

A MULTIPURPOSE TRANSFER BELL FOR LOADING CONTAINERS AT GREIFSWALD NPP DECOMMISSIONING

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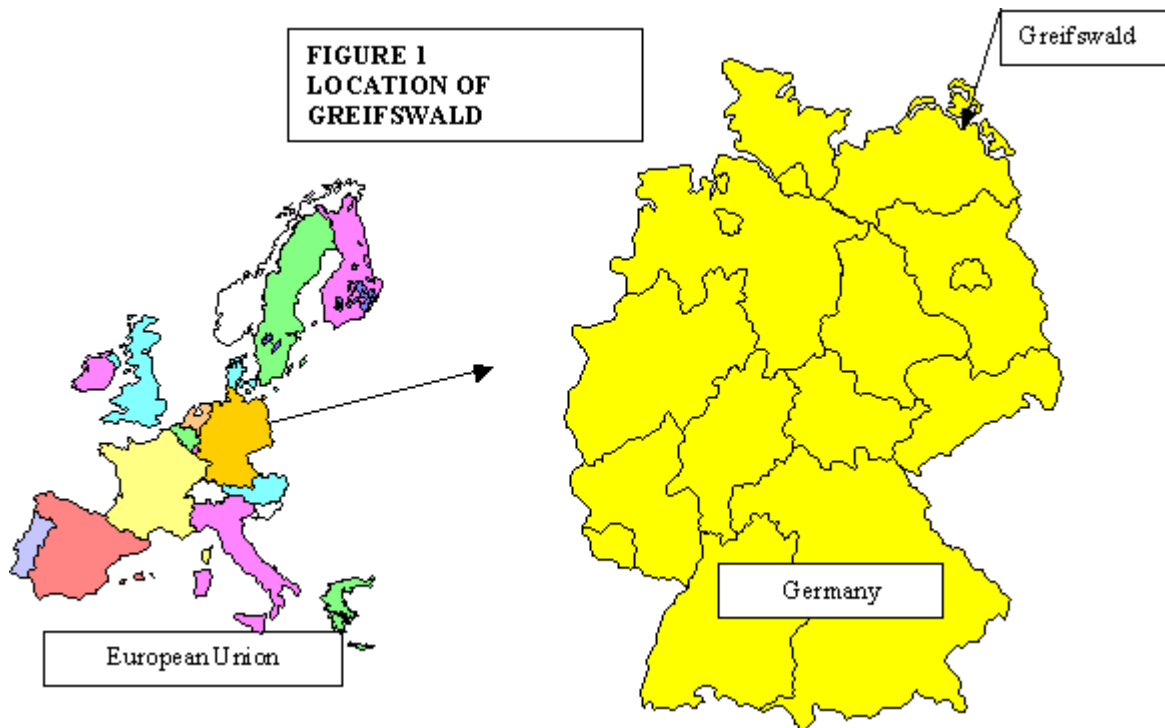
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When Germany was reunified in 1990, the Soviet designed VVER 440 units of Greifswald NPP, on the Baltic sea (Figure 1), were stopped. Five units were in operation and 3 more under construction. These Soviet designed pressurized water reactors did not only supply electricity to East Germany and Poland, but also heating to the nearby town of Greifswald.

The Energiewerke Nord GmbH (EWN) was assigned the task of dismantling the NPP. EWN had available numerous highly trained engineers, that had been previously in charge of NPP operation, and to have scale-one unactive mock ups, since some units were under construction and had not started up at the time of the dismantling decision.



DEFINITION OF THE PROBLEM:

As EWN was planning its operations, they found that they would have to handle highly activated parts from the core or from the so called Schachtlager (well storage) in a safe way, in order to load them into transport packagings, interim storage or final storage containers.

A flexible bell system was then designed and tested by Transnucléaire, a French company specialized in transport and in designing transport and storage packagings for radioactive materials. Its experience in cask handling and shielding issues could be readily transposed to a bell. It also comes from the methods of loading MTR fuel at reactors where the lifting capacity leads to use bells to get spent fuel to the transport cask that is too heavy to be handled over and in the pool. Transnucléaire was backed up by DSR, a Berlin based company, that has extensive knowledge of VVER technology and of German nuclear standards and procedures.

The resulting bell is a multipurpose equipment that can handle heavy or small parts, in less than definite positions, and can check the radiation level of the parts being handled.

