



Decommissioning of the BR3 PWR

AS PART OF the cleanup and restoration of previously contaminated sites and premises, the Decommissioning and Decontamination (D&D) activities aim at declassifying installations formerly devoted to industrial or scientific production (such as power plants, fuel fabrication plants, waste conditioning plants, and research installations) and having used radioactive isotopes or contained sufficient radioactivity to be submitted to regular controls. Nowadays, there are about 400 nuclear power plants and as many research or pilot reactors in the world, as well as many nuclear industries and laboratories. Many of them are already shut down or will be within a few years. The required technologies and procedures must now be developed and optimized to be ready for decommissioning these installations.

SCK•CEN has three main nuclear reactors, of which BR3, a pilot PWR, was the only one to produce electricity. After 25 years of successful operation, this reactor was definitively shut down in June 1987. In 1989, it was selected by the EC as one of its four pilot projects in the framework of its five-year Research and Technological Development programme on the decommissioning of nuclear installations. This contract was renewed in 1996, with two German partners: EWN-Greifswald and KRB-Gundremmingen.

Objectives The main objective of the decommissioning programme is to contribute to the activities needed to hand down a clean and safe world to the next generations, in the most economical way. More specifically, this programme aims to develop, test, and optimize the required technologies and procedures for the D&D of nuclear installations, in order to minimize the corresponding waste and the distributed doses. It also aims to minimize the environmental impact of those activities.

From the economical point of view, the optimization of the developed techniques and methods aims at reducing the cost of the end-of-life of the installation, but the ability to estimate precisely the actual cost of D&D is also an important factor for the acceptability of nuclear energy and for ensuring that enough money is available for the required cleanup.

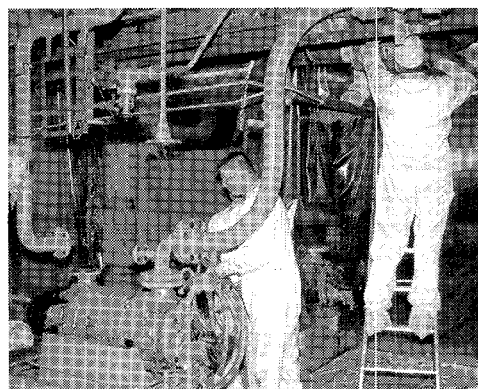
Programme Through the BR3 decommissioning project, aiming at a complete cleanup of the site of the first European PWR plant, SCK•CEN develops the necessary tools, techniques, and methods of D&D and builds important know-how in this domain. These developments and know-how are then made available to the industry, to perform the actual large projects using the best up-to-date methods and knowing their cost. This collaboration with the industry is mainly carried out through partnerships or actual industrial projects. Moreover, the experience thus accumulated and the skills thus developed are also useful for the regulatory bodies and international or national institutions in charge of defining the limits of and constraints on the future activities in this field.

Achievements The main achievements for 1997 can be classified in three fields:

- the pilot dismantling project, which mainly focuses on developing and testing tools and methods for the D&D of nuclear power plants and installations;
- the management and minimization of the generated D&D waste;
- the valorization of the accumulated experience through contracts with international institutions and industrial partners.

Within the BR3 decommissioning project, we reached the following six goals.

- We dismantled the auxiliary equipments and loops, applying the ALARA principle to all levels of the activity, and optimized the methods used to minimize the production of waste (Fig. 1).



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Figure 1 The technique selected to dismantle this internally contaminated auxiliary loop ensures a low contamination of the working area.

Figure 2 This Health Physics worker carries out the last measurement before the free release of the concrete antimissile slabs, to ensure an independent measure.



- We decontaminated, up to their free release, the concrete antimissile slabs used above the reactor pool (Fig. 2).
- We modelled the radiology of the primary-loop area in the plant container to simulate the future dismantling operations and to minimize the dose uptake by selecting the most appropriate procedure and dismantling plan.
- We started to implement the quality-assurance procedure for dismantling loops and equipments and for managing the waste.
- We compared thoroughly two methods for dismantling the reactor pressure vessel either in situ or by removing it into the refuelling pool and dismantling it afterwards. We finally selected the latter as it includes far less technical uncertainty and allows us to reuse existing tools as much as possible, for instance during the dismantling of the reactor internals, and thus turned out to be much cheaper than the in situ method. Detailed design and ordering of the main components were already started.
- We began to remove the contaminated thermal insulation of the primary loop containing asbestos. The area should be declared asbestos-free in early 1998.

As regards the management of the generated D&D waste, we completed the detailed design of the chemical decontamination unit based on the Ce^{4+} process and ordered the main components. This unit, based on the regeneration of the Ce^{4+} for minimizing the secondary waste produced, will allow the free release of much

of the dismantled materials, thus drastically reducing the generated waste.

During the year 1997, some 200 tons of material were free-released thanks to the management put in place, the sorting, measurements, and decontamination using simple washing techniques or the wet abrasive blasting process for metals and the scabbling for concrete.

