New control system for BR2

Preventive approach to process control

In 1961, the BR2 reactor became critical for the first time. Yet the multi-functional research reactor at SCK•CEN is not out of date – quite the contrary. Regular upgrades and innovations keep the reactor in step with the latest advances in technology. In 2010, the control system of BR2, a vital part of the reactor, was replaced as a preventive measure.

Check-ups and maintenance constitute an integral part of the operation of all nuclear facilities at SCK•CEN, including BR2. This is not limited to the ten-yearly inspection conducted by the Federal Agency for Nuclear Control (FANC), in connection with the review of the nuclear permit. Apart from this control cycle, SCK•CEN closely tracks the performance of the various BR2 components. Thus, among other things, the full instrumentation of the primary circuit was replaced as part of regular upgrades during the last decade. Through such systematic technical upgrades, nothing is left to chance and safety remains guaranteed. Moreover, in this manner, it is ensured that BR2 is equipped with state-of-the-art technology.

Unique control system

The driving force behind a nuclear reaction is the neutrons emitted whenever a nucleus is split. In order to ensure the safe operation of a nuclear facility, the nuclear reaction should be kept under control and the flux level in the reactor should be regulated. For this reason, the installation is equipped with a control system. The control rods, generally composed of cadmium, have a high neutron-absorbing capability. Absorbed neutrons can no longer cause fission. Control rods slow down the chain reaction when they are introduced deeper into the reactor. Conversely, they speed up the reaction when they are drawn out of the reactor.

This control system is a unique part of the reactor. No two reactors have control rods of the same design. The efficiency of the control rods reduces after a long period due to 'burn out' – consisting of a reduction of absorbent material over the years – and must be replaced. After nearly fifty years of service, the control rods in BR2 were due for replacement.

Hafnium

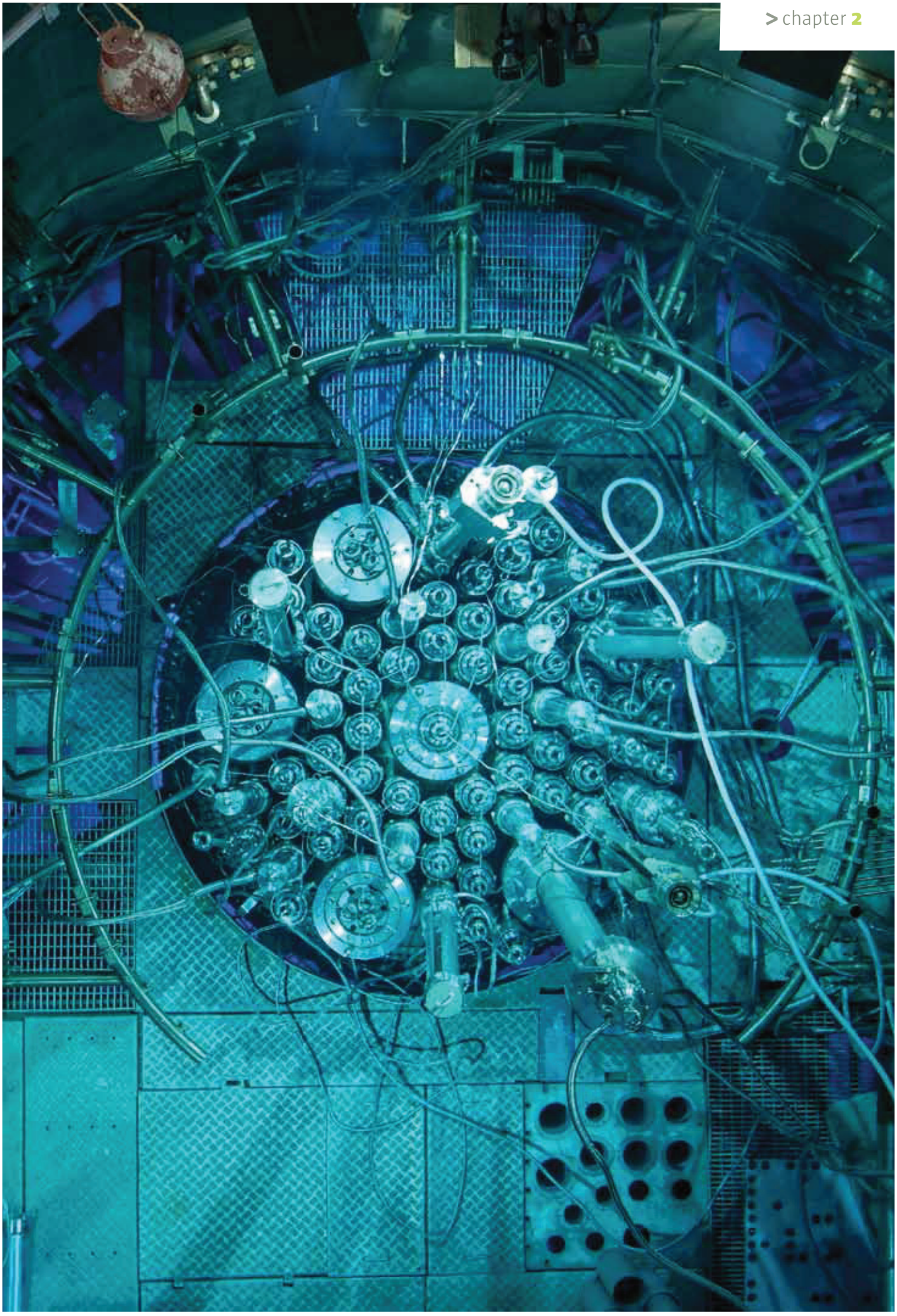
The absorbing parts of the old control rods in BR2 were made of cadmium. However, these control rods have a complex structure, which makes them difficult to manufacture. The adsorption material is drawn into an aluminium tube through coextrusion: an expensive process. Moreover, cadmium is toxic, and therefore a metal to be avoided.