REGULATORY FRAMEWORK:

The governing regulations were the German Atomic Law, the German ordinance for radiation protection and the KTA 3902 standard that applies to handling systems in a German nuclear power plant. KTA 3902 is a very stringent standard, that goes beyond the NUREG 0612 and intervenes at two levels in the bell design, fabrication and testing:

- The bell is an object that is being handled in a NPP over the open reactor vessel: therefore its handling attachments had to be defined and tested according to KTA 3902.
- The bell grapple and winch system handles radioactive parts the drop of which may expose personnel to radiations: grapples and winch safety have themselves to be designed according to KTA 3902. This meant for instance that a simple tweezers type grapple had to be demonstrated to be able to apply twice the friction needed to hold a part in its grip.

Application of KTA entailed several discussions with the TÜV oversight authority as to part and drop consequence classification, interpretation and implementation. This classification, that analyses what irradiation or criticality effect a malfunction would have, then defines the category and extent of mechanical analysis, manufacturing controls and tests to be performed for delivery. It is to be noted that, similar to other regulations, a handling system designed and manufactured after KTA 3902 is considered as fail safe, and analysis of consequences of drops to the facility become unnecessary.

No specific license for operating the bell was necessary, as the justification documents were included in the general license application for the dismantling of the NPPs.

DEFINITION OF THE PARTS TO HANDLE:

Although most of these parts could be partly identified and assessed as to their radiation source strength, some could be only partly defined, and their actual status or position was not a certain thing. It was therefore necessary to come to a flexible design.

The inventory of parts to handle was complex:

- Cobalt 60 activated parts shaped like a fuel assembly but made of boron stainless steel and playing the role of a control rod in a PWR reactor,
- old sensors, with or without connecting wires,
- miscellaneous activated parts, weighing a few kilograms
- connecting rods for control assemblies almost 5 meters long.

EWN had thoroughly job of estimated the needs and possible source terms with the help of DSR, a COGEMA group company specialized in nuclear engineering with emphasis on decommissioning. The main sources would be Co 60 gamma sources.

Because in a dismantling operation, operators may well see their productivity go down because of dose uptake, keeping the bell operating dose rates as low as reasonably possible was specified strictly.

With DSR, a radiation measuring system was included in the bell so as to prevent exceeding predicted dose rates levels, should a part be more activated by anticipated through calculation.

INTERFACES AND LOCATION OF THE PARTS:

Handling the bell itself raised no major difficulty: the generously dimensioned overhead cranes of a VVER NPP would meet no difficulty in lifting the 25 tons of the bell. Care would have to be given to make sure that the length of the bell would not be a hindrance. This is why the winch system (see figure 2) was positioned at two third of the overall height of the bell.

The bell would have to be handled in loaded condition by this crane.

The larger parts (shielding assemblies, connecting rods, control elements) were generally placed in a very well defined **underwater** position in the reactor vessel. Here the solution was to position the bell on a maintenance shielding plate, with penetrations through which the guiding tubes for the grapple would be positioned.

Because of the underwater position of these parts, it was required by the authorities that the rotating obturator at the bottom end of the bell be watertight.

The Schachtlager (well storage) consists of a closely bundled array of tubes approx. 9 meters long and 180 mm diameter, each plugged by a shielded lid. A drawer obturator allows positioning the bell over a given well and opening up the lids without radiation streaming.

The specification was that the bell should be designed not only to recover parts in a non descript state at the bottom of a well in the Schachtlager, but also that it should be possible to deposit the parts from the reactor vessel into the Schachtlager and then recover them later on.

This entailed the development of a grapple and hoist system that would prevent undue torsion on the winch system cables and thus avoid to lose the angular orientation of the grapple without having to resort to lateral guides.

Several connecting rings and parts were also supplied to be adapted to different interfaces.

DESCRIPTION OF THE BELL:

Transnucléaire designed, licensed and manufactured a 25 tons transfer bell (Figure 2), steel shielded, with the following main characteristics:

- lifting capacity 300 daN
- maximum allowable diameter of part 180 mm
- maximum allowable length of part 4.9 m
- maximum source accepted (Co60) $8.5 \cdot 10^{13}$ Bq

In order to cater to the handling of the bell within the reactor hall after loading wet parts from the pool, the bottom end of the bell was fitted with a rotating shielded valve.