To ensure as good as possible a management of the waste and material stream and present a constant level of confidence, we are implementing a quality-assurance system for the whole dismantling process and for the material stream management.

Finally, to valorize the acquired experience and skills outside of SCK•CEN, we started or carried out different contracts and collaboration with international organizations and industrial partners. After commercial contracts in 1996 for D&D data and the estimations of decommissioning costs with Japanese and Belgian industries, 1997 saw the signature of a framework contract with a large French industrial partner, Framatome, in the field of D&D and radioactive waste management. At the end of the year, a contract for the study of a decommissioning plan and management in five countries of Central Europe was awarded by the EC to SCK•CEN and to other Belgian and European industrial partners. We also carried out a study for decontaminating hot cells for a Belgian industry and contacted a research institution to estimate the cost of the D&D of a research reactor.

Partners, sponsors, and customers

Scientific partners Belgatom — Framatome — Studsvik Radwaste — Belgoprocess (BP) — Energiewerk Nord GmbH (EWN) — KRB-A Kraftwerk — Wetenschappelijk en Technisch Centrum voor het Bouwbedrijf/Centre scientifique et technique pour la construction (WTCB/CSTC) — University of Hannover — International Atomic Energy Agency (IAEA)

Sponsor European Commission (EC), DG XII and DG XI

Customers Sumitomo — Institut des radioéléments (IRE)

Scientific output

Publication in 1997

Y. DEMEULEMEESTER, "Kernreactor ontmantelen," *Natuur en Techniek* jg.65, 5 (1997).

Presentations delivered in 1997

J. DADOUMONT, V. MASSAUT, "Comparison of Cutting Techniques in the BR3 PWR Decommissioning Project," Seventh Int. Conf. on Cutting Technology (ICCT 7): Hamburg, Germany, March 5-6, 1997.

Y. DEMEULEMEESTER, V. MASSAUT, A. LEFÈBVRE, "The Use of Mechanical Cutting Techniques in the Decommissioning of Highly Radioactive Reactor Internals," Fifth Int. Conf. On Nuclear Engineering (ICONE 5): Nice, France, May 26-30, 1997.

Y. DEMEULEMEESTER, R. MANDOKI, M. KLEIN, V. MASSAUT, S. MOERS, "The Management of the Material Flow by the Dismantling of a Nuclear Reactor: Approach and Experience Gained during the Dismantling of the BR3 Pilot Dismantling Project," Third European seminar on Melting and Recycling of Metallic Materials Decommissioning: Nyköping, Sweden, June 11-13, 1997.

V. MASSAUT, "Lessons Learned during the BR3 European Pilot Decommissioning Project," Fifth int. conf. on Decommissioning of Nuclear Facilities: London, United Kingdom, February 19-21, 1997.

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V. MASSAUT, J. DADOUMONT, "The BR3 Decommissioning Project: A Pilot for Submarine Reactors. Risk Prevention Approach and Lessons Drawn, Analysis of Risks Associated with Nuclear Submarine Decommissioning, Dismantling and Disposal," NATO advanced research workshop: Moscow, Russia, NIS, November 24-26, 1997.

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Lectures taught in 1997

V. MASSAUT, M. KLEIN, "Research and Development in Decontamination and Dismantling Technology: The Belgian Approach (Lecture 6.2)," IAEA Regional Training Course on Decommissioning of Research Reactors and Other Small Nuclear Facilities: Bucharest, Romania, June 9-20, 1997.

V. MASSAUT, M. KLEIN, "Organization, Staffing and Training Requirements in the Decommissioning of Research Reactors (Lecture 11.1)," IAEA Regional Training Course on Decommissioning of Research Reactors and Other Small Nuclear Facilities: Bucharest, Romania, June 9-20, 1997.

V. MASSAUT, L. NOYNAERT, R. CORNELISSEN, J. MARIEN, S. HARNIE, "Decommissioning of Nuclear Laboratories and Other Facilities Supporting Operation of Research Reactors (Lecture 13.1)," IAEA Regional Training Course on Decommissioning of Research Reactors and Other Small Nuclear Facilities: Bucharest, Romania, June 9-20, 1997.

M. SCHRAUBEN, V. MASSAUT, "DES en génie nucléaire: Déclassement des installations nucléaires. 1^e partie: Principes et stratégies (trois chapitres)": SCK•CEN, Mol, Belgium, April 24-25, 1997.

Expert Group contributions made in 1997

V. MASSAUT, "BR3 Decommissioning Project," report to the TAG 22 (OECD/NEA) (November 1996 - May 1997). 55Bis/97-04.

M. KLEIN, V. MASSAUT, "Dismantling Technologies in Decommissioning of the BR3 Reactor," IAEA experts meeting on regional technical co-operation project on Planning and Management of Decommissioning for WWER NPP's Workshop: Bratislava, Slovakia, May 12-16, 1997.

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