with its internals and the biological shield will remain, after removal of fuel, until the end of the dormancy period. By achieving level 2 at the end of 2002, about 80% of the site will be released.

During the dormancy period, which is planned for about 30 years, the site will be under surveillance, and the radiation inside the reactor shield will decay to levels which will facilitate the complete dismantling (IAEA level 3) at minimum radiological costs.

HISTORY OF THE GRAPHITE SILOS

Gas-cooled reactors generate large quantities of graphite wastes, mainly in the form of spent fuel sleeves. Spent fuel sleeves are of cylindrical shape, have dimensions of 60 cm in length and 13,7 cm in diameter, and include a stainless steel seat wire in one of its ends.

During the operation of the Vandellós 1 plant, graphite sleeves were stored in three concrete silos on site (Figure 1), which included about 1000 tonnes of graphite and seat wires. Each silo has dimensions of 24 m x 7.20 m x 8,70 m. Concrete walls are 0,75 m thick and upper and lower slabs are 0,80 m thick.

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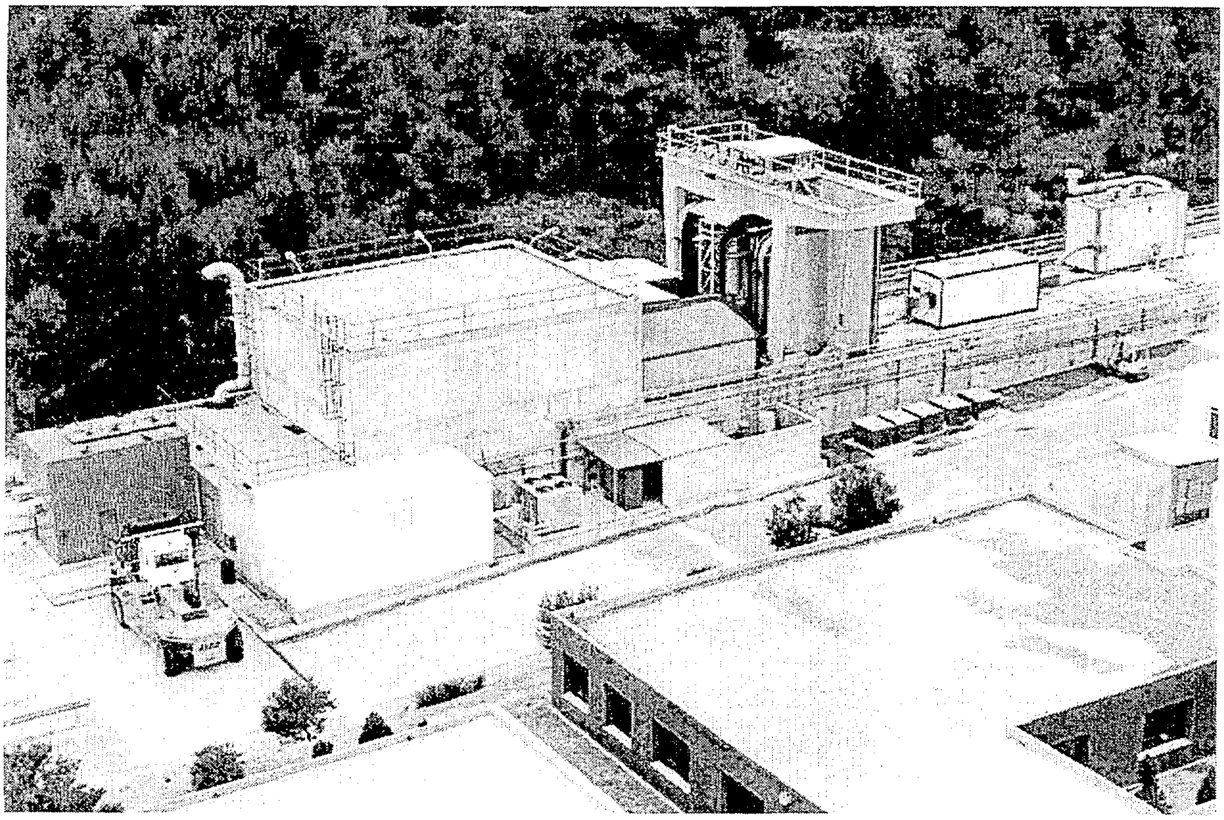

