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EXPERIMENTS WITH NEUTRON DETECTORS DEVELOPED AT IPEN-CNEN/SP, UTILIZING THE IEA-R1 NUCLEAR REACTOR

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The Institute for Energy and Nuclear Research (IPEN), of the Brazilian National Nuclear Commission (CNEN), at Sao Paulo, Brazil, is engaged, since 1983, in a neutron detector technology development program. One of the future applications of these detectors is on the field of control and monitoring of nuclear reactors, where it is necessary to know the neutron flux at all times, over all power range. To meet all these performance and physical characteristics needed for the reactor operation, several detectors are being developed and tested. To prove the validity of the design, materials and mounting techniques and also the operational characteristics of the detectors, several tests were carried out in the IEA-R1, 2MW swimming pool nuclear reactor, where the initial operational physical characteristics such as thermal neutron flux and gamma flux sensitivity were obtained. Subsequently in order to know the aging effects on materials over long-term irradiation and mainly to determine how the detector sensitivity are affected as a function of reactor operation time or neutron fluence, two long-term experiments were planned using out-of-core and in-core neutron detectors. The duration of each test was calculated for a neutron fluence of 2E+16 nvt and 1E+20 nvt respectively wich means about two years test in the operation conditions of the IEA-R1 reactor (40 hours full power/week).

The out-of-core detectors chosen were a boron-10 compensated and uncompensated ionization chambers and the in-core detectors were a set of ten SPND, where the emitter materials utilized in prompt responding SPND were cobalt, platinum and hafnium, and the delayed responding emitter were silver and rhodium

EXPERIMENTAL ARRANGEMENT

The out-of-core arrangement is constituted by two separeted assemblies, each for every one detector. Each assembly is formed by a "dry-tube" fixed on the top on a reflector element by means of an special plug. In these positions the maxium thermal neutron flux reaches 1.4E+09 nv. The in-core assembly consists in an special reflector element with the SPND, and its supports facing to a fuel element. Behind them, there are three guide tubes for insertion of the movable gamma and neutron flux monitoring detectors. The maxium thermal neutron flux on this position is 1.0E+13 nv. Figure 1 shows an schematic arrangement of the out-of-core an in-core detectors assemblies, and its position in the core configuration.

All the electrical signals coming from out-of-core and in-core assemblies are feed through a mineral insulated cables to the connection board. The on-line data acquisition is performed by two separated systems, placed at the reactor control room.
One of these systems is connected to the out-of-core detectors. In this system electrical current signals from each detector are read continuosly by a two channel electrometer connected by an IEEE - 488 interface to a PC computer. Software allow to acquire data in real time with a rats of two acquisitions per second from each detector. Once every minute the current mean value from each detector and the operation time are saved on magnetic hard disk for further analysis and daily report operation print-out. The whole test can be monitoring on the EGA color display monitor where are shown: detector data, power reactor in absolute value calculated from detectors data and on logaritmic grafic bar, and the reactor power as a function of operation schedule on linear and logaritmic scale.
The data acquisition system for the SPND detectors consists in a multiplexer with 20 high imedance

inputs and only one high impedance output connected to the electrometer input. A IEEE 488 interface controls and transfers data from the electrometer to a PC computer, and a digital I/O card controls the multiplexer operation. An specific software permits to read sequenclally the 20 input signals once every minute and store the experimental data on hard disk. An EGA color display monitor shows in real time the instrumental readings and nuclear data parameters.
In both systems usually no operator intervention is required except when restarting the system, updating the system parameters, display optional information, or copying data from hard disk to another storage device is required.

RESULTS

After 18 months of the operation experiment with tue out-of-core detectors the thermal neutron fluence is 1.5E+16. First results of the correlation made between data from tested detectors and control reactor detectors showed an excellent agreement, and no variation of the initial thermal neutron sensitivity was reported.

Initial thermal neutron sensitivity determined from each SPND was in agreement with sensitivity values reported in the literature for similar detectors. Periodic calibration, using a movable fission chambers, showed that after six months of test operation, no variation of thermal neutron sensitivity was detected. In this case, as previously planned, the author expect to extend this experiment for two years in order to establish a thermal neutron sensitivity depletion curves.

References

(1) H. E. Bañados Pérez, Arthur R. Vieira and Teresinha F. L. Daltro. Long-term experiments with neutron detectors developed at IPEN-CNEN/SP. Proc 7th Symposium on Radiation Measurements and Applications, Ann Arbor, MI, USA, May 1990.

(2) H. E. Bañados Pérez, Teresinha F. L. Daltro, Desenvolvimiento de detectores "In-core". Proc III General Brazilian Congress on Nuclear Energy, Rio de Janeiro, Brazil, July 1990.

(3) Arthur R. Vieira, Homeró E. Bañados Pérez. Testes de longa duracao no IEA-R1 com cámaras de ionizacao de neutrons compensada e ñao compensanda. Proc III General Brazilian Congress on Nuclear Energy, Río de Janeiro, Brazil, July 1990.