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MANAGEMENT AND STORAGE OF NUCLEAR FUEL FROM BELGIAN RESEARCH REACTORS


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Abstract

Experiences and problems with the storage of irradiated fuel at research reactors in Belgium are described. In particular, interim storage problems exist for spent fuel elements at the BR2 and the shut down BR3 reactors in Mol.

1. INTRODUCTION

SCK·CEN owns 5 research reactors, three of them still in operation, the others are now being decommissioned.

- BR1, a 3.5 MWth graphite moderated and air cooled reactor. It went critical in 1956 for the first time. It is now only used at low power for research, activation analysis, dosimetry, etc., on a discontinuous basis.

- BR2 is a powerful (120 MWth) Materials' Testing Reactor. It went into operation early in 1963 and has been intensely used for research projects on the behaviour of structural materials and nuclear fuels. It will operated on a continuous basis up until mid-95. A decision for continued operation - after an extensive two-year refurbishment programme - has to be taken by end of 1994 based on technical and economical studies.

- BR3 is a small (40.9 MWth) PWR reactor. It was operated from 1962 until 1987. This reactor was used primarily for testing of advanced fuel. The plant was finally shutdown on 30 June 1987 and is now being decommissioned.

- BR02 is the nuclear mock-up of the BR2 reactor. It was mainly used to study the nuclear characteristics of the various BR2 core configurations and to determine the precise irradiation parameters for complex experiments. BR02 is now being decommissioned.

- VENUS is a critical assembly which came into operation in 1963. It is used to perform reactor physics experiments in support to various LWR research progammes.

- ***The State University of Ghent*** owns a 150 kW research reactor, with slightly enriched (5%) uranium fuel. The core is water moderated and cooled, and has a graphite reflector. Its is mainly used for research and analytical studies.

2. MANAGEMENT STORAGE OF IRRADIATED FUEL

2.1 BR1 Reactor

BR1 is fueled with natural metallic uranium with an Al cladding. The reactor loading comprises 12 639 fuel elements. A dry storage is available. It is made of concrete with horizontal channels. The dry storage can contain about 20 % of the reactor loading. The wet

storage has a capacity of 13 000 assemblies. There is presently no plan to dispose of the irradiated fuel (1037 fuel elements already in storage).

2.2 BR2 Reactor

- The BR2 reactor is fueled with 93 % HEU. Fuel elements are made of a core - Al-U cermet - sandwiched between Aluminium plates.

- Storage is available in the Containment Building (about 200 places) and in the Storage Channel outside (800 places available in January 1993).

By January 1993, the storage capacity of the storage channel was nearly exhausted. The storage capacity has been expanded to allow the continuation of the operation beyond 1995 and to allow an inspection and maintenance of all compartments of the storage channel. Storage expansion is implemented through reracking, i.e. introduction of new high density racks and modifications to old storage racks. After reracking, the capacity of the storage channel is now 1 550 fuel elements.

At the present, the largest compartment (093) of the storage channel has been refurbished. Preparations are now under way to refurbish the next two compartments.

A description of the underwater storage facilities before and after expansion has been described in detail elsewhere [1].

- Two hundred and forty fuel elements were transferred to A.E.A. Dounreay for reprocessing in 1993/1994. This transfer was needed to allow the refurbishment of the storage channel.

The reuse of the recovered HEU. (with a 74 % residual enrichment) has been studied. A demonstration programme is in progress which started in December 1994 with the irradiation of 6 test fuel elements.

- Alternative solutions to underwater storage should be available for operation after the refurbishment of the reactor.

To date, the following different solutions have been examined:

* Reprocessing at the Dounreay plant.

* Dry interim storage in thick containers, to be stored in a building on the Belgoprocess site (Mol).

* Dry (interim) storage in thin containers to be stored in a shielded building - foreseen for storage of vitrified waste from Belgian power plants - on the Belgoprocess site.

The technical and financial aspects of these solutions have been examined and compared with available results from Germany.

- The possibility of returning the fuel back to the U.S. is now again open and is being followed by a Research Reactor Group under leadership of the Edlow International Company.

2.3 BR02

BRO2 fuel is non-active. Most of the fuel elements can also be used in the BR2 reactor. Therefore there are no specific problems for this reactor.

2.4 BR3

- Two hundred fuel assemblies containing about 2000 fuel pins are stored under water at the BR3 site since the final shutdown of the plant. The fuel pins are clad with Zircaloy and contain U and Pu oxides with initial enrichments up to 10 %.

- Also for BR3, different alternative solutions were examined.

* Reprocessing by COGEMA or AEA Technology.

* Dry storage in thick containers.

* Dry storage in thin containers.

As for BR2 fuel, the dry storage option was considered on the Belgoprocess site. A prototype dry storage cask (Mini-Castor) has been built and the different options are being technically and economically compared.

2.5 VENUS

The fuel is made of BR3-type pins with various enrichments and compositions. No storage problems exist due to the fact that the fuel is not active (no power operation).

2.6 THETIS REACTOR

The core contains 20 assemblies. Each assembly consists of 25 fuel rods, stainless steel clad. A pool storage (3 positions) and a vault storage (24 assemblies) are foreseen. There are only three assemblies in storage and no problems are reported.

3. CONCLUSIONS

Storage problems exist for two research reactors in Belgium (CEN/SCK).

The storage problems at the BR2 were very acute and constituted a threat for a further continuation of the operation. A storage expansion programme has been implemented to increase the storage capacity. An alternative solution to the on-site underwater storage ***has*** however to be found within the next years.

The problems experienced for the BR3 reactor are quite different: the plant is being decommissioned and the fuel can be stored safely underwater for a long period (Zircaloy cladding). Long term problems (buildings, infrastructure ...) can however be encountered. The fuel is non "standard" PWR fuel and cannot be reprocessed in existing commercial LWR reprocessing plants.

REFERENCE

[1] GUBEL, P., "Interim Storage of Spent Fuel Elements at the BR2 Reactor", Annex to the paper "Storage Experience with Spent Fuel at Research Reactors in Belgium", IAEA-TECDOC-786, IAEA, Vienna (1995) 18.

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