Figure 1: Aerial view of graphite silos

In 1995, prior to the start of the decommissioning activities, the graphite sleeves were removed from the silos and conditioned into high integrity containers which were placed in a temporary storage facility on site. This recovery and cleaning process, implemented by the owner of plant HIFRENSA, consisted of the following sequence of operations:

- Recovery of the waste from inside the silos using a mobile enclosure and a telemanipulator.
- Transfer of the waste to the processing unit.
- Processing of the graphite waste where the graphite sleeves were crushed, the seat wires were separated and graphite and wires were placed in different containers.
- Transfer of the waste containers to a temporary store on site. (Figure 2).
- Final clean up of the silos.

As a result of these operations, two of the silos were cleaned to radiation levels up to 0,5mSv/h and the remaining one to levels close to 5 mSv/h.

RADIOLOGICAL CHARACTERISATION OF THE SILOS

Sampling and radiological monitoring of the inner surfaces of the silos indicated that the main contaminating isotopes were ^{3}H, ^{14}C, ^{55}Fe, ^{59}Ni, ^{63}Ni, ^{60}Co, ^{90}Sr, ^{137}Cs, ^{154}Eu,, ^{234}U, ^{238}U, ^{239}Pu, ^{241}Pu y ^{241}Am. Radiation levels inside the silos were mainly due to ^{60}Co, ^{137}Cs and ^{154}Eu.

In addition, core samples were taken from the walls and floors in order to quantify the in-depth contamination of the material. After crushing and milling, analyses of the core samples indicated that the contamination had penetrated deeper in the floors and the lower parts of the walls up to 4 to 5 cm.

