Dismantling of the Zion NPP: Double record for Siempelkamp

In October 2010, Siempelkamp Nuclear Services (SNS) was commissioned with dismantling the installations and reactor pressure vessel (RPV) of the US Zion NPP double block plant. This dismantling process represents the most extensive disassembly of an NPP that has so far been carried out not only in the USA, but anywhere in the world. Moreover, the project represents the largest single order value that a customer has so far placed in the nuclear technology business unit.

By Martina Glücks

During the dismantling of the Zion NPP, the Siempelkamp experts from the fields of dismantling and decommissioning are working hand in hand. The various areas of expertise at Siempelkamp will be cooperating across the pond: Siempelkamp Nukleartechnik and NIS Ingenieurgesellschaft on the German side, and the US subsidiary Siempelkamp Nuclear Services on the American side. Bundled synergies and the many years of experience of this well-versed team of experts are available to our customers for the safe, inexpensive and environment-friendly execution of their project.

In the interview, John Mageski, Managing Director of SNT US and SNS, as well as Christian Jurianz, Head of International Sales at SNT, explain to what extent German and American competences are able to impress here.
An American company with a German parent – Siempelkamp – has acquired a significant single order for the largest dismantling project on the American market. What is this success based on?

John Mageski: Our work and extensive experience from more than 16 dismantling projects that we have successfully carried out since 1995 under MOTA – since April 2009 MOTA has been operating under the name Siempelkamp Nuclear Services Inc. – is highly appreciated. Our core personnel can look back on 25 years of professional experience in the field of dismantling. The SNS engineers and technicians are some of the most respected and experienced specialists in the industry. With us, everything just clicks: the employees and the technologies.

Christian Jurianz: We Germans on the other hand are renowned for our know-how, our accuracy and the high safety level of our work. Furthermore, Siempelkamp was already well-known in North America before the acquisition of MOTA: We already had a name on the US market as a manufacturer of storage casks for the transport and storage of radioactive wastes and as a successful supplier of stud tensioning technology. The international decommissioning projects are also closely followed in the USA, so that our 15 decommissioning references in Germany have not gone unnoticed. Other countries closely followed the thermal dismantling of the RPV at the German Stade NPP with interest. With our wide range of services over 15 years, we also were involved with the dismantling of the Kahl experimental nuclear reactor down to the ‘green field’ stage and release from the Atomic Energy Act in October 2010.

How is Siempelkamp currently positioned in times of the (unexpected) phasing out of nuclear power in Germany?

Christian Jurianz: On the international level, we are the company with the greatest and most extensive experience of dismantling – thanks to our many years of working in the field of dismantling/decommissioning both in Germany and on the US market. This service aspect has become well-established in addition to the activities in the field of the supply of components for the construction of new and retrofitting of existing NPPs. In this respect we see ourselves well positioned in Germany for the future and are retaining all of our jobs.

John Mageski: One advantage is the bundling of the Siempelkamp competences – this has also opened up new business segments which did not previously exist for the US subsidiary. Customers in the USA do of course appreciate the “Made in Germany” label, but prefer the project to be executed through an American company.

Speaking of Zion – which dismantling strategy is being used for the reactor pressure vessel?

John Mageski: We have a strategy both for the mechanical and for the thermal dismantling process. A decision on which process to use will be taken not later than the end of 2011. This decision depends on the project length, the safety of the process and economic aspects. The safety technology of course also plays a decisive role.

Which processes does the German parent company work with?

Christian Jurianz: When we speak of the dismantling of the RPV, we clearly prefer the thermal method. We have already employed this method with great success at the multipurpose research reactor (MPPR) in Karlsruhe and at the NPP in Stade. Siempelkamp offers an excellent choice of tried and tested procedures – both thermal and mechanical – which can be implemented according to customer and project requirements, taking into consideration the safety technology.

A look into the future?

