ABSTRACT

The fuel cell laboratory was constructed in three phases and taken into operation in the years 1962 to 1966. The last experimental work was carried out in 1996. After all cell internals had been disassembled, the fuel cell laboratory was transferred to shutdown operation in 1997. Three cell complexes, which differed, in particular, by the type of shielding (lead, cast steel, concrete), were available until then for activities at nuclear components.

After approval by the regulatory authority, the actual dismantling of the fuel cell laboratory started in March 2000.

The BZ I laboratory area consisted of 7 cells with lead shieldings of 100 to 250 mm thickness. This area was dismantled from April to September 2000. Among other things, approx. 30,000 lead bricks with a total weight of approx. 300 Mg were dismantled and disposed of.

The BZ III laboratory area essentially consisted of cells with concrete shieldings of 1200 to 1400 mm thickness. The dismantling of this area started in the first half of 2001 and was completed in November 2002. Among other things, approx. 900 Mg of concrete was dismantled and disposed of.

Since more than 90% of the dismantled materials was measurable for clearance, various clearance measurement devices were used during dismantling.

The BZ II laboratory area essentially consists of cells with cast steel shieldings of 400 to 460 mm thickness. In September 2002 it was decided to continue using this laboratory area for future tasks. The dismantling of the fuel cell laboratory was thus completed. After appropriate refurbishment, the fuel cell laboratory will probably take up operation again in late 2003.

INTRODUCTION

The fuel cell laboratory was constructed in three phases and taken into operation on the premises of Research Centre Jülich in the years 1962 to 1966. Three laboratory areas (BZ I to BZ III), which were taken into operation one after the other, served inter alia for the remote-controlled investigation of irradiated fuel elements and for repairs to strongly activated or contaminated reactor components (see Fig. 1 for arrangement of the laboratory area).
Fig. 1 Arrangement of the laboratory area in the fuel cell laboratory

The laboratory areas differed primarily by the type of shielding materials. Lead, cast steel and concrete were used here as shielding material. In 1966, the last experimental work was stopped and the facility put out of operation. Within the framework of the still valid operating licence, all remaining experiments and experimental devices were removed from the cells and disposed of. Furthermore, all cells were decontaminated from inside. After approval by the regulatory authority, the dismantling of the cell complexes started in March 2000. The Operation Management Department of Research Centre Jülich is the unit of organization responsible for planning, engineering, administration and disposal within the framework of dismantling measures. External specialists were exclusively used for manual dismantling.

LICENSING PROCEDURE

In November 1997, an application under the German Atomic Energy Act was filed concerning the stop of operation and the dismantling of the fuel cell laboratory. This was a comprehensive application which, in addition to the dismantling of the laboratory areas, also contained the decontamination and clearance measurement of the building and release from the Atomic Energy Act. The application was based, among other things, on a concept description for dismantling and decommissioning the fuel cell laboratory, which in addition to the disassembly measures also considered aspects of safety at work and health physics, of the organization and the clearance measurement of plant parts. Moreover, the radiological condition of the fuel cell laboratory was described in an additional document. The application was approved in October 1998 specifying 17 incidental provisions. Apart from organizational requirements, these incidental provisions
concerned, in particular, aspects of performing the dismantling activities, of radiation and emission protection, of waste management and clearance measurement. After fulfilling all incidental provisions and clearance of the dismantling work by the regulatory authority, dismantling was started in March 2000.

STRUCTURE OF THE LABORATORY AREAS

The BZ I laboratory area (see also Fig. 1) comprised 7 lead cells that differed from each other with respect to size, equipment and shielding thickness. The cells were constructed from lead bricks encased in steel frames and in part lined with PVC or stainless steel boxes. The shielding thickness was between 100 and 250 mm, lead bricks of 50 and 100 mm thickness being used for constructing the shieldings. The internal dimensions of the cells ranged from approx. 1.2 x 1.0 x 1.9 m to 2.9 x 2.7 x 2.5 m.

The BZ II laboratory area (see also Fig. 1) is a cell block composed of three working cells, one waste cell and a glovebox. Except for the glovebox, all cells have shielding walls made of cast iron blocks. The walls and ceilings are between 400 and 460 mm thick. The cast iron blocks of which the cells are composed weigh up to 5 t. The shielding walls of the glovebox consist of lead 50 mm in thickness. The working cells relevant for the activities have internal dimensions of approx. 3.0 x 1.9 x 2.6 m. All cells are equipped with stainless steel boxes.

The BZ III laboratory area (see also Fig. 1) is a cell block composed of four working cells, one waste cell, one microscopy cell and a transfer cell. Except for the microscopy cell and the transfer cell, all cells had shielding walls made of concrete. The concrete used was iron-reinforced and had a density between 2,300 and 2,800 kg/m³. The walls and ceilings were between 1200 and 1400 mm thick. The shielding walls of the microscopy cell consisted of steel with a thickness of 400 mm. The transfer cell was shielded with 100 mm of lead. The working cells relevant for the activities had internal dimensions of approx. 2.0 x 2.0 x 2.1 m. All cells were equipped with stainless steel boxes.

Grabs or manipulators and rotating or sliding lid airlocks were integrated into the cells of all laboratory areas. Nearly all the cells were equipped with lifting gear. All rear walls of the cells in laboratory areas BZ II and BZ III and some of the rear walls of laboratory area BZ I were or are movable gates. Transport ducts below the cells of laboratory areas BZ II and BZ III connected the cells with each other.