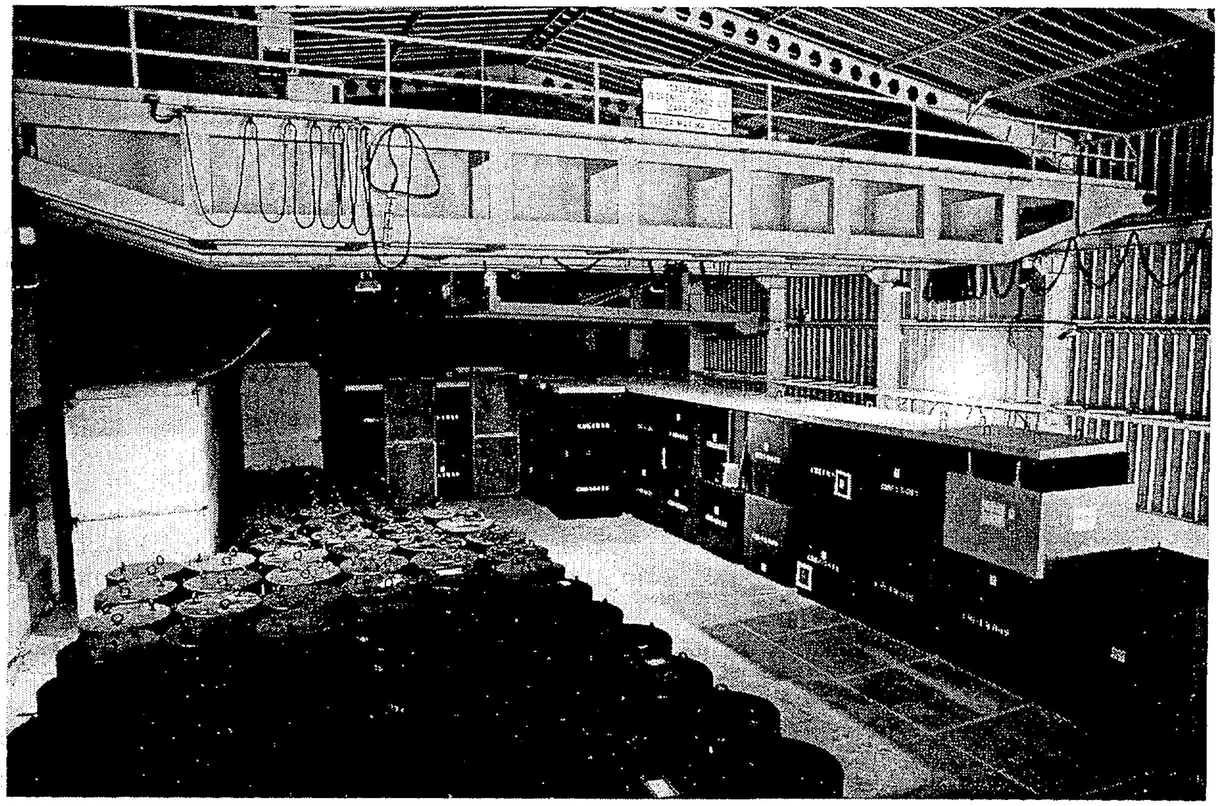

Figure 2: Temporary storage on site

In the upper part of the walls and the ceilings, the penetration of the contamination was variable from a few millimetres to 2 cm.

As a result, it was indicated to adapt the technical decontamination approach in order to segregate the surface layer from the main part of the walls. As such, only the material resulting from the removal of the surface layer should be considered as waste.

DECOMMISSIONING WORKS

ENRESA started the decommissioning of the graphite silos in 2000. The aims of the decommissioning works were to limit radiation risks to the workers and the population according to the universal criteria of the ALARA principle and to decommission the silos up to a level where no controls on contamination and radiation are required any longer in view of a conventional demolition.

Decommissioning involves the dismantling and removal of equipment from the silos, the decontamination of walls, ceilings and floors, and the dismantling of the ventilation system. These activities were followed by a complete monitoring for unconditional release of the remaining structures. Most of the work involved hands-on operations under protective clothing, due to the high levels of radiation and the presence of alpha contamination in equipment and building surfaces. Specific breathing and air ventilation systems were provided to enable the operators to carry out the decommissioning tasks in acceptable working conditions.

The decommissioning approach was very much influenced by the principle of waste minimization and specific actions were taken to achieve this goal and improve working conditions, such as:

- Improve concrete decontamination methods using adapted techniques with higher and more efficient working rates and lower waste production.
- Do not favour techniques that are labour intensive, difficult to handle or difficult to automate.

- Develop industrialised systems for decontamination works reducing the exposure and physical load on the operators.
- Increase the work efficiency by introducing adapted automated techniques and improved working circumstances.

A self-propelled floor shaver was successfully used for the decontamination of the concrete floors. These techniques use a diamond tipped rotary cutting head designed to give smooth surfaces which are easier to measure. They show a good efficiency and a 30% reduction in secondary waste production and reduce the physical load on the operators due to the absence of vibrations.

For the decontamination of concrete walls, where the contamination has not penetrated too deeply (a few mm.), a handshaver (figure 3) was used. The shaver is equipped with a disk with diamond segments bonded onto the face of the disk. It has a controlled dust extraction and produces very low vibrations.