Christian Jurianz: With the coming into force of the 13th Atomic Energy Act Amendment on 6 August 2011, some NPPs in Germany have lost their entitlement to power operation. As a result, in approximately four to five years, there will probably be various decommissioning projects starting up in Germany. We are securing jobs and expertise in order to be prepared for these projects. Also in other European countries – e.g., in Great Britain and France –dismantling projects will be started in the near future. We have already performed corresponding initial studies for Italy.

Mr Mageski, Mr Jurianz – thank you very much for this discussion!
Three reference projects, three core competences:

Stade NPP – Zion NPP – Karlsruhe MPRR

“It is not the process which determines the task, but the task which determines the process!” Three current projects illustrate how multifaceted the range of services of Siempelkamp Nukleartechnik is.

1. RPV dismantling at the Stade nuclear power plant: innovative concept

On 14 November 2003, the nuclear power plant in Stade was taken off the grid after 30 years of operation for economic reasons. Since September 2005, the plant has been in the residual operation phase and dismantling has begun. Such dismantling is a complex task and is performed in five phases, which are scheduled to be completed in 2015. The disassembly, dismantling, packaging and disposal of the reactor pressure vessel (RPV) are constituents of phase 3.

In 2008, the team of experts at NIS Ingenieurgesellschaft mbH was commissioned by E.ON Nuclear Power with the dismantling and packaging of the RPV at the Stade nuclear power plant: the specialists disassembled, dismantled and packaged the reactor pressure vessel, RPV lid and the peripheral equipment. Dismantling of the RPV was mainly carried out thermally using the oxygen-propane cutting method. Mechanical cutting processes such as using a band saw were employed in support.

Planning, procurement of equipment and testing as well as putting into service on site were carried out within 16 months. The actual process of dismantling the RPV was performed within a period of four months. The high speed of the project made it possible to thermally dismantle and package the lid within just 13 working days.

Beforehand, NIS already performed the important planning work that enabled the project to be executed quickly: e.g., sample-taking and dose rate measurements. “With the help of the sample-taking in the RPV, we have created a reliable data record to be able to plan the subsequent loading of the waste containers precisely,” says Andreas Loeb, NIS Project Manager in Stade.

In 2010, NIS was awarded a further contract for the Stade project: the dismantling and clearance planning for large components. Here, the focus was on the development of a dismantling concept for the polar crane, as well as a clearance concept for the containment. This contract is associated with the performance of the radiological assessment of the two components. With over 350 individual tests and their radiological evaluation, NIS created a reliable basis for the planning process.

The contract was completed at the end of 2010 – exactly on time and within budget.
The Stade project – an overview

- RPV: thermal dismantling in the air and on a dismantling turntable using a band saw
- RPV lid: also thermal dismantling in the air and on a dismantling turntable using a band saw
2. Zion NPP: dismantling of the RPV and the reactor core internals – challenge with a new process

Zion NPP undergoing dismantling since 2010

40 miles north of Chicago along the banks of Lake Michigan is the Zion nuclear power plant. In 1998, after more than 20 years of operation, the two reactor units of the NPP were finally taken off the grid. The dismantling of the Zion NPP started in 2010 – and will be the most extensive dismantling process that has ever been carried out in the United States.

In October 2010, Siempelkamp was awarded the contract by ZionSolutions to segment both the reactor pressure vessels (RPV) and the core internals. The reactor core internals, consisting of components such as the core shroud, moderator tank, core structure and thermal shield, are dismantled under water in their installation position. Segmentation under water ensures sufficient shielding against radioactivity.

For the segmentation of the reactor pressure vessel, Siempelkamp developed a concept with two technical processes: a mechanical and a thermal dismantling process.

The mechanical process by means of which SNS has so far successfully performed all RPV dismantling is based on specially designed and produced cutting tools that make use of tried and tested designs and technologies from earlier SNS decommissioning projects. A few examples of this technical equipment are the volume reduction station, the circumferential-hydraulically operated rotating cutting equipment (C-HORCE) and the bolt milling tool. In order to guarantee perfect performance during use, the operating capability of each dismantling tool is tested at the test stand on the SNS premises.