Researchers at SCK•CEN were therefore looking for an alternative. Hafnium was selected as the new absorption material, based on theoretical studies and a testing programme. The advantage of this metal is that it is highly corrosion-resistant, absorbs more neutrons and can be produced untreated (without tube).

The replacement of the cadmium control rods with hafnium in BR2 was preceded by a long period of study and testing.

"The control rods of BR2 were replaced. This had to wait until we had conducted a wide range of experiments to demonstrate the efficiency and safe operation of the new material."

Geert Van den Branden
Edgar Koonen



Replacement of control rods

The replacement of the cadmium control rods by hafnium in BR2 was preceded by a long period of study and testing. The theoretical studies had already commenced in 2006, in which SCK•CEN specialists also studied the absorption capacity of other metals such as europium. In 2008, SCK•CEN carried out a first series of comparative tests on a number of rods in the reactor, enabling the validation of the capacity of hafnium to absorb high quantities of neutrons. A test report was then drawn up on the basis of a more extensive experiment, after which FANC permitted the use of hafnium rods at full capacity.

In February 2010, the old control rods were replaced with new ones. These will remain in operation until the end of the life of BR2, or until the new MYRRHA research reactor becomes operational.

BR2: one reactor, multiple applications

The Belgian Reactor 2 or BR2 is one of the most powerful research reactors in the world. Since its beginning in 1963, this materials testing reactor has used highly enriched uranium, with pressurised water as a coolant and moderator. BR2 plays a prominent role in international research into the behaviour of reactor materials. In BR2, SCK•CEN irradiates nuclear fuels and materials for different types of reactors and for the European fusion programme.

BR2 also has a production function in addition to a research function. Worldwide, BR2, along with four other reactors, is responsible for the production of 90% of the total amount of molybdenum-99. This is the radioisotope used for diagnosis and treatment in nuclear medicine. Other radioisotopes are also used in industry. They are present in sensors, for example, to determine the density and the moisture content of substances.

Silicon is also irradiated in BR2. This creates a high-quality semiconductor which is used in the electrical components of hybrid cars and wind turbines, among other things. Recently, SCK•CEN equipped BR2 with an additional facility that allows even larger blocks of silicon to be irradiated.

SCK•CEN is ISO 9001-certified for the production of the radioisotope molybdenum-99 and for the doping of silicon.

Shipment of irradiated materials for the extraction of radioisotopes for medical applications. In 2010, BR2 made a major effort to ensure the continuity of supply of molybdenum-99. The irradiation capacity was increased by 50% and the working period of the reactor was increased by 25%. This enabled SCK•CEN to achieve a production volume of 25% of the world demand in 2010.