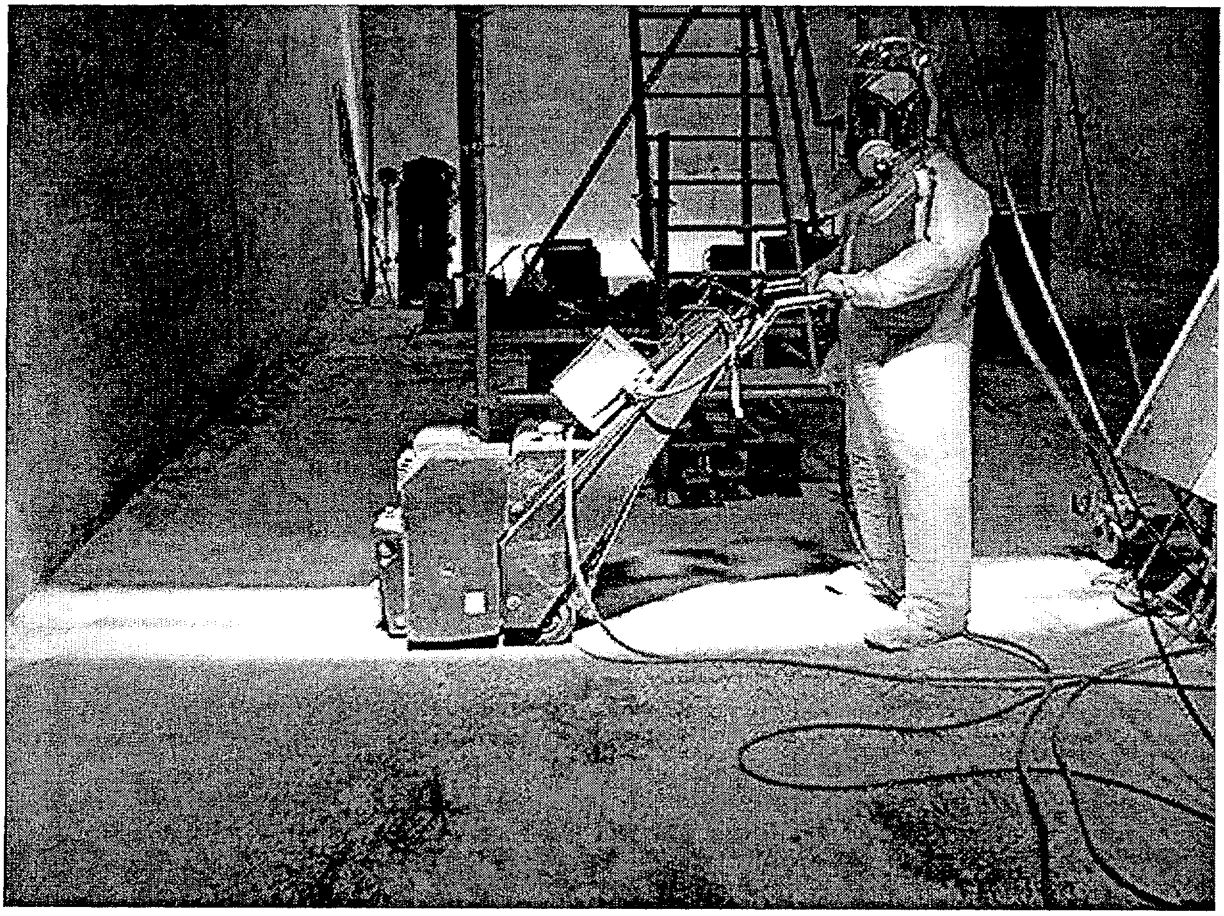

Figure 3: Handshaver for concrete decontamination

When the contamination has penetrated deeper into the concrete surface and layers of a few cm have to be removed from the walls, the use of shavers is not appropriate as it would require the work to be done in several steps and would increase substantially the collective doses to the workers. In order to improve the efficiency in these cases, an adapted milling cutter fit on a raising platform, was used for the decontamination of the concrete surfaces. Such a tool (Figure 4) enables the removal of a 5 mm thick layer of concrete in a single pass.

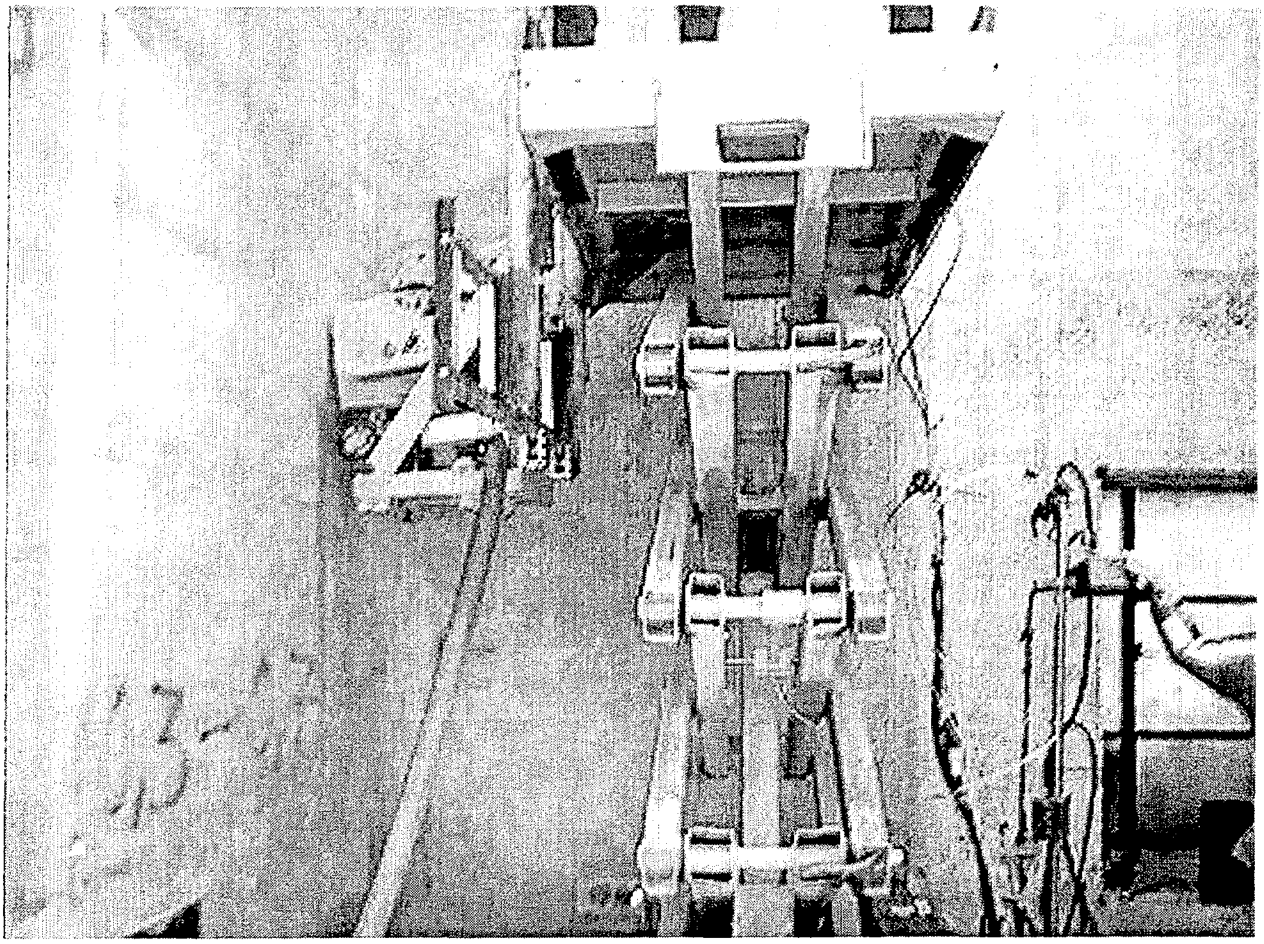

Figure 4: Milling cutter for wall decontamination

The milling cutter is equipped with a cutting drum and a dust control cover for connection to a dust extraction system. The dust extraction system captures dust and debris at the cutting tool surface, minimizing cross contamination, and incorporates a filtering system to recover concrete particles. Using this technique results in a rather smooth surface, which can be easily measured using clearance's method.

STORAGE OF GRAPHITE WASTE

A new storage facility dedicated to the graphite is now being built on site. This facility is located inside the reactor building and is designed to accommodate about 300 graphite waste and seat wires containers.

The layout of containers and the method and sequence for placing them within the facility have been designed to minimize the doses to the workers and the public.

The facility is equipped with the auxiliary systems required by the regulations and will be under surveillance and maintenance during the dormancy period.

CONCLUSIONS

This paper has presented an overview of the decommissioning and decontamination activities performed for the graphite silos of the Vandellós 1 nuclear plant. Special emphasis has been placed on the use of automated industrial technologies, which minimize waste production and improve efficiency and working conditions.