The thermal dismantling process, which is available as an alternative, has already been used with great success in Stade NPP. The so-called oxygen-propane cutting method has the great advantage that the dismantling work can be performed within a shorter period. The cutting speed for 200-mm-thick steel is 4.0 mm/sec, whereas for the mechanical method it is only 0.25 mm/sec.

The reduced use of additional technical equipment and the high level of process reliability also speak in favor of the method. The result: a reduction in the radiation protection requirements and the radioactivity doses to which the employees are exposed. Put briefly: the oxygen-propane method guarantees a high level of process reliability both for the company performing the dismantling and the operator. The use of this process would be a premiere for our colleagues from SNS and the American market, at the same time representing a guarantee of maximum planning reliability.

Since April 2011, Siempelkamp has set up construction site offices on the Zion site and started with the shielding preparations. After the decision on the appropriate dismantling process for the RPV (not later than the end of 2011), the start of the segmentation work is planned for the third quarter of 2012. Dismantling of the reactor pressure vessel and reactor core internals is to be completed in 2014.
The Zion project – an overview

- RPV: two processes available for selection – thermal or mechanical dismantling in the air
- Reactor core internals: mechanical dismantling under water in the installation position
The multipurpose research reactor (MPRR), which was decommissioned in 1984, is one of the nuclear technology plants currently being dismantled on the site of the former Karlsruhe Research Center, now known as the Karlsruhe Institute for Technology (KIT). The dismantling concept for the MPRR provides for complete removal of the plant for the creation of a ‘green field’ in eight dismantling steps. Since 2008, the last two steps have been ongoing.

2008 – 7th dismantling step: The experienced dismantling team of NIS started with the contract to dismantle the RPV together with its core internals. Here, the main process selected by the experts was the thermal oxygen-propane cutting method for segmenting the RPV in the air. Additionally, mechanical dismantling using a band saw was applied. The reactor core internals were cut up both thermally and mechanically under water. For the thermal underwater dismantling process, the plasma cutting method was available, supplemented by mechanical tools – these were used for the control rods, for example. With the dismantling of the RPV and its internals, a total of 400 t of material were segmented and packaged into casks and containers suitable for final repository.

2009 to 2011 – 8th dismantling step: The SNT team goes into action. The dismantling of the activated heavy concrete of the biological shield was performed using a remote-controlled demolition excavator complete with accessory equipment. The excavator was attached to a specially produced platform, the suspension and fixed mounting frame. For the dismantling of the steel liner, which was located on the inside of the biological shield, band saws were used. Here too, all of the equipment was first successfully tested in the test stand before being assembled in the reactor building. 300 t of heavy concrete and approximately 10 t of steel were dismantled and packaged in a manner suitable for the final repository.

All of the work – from concept planning and production to delivery of the dismantling tools including accessories, assembly, final repository packaging, testing of the dismantling equipment and of course the actual dismantling work – was in the hands of Siempelkamp Nukleartechnik!
Project goals: process reliability for disassembly / dismantling / packaging

- Performance in line with protection targets – e.g., dose minimization, waste minimization, personal safety, occupational health and safety and plant protection
- Technically safe implementation
- Risk minimization
- Waste minimization – optimum use of waste containers and disposal routes
- Packaging in compliance with the intermediate and final repository conditions
- Cost transparency

Conclusion: Dismantling is performed in accordance with an optimized technical process – always taking into account the radiological conditions, maximum safety technology, the project duration and costs.

The MPRR project – an overview

- RPV: mechanical and thermal dismantling in the air – in the installation position, as there was no room available for removing the RPV
- Reactor core internals: thermal dismantling under water in the installation position
- RPV lid: mechanical dismantling on a dismantling turntable using a band saw
- Displacer / packed bed: mechanical dismantling in the air on a dismantling turntable using a band saw
- Biological shield: mechanical dismantling process using standing and hanging frame with remotely-operated demolition equipment and subsequent comminution of the activated pieces of concrete in a concrete treatment unit

