NEW COOLING SYSTEM OF THE FRG-1
TWO BARRIER SYSTEM OF THE PRIMARY COOLANT CYCLE

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Abstract

The GKSS research center operates the swimming pool reactor FRG-1 with a thermal power of 5 MW as national neutron source for neutron scattering experiments and sample irradiation as well.

Before changing the primary coolant cycle consisted of the reactor core and the closed piping including pumps, heat exchanger and delay tank. The closed cooling circuit was located underneath the reactor pool, in the so-called radioactive cellar. This piping system served secondary coolant system. Due to the location of the primary coolant cycle below the operation pool a postulated 2-F line break and simultaneous failure of the pool slide gate valve could lead to a falling dry of the total reactor core.

the new primary coolant system was built in the beginning 2002 in a partitioned cell all within the radioactive cellar, so that the reactor core remains with water with the assumed incident. Due to the new two barrier-inclusion of the primary circuit only the melting of two fuel plates (from total 252 fuel plates) has to be taken into account.

This measure and the core compactness in 2000 with a neutron flux gain of a factor of 2 makes the FRG-1 ready for the next 15 years of reactor operation.

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Introduction

The GKSS research center operates the swimming pool reactor FRG with a thermal power of 5 MW as national neutron source for neutron scattering experiments as well and for sample irradiation. For the safe reactor operation as soon as the supply of an attractive neutron source for the research large efforts became undertaken, in order to update the FRG on the state of science and technology. As example are mentioned the renewal of the reactor protecting system, the fire- and physical protection system, new control rods and core support frame, installation of a cold neutron source as well as core compacting by the use of high-density fuels [1].

The new primary coolant system

Before changing the primary coolant circuit the FRG consisted of the open operating pool with reactor core and the closed piping including pumps, heat exchangers and delay tank. The closed piping circuit was located underneath the operating basin, in the so-called "radioactive cellar". This piping system served the heat dissipation in connection with the secondary coolant cycle. The schematic representation of these cooling circuits is shown in fig.1. The volume of the not hermetically waterproof radioactive cellar underneath the operating pool is larger than the volume of the pool. Due to the location of the primary coolant cycle below the operation pool a postulated 2-F line break and simultaneous failure of slide gate valve could lead to a falling dry of the total reactor core.

At the beginning of 2002 accomplished cooling circuit change is schematically represented in fig. 2. The new primary coolant system has following substantial characteristics:

- complete renewal of the primary coolant cycle with a simplified piping and an exposition pressure of 6 bar (photo 1)
- Reduction of the volume of the cooling circuit range in the radioactive cellar by the installation of three waterproof bulkheads so that the reactor core remains covered with sufficient water with the assumed incident.
- Sectional renewing of the secondary coolant circuit for tying up to the new primary circle
- Installation of new incident-safe pool slide gate valve drives.

A more compact and clear execution was only reached by the renewal and simplified guidance of the primary pipe system mainly by the omission of the delay tank and the use of only one primary pump.
The delay tank - the flowing through cooling water needs approx. 20 seconds – was meant for the reduction of the N16-Aktivity. By the intermediate installation of a approx. 1.5 m thick warm water stacking with a radioactive cleaning in the operating pool a separation to the active primary water were reached. Further a high reliability of the primary pump resulted from the operational experience of many years, so that also with only one pump the availability of the FRG is not considerably impaired.

The secondary coolant circuit of new geometry had to be adapted by the renewal of the primary cycle. The reduction of the volume of the new primary cell was reached by the installation by three waterproof bulkheads. The bulkheads as well and all feed through are appropriate for a pressure by 1.3 bar (photo 2).

All modification work such as dismantling/cutting up and conditioning of the contaminated tubing system, build up of the new system with 100 % expert examination, an extensive initial start-up program beside the regular work in the winter maintenance was done in 2 1/2 months. Due to the new two-barrier inclusion of the primary coolant cycle only the melting of two fuel plates (from total 252 fuel) plates has to be taken into account.

Photo 1: Coolant cycles with heat exchanger and bulkhead

Photo. 2: Bulkheads with feeds through

This measure and the core compactness in 2000 with a neutron flux gain of a factor of 2 makes the FRG ready for the next 15 years reactor operation.

[1] W. Knop, W. Jager und P. Schreiner: FRG-1 Compact Core with Higher Density Fuel – Experiments from the first to the Equilibrium Core, International Meeting on Reduced Enrichment for Research and Test Reactors (RERTR), Bariloche, November 4 – 8, 2002, Argentina