NPPCI – TOPICS IN THE GERMAN DEMOCRATIC REPUBLIC

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1. Computerized Operator Support System

In several countries Computerized Operator Support Systems have been developed to help the operator during normal and abnormal plant operation. One of the main tasks of such systems is the support of safe load-following operation for normal plant conditions and the disturbance analysis for abnormal conditions respectively.

The use of high performance core monitoring systems on the basis of SPD's will be a necessary preposition for assisting the operator during load-following operation.

The mathematical background of load-following has been studied for some years. Generally, the solution procedures are of implicit nature and require the use of numerical tools with difficulties in handling high dimensional processes.

An alternative procedure has been proposed for the solution of the load-following problem using inverse systems [1]. This enables to control dynamic processes in an explicit way without using goal seeking methods. The computation of inverse systems can be realized off-line and the on-line computation amount and on-line storage capacity are very small.

The problem arising by the application of inverse concepts is the assumed linearity of the process model. It seems to be valuable to compare this approach with other methods solving the load-following control problem.

Because of the high scale and degree of sophistication of nuclear power plants, computerized disturbance analysis systems are necessary and have been developed. In the case of emergencies, the operator staff is faced with a problem, which may be described as "too much data but not enough information". Conventional surveillance systems may be fail in those situations. Therefore, the methods of artificial intelligence must be integrated into disturbance analysis systems. As an attempt in this direction the disturbance analysis system SAAP-2 can be considered [2]. This system is in development for the surveillance of the Rossendorfer Forschungsreaktor. Several methods of artificial intelligence are included into the procedures for monitoring of processes, interpretation of process data, diagnosis of faults and planning of recovery actions.

2. Investigations by means of prompt self-powered detectors

For almost 10 years Rh-SPD's have been used as in-core sensors for supervision of power density distribution in WWER 440 units of the NPP Greifswald / 3 /. Reactor dynamic perturbation measurements were also carried out by using Rh SPD's / 4 /.

In 1982 a programme for the investigation of the behaviour of prompt SPD's with Co-emitter and Pt-emitter in WWER-reactors has been started.

The following special tasks should be solved / 5 /:

- measurement of reactor γ-ray field and local neutron flux/γ-ray distribution
- study of space-dependent dynamic processes inside the core.

For application in the Greifswald NPP and in the Rheinsberg NPP special lances have been developed which contain 3 Co-SPD's and 2 Pt-SPD's. With the lances the spacetime behaviour of core parameters has been studied / 6 /, including the measurement of axial distribution of γ-ray and neutron flux density, reactor dynamic perturbation measurements for the on-power determination of the differential reactivity weight of moved control rods and shut-down experiments after full power and reduced power operation.

The investigations carried out have demonstrated that prompt Co SPD and Pt-SPD are a qualified tool to measure the space time behaviour of neutron flux.

By using these detectors the accuracy of reactor dynamic perturbation measurements can be considerably improved in comparison to the use of Rh-SPD's. Experimental data of neutron flux variations after reactor shut-down have been used for the verification of reactor dynamic computer codes.

3. Experimental fuel assembly

The investigations by means of experimental fuel assemblies (EFA) in the Rheinsberg NPP have been concluded. The EFA is an original fuel assembly of WWER-440-type with an additional instrumentation (thermocouples, SPND's, pressure detectors) and a throttle at the coolant input allowing a controlled reduction of coolant flow trough the fuel assembly [7, 8].

The research programmes which has been realized commonly by several institutions of four CMEA member countries (Soviet Union, Czechoslovakia, Hungary, GDR) had been started a few years ago with the following main aims

- to study various kinds of boiling in pressurized water reactors and