Segmentation of the RPV flange ring on a band saw
The main coolant lines being drawn out of a device of the biological shield for dismantling
RPV segments being put into storage in buffer storage racks for subsequent packaging
RPV flange ring completely separated using the thermal cutting process
The dismantling of the RPV and its installations is followed by the dismantling of the equipment and decontamination of the rooms

Remote-controlled dismantling of the biological shield
Dismantling of the biological shield using the demolition excavator on a platform of the suspension and fixed mounting frame
Concrete filling device for comminution and packaging of the heavy concrete segments of the biological shield

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Techniques and technologies are a success factor of Siempelkamp dismantling projects, with manpower being a second one. As an NIS mechanical engineer, Dieter Stanke is part of this success. The 53-year-old has been working in nuclear technology for more than 27 years – and sees his involvement in a dismantling project as a new and exciting challenge every day.

In my opinion there is no field of work that is so full of variety as nuclear technology. You have to have a large amount of technical expertise at your disposal and be at home in practically all fields which technology has to offer.

Electricity, water and gas lines have to be laid from A to B. Electrical engineering, supply technology, lifting technology and ventilation technology represent the ambitious technical challenges that we have to overcome. Every dismantling concept is always adapted specifically to the space conditions that we find on site. Here, it is important to take into account the radiological regulations and the highest safety aspects.

One aspect of my work which appeals to both me and my colleagues: no two projects are the same! We are responsible from the concept, through procurement, testing, personnel training and execution, to the final scrapping of the technical equipment that has been developed. Some of our technologies have development and construction times of up to four years. They are then used for eight weeks before being scrapped, even though the machine technology is working perfectly. This then meant the final point of a highly concentrated, highly professional and highly individual procedure.”

Where to find the reactor components

- Steam generator
- RPV lid
- Upper packed bed* under the RPV lid
- Primary cooling lines including pumps
- Biological shield
- Reactor pressure vessel (RPV)
- Reactor core installations in the RPV:
  - Lower and upper core structure
  - Core shroud
  - RPV flange
  - Thermal shield
  - Moderator tank
- Lower packed bed* in the RPV

* = packed bed only in pressurized heavy-water-moderated and cooled reactors
From shutdown to dismantling: the process

What happens in the nuclear power plant …

The plant is shut down, the fuel elements removed from the reactor pressure vessel. In the fuel assembly storage pool, the spent fuel elements are given their new home for at least 5 years – including after-cooling and subsequent packaging in CASTOR® casks.

… and this is where Siempelkamp works!

Siempelkamp takes advantage of this period – and

- supports the plant operator as part of the decommissioning approval planning process – e.g., in the submission of applications such as the compilation of authorization documents to actual approval, support and communication with the authorities, approved experts and test bodies, taking into account the current legal requirements and regulations
- develops decommissioning strategies and technologies – e.g., studies and concepts for dismantling, tools and waste management structures, precisely coordinated with the type of reactor and NPP-specific space conditions.

The approval concept is sometimes drawn up in partial steps and sometimes in its entirety: analysis – strategy – technology.

After approval, the procedure continues on site at the plant – with Siempelkamp

Primary circuit decontamination is due (decontamination of the activity inventory)

This is followed by remote-controlled dismantling / disassembly. “Higher activated comes before less activated” is the rule. Here, it is not possible to use any standardized processes. This is when the Siempelkamp detailed planning procedure comes into its own, which was already started during the approval phase.

Thermal or mechanical dismantling methods are used in order to dismantle the reactor core internals, the reactor pressure vessel and the biological shield.

At the same time, the waste treatment process accompanying all phases of the decommissioning procedure continues. The important points:

1. Determination of the radiological data – e.g., radiation protection planning and control, clearance measurement and documentation.
2. Selection / definition of the waste treatment method, e.g., for treating solid, liquid and gaseous radioactive wastes, also taking into account volume reduction.
3. Delivery and project management during the waste treatment phase.
4. Packaging of the residual substances for the final repository.

The bottom line: Siempelkamp provides the right strategy – whether in the approval process or in the technical field (radiology, mechanical, electrical and process engineering).