RADIOLOGICAL CONDITION

Due to the function of the fuel cell laboratory, very different materials were handled in the cell areas, including nuclear fuels and widely differing nuclide mixtures. For this reason, the decisive nuclide vectors and key nuclides greatly differ from cell to cell and often also within a cell. A first radiological condition of the fuel cell laboratory was described in a separate document within the framework of the licensing application. Due to the significance of the radiological situation, especially also for the clearance measurement path, an extensive verification of the radiological situation was additionally initiated by the authority for each section. The results of these verifications showed that the radiological condition generally corresponded to the data already specified in the application. Although the nuclide vectors varied from cell to cell due to the history, Co 60, Cs 137 or Sr 90 were always found as key nuclides. The alpha share in the contaminations was generally below 1 %.
Dismantling History

After fulfilling all dismantling prerequisites and clearance of the detailed planning by the regulatory authority, the dismantling activities in the BZ I laboratory area started in spring 2000. Apart from the machinery and the manipulators, the main dismantling volume consisted of approx. 30,000 lead bricks with a total weight of approx. 300 Mg (see Fig. 2).

Fig. 2 Dismantling of the laboratory area BZ I (lead)

Due to the confined space in the BZ I laboratory area and the large amount of rapidly arising waste components, the waste logistics and the clearance measurement procedure were of particular significance. Due to the condition of the lead bricks (coated, deformed, provided with notches or boreholes) it was only possible to measure approx. 10% of the lead bricks by a special clearance measurement device on site. The rest of the bricks were transferred to the Decontamination Department for reconditioning. The dismantling of the BZ I laboratory area was completed in September 2000.

The dismantling of laboratory area BZ III was started in the first half of 2001. All technical equipment in the form of manipulators and periscopes as well as the inner boxes were removed from the cells and disposed of via the Decontamination Department by mid-2001. Furthermore, extensive decontamination measures were carried out in the transport duct of the cell block, which was contaminated by up to 4,500 Bq/cm². The dose rate was up to 30 mSv in this duct. On account of the geometrical and radiological conditions it was decided that the corresponding decontamination measures should not be carried out during dismantling but prior to dismantling in the still closed duct. To this end, a remote-controlled cleaning robot was introduced into the duct, whose cleaning efficiency led to a significant reduction of the radiological load in the duct. The transport duct was disassembled, disintegrated and disposed of after the technical equipment had been removed.
In conformity with the requirements by the licensing authority, gentle techniques for concrete disintegration had to be used to ensure the integrity of the building. After the work for the disintegration of the concrete cells had initially proceeded very slowly due to an unfavourable company constellation, SAT (Sanierungstechnik GmbH) was entrusted with the dismantling activities in spring 2002. This decision in conjunction with the change to a modified dismantling concept proved to be optimal. In particular, the changed dismantling concept, which basically consists of a combined use of diamond rope saw, Hydrostress cleaving and the use of dismantling excavators for redisintegration, has proved efficient (see Fig. 3).

![Dismantling of the laboratory area BZ III (concrete)](image)

**Fig. 3 Dismantling of the laboratory area BZ III (concrete)**

The dismantling of the BZ III laboratory area was completed in November 2002. It was found that, taking account of the specific circumstances and using suitable disintegration techniques, suitable equipment and suitable staff as well as implementing the right dismantling logistics, a dismantling time of approx. 100 working days is a realistic period for approx. 900 Mg or 300 m³ of concrete.

**CLEARANCE MEASUREMENT AND DISPOSAL**

For an efficient clearance measurement of the lead bricks arising in dismantling the BZ I laboratory area, an automated measuring bench for contamination checking was designed and manufactured by the Department for Safety and Radiation Protection of the Research Centre, which specially serves for the clearance measurement of lead bricks (see Fig. 4).
Fig. 4 Automated measuring bench for the clearance measurement of lead bricks

Initially set up in the fuel cell laboratory, this device was later moved to the Decontamination Department to measure the reconditioned lead bricks for clearance. After removing the coating on the lead bricks, approx. 99% of the bricks were measured for clearance. Approx. 90% corresponding to approx. 320 Mg of dismantled parts from laboratory area BZ I was measured for clearance and conventionally (recycling, landfill) disposed of. The remaining 10% was disposed of as radioactive waste.

Approx. 92% of the dismantled materials from laboratory area BZ III was measured for clearance. This corresponded to a mass of approx. 1,110 Mg. The balance of 8% was transferred to the Decontamination Department for further conditioning. A clearance measurement device was taken into operation in the fuel cell laboratory in the first half of 2001, based on the principle of total gamma measurement, to ensure an effective and reliable radiological assessment of the dismantled parts with the aim of clearance measurement. The measured data obtained in the clearance measurement campaigns have been saved in a database system specially designed for dismantling. For the concrete rubble, an additional conditioning step consisting of toggle jaw breaker and concrete shredder was installed in front of the clearance measurement device to crush concrete fragments to a defined size. For the homogenization and clearance measurement path SINA Industrieservice GmbH was engaged, which has proved efficient in this field due to its technical know-how.

OUTLOOK

The dismantling of the fuel cell laboratory was completed by dismantling the BZ III laboratory area. Current findings reveal that the BZ II laboratory area offers conditions in terms of licensing and hardware which no other Hot Cell facility of Research Centre Jülich can present. These findings result, in particular, from the requirement specifications obtained by searches concerning users of similar facilities at the Research Centre. Moreover, cost estimates have shown that after appropriate refurbishing the fuel cell laboratory with an intact BZ II laboratory area can be operated much more economically than the other facilities.
It was therefore decided in late September 2002 to complete the dismantling of the fuel cell laboratory by dismantling laboratory areas BZ I and BZ III. Refurbishing will start soon. The fuel cell laboratory will probably take up operation again in late 2003.