All 7 different grappling devices were designed to be able to seize the various parts in different configurations or made of diverse materials within a very restricted space. One grapple was also fitted with a remote control camera in order to guide the operator.

FIGURE 2

THE TRANSFER BELL



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The following grapples were designed:

- 1) grapple for control assemblies and connecting rods
- 2) grapple for shielding assemblies
- 3) grapple with video transmission with the following configuration
 - a) mechanical grip
 - b) pneumatic grip with several claws set for different parts
 - c) suction grip for lightweight plates
 - d) electromagnet

The grapple with video remote control has been designed for dry conditions, while the first two operate in dry or wet condition.

FIGURE 3
EXAMPLE OF GRAPPLE



Because of the uncertainty on the source terms of parts to be handled, a double approach for radiation safety was implemented:

- The operation of the bell is semi automatic and remotely controlled, so that the operator stands more than 10 meters away from the device, possibly behind additional shields
- The bottom part of the bell is equipped with a radiation sensor that measures the emission from the part being loaded in real time, thus tripping an alarm if the source is worse than planned for. The maximum dose rate on surface of the parts was 660 Gy/h, and the measurement system covers a range of $1/1000^{\text{th}}$ to 1000 times this value.

The automaton, connected to several sensors, provides for recording of the operation, checking of radiation level, limiting the handling efforts against overload, displaying position of the grapple and lifting rate of the system, remote control of grapple and winch, recording and displaying the status of the rotating valve at the bottom of the bell.

Provisions were made so that positive fastening of the heavier parts was achieved and confirmed by position sensors combined with load sensors: when the bell is transferred from the pick up point to the deposition point, power is disconnected. It is thus necessary to make sure that the heavy parts may not be dropped.

Provisions were also made so that should there be a malfunction of the grapple when the bell carries a highly radioactive part, it is possible to unlock the grapple manually, lift it off and replace it without exposure of personnel to radiations:

This was done by giving access to the top side of the bell, through which a grapple can be extracted and replaced while the radioactive part stays inside the bell. Ports give access sideways to the grapples so as to be in a position to unblock the held part manually.

FABRICATION:

After the preliminary documentation had been approved by TÜV and by EWN, fabrication took place and was performed in 12 months.

The main body of the bell is forged carbon steel and the rotating valve is stainless steel.

Extensive testing took place before shipping, using a steel girder structure to support the bell.

The whole program was managed within a ISO 9001 certified QA system.

Licensing for using the bell was applied for by the EWN within the framework of its general license for dismantling the NPPs, on the basis of safety analysis established by Transnucléaire and DSR. The compliance with the lifting regulations and KTA (Nuclear Technical specifications) was proven under supervision of the TÜV (Association for technical supervision).

TESTING

After delivery on site and testing at one of the inactive units the bell has been put into service. The testing was extensive and demonstrated the capability of:

- checking the safety automaton operability,
- testing the gamma measurement apparatus and its protection function,
- confirming the good operability of the winch and block system: the block, when hanging freely with heavy (up to 300 kg) or light loads (1 kg) does not rotate and stays in the same orientation even when 9 meter below the bell obturator,
- correct positioning over and grappling of the heavy parts to be handled,
- identification of miscellaneous parts in the Schachtlager thanks to the camera,
- orientation of grapple to seize these parts,
- easy substitution of grapples,
- back up systems to replace safely a grapple that might be blocked inside the bell while holding a highly radioactive part: possibility to unblock it, replace it and regain hold of the part without exposure of personnel,
- efficiency of the overload control system to avoid damaging any of the surrounding structure,
- transfer of the loaded bell to a different position and deposition of the payload in different containers.

CONCLUSION

The transfer bell is now operational in Greifswald and has been operating to the satisfaction of EWN: It has already been used for simple but also very complex processes and, according to the operators, it works very well.

A request was recently made to Transnucléaire of checking that no risk is associated with the automaton and the upcoming year 2000...As we confirm that no risk is associated therewith, we certainly expect the bell to work well ahead into the next century. It will stand proof of the possibilities to transpose know-how from transport containers to NPP site machines.

We have thus demonstrated a handling bell with a wide range of handling capacity and recovery systems in case of malfunction, and with built in safety features that allow real time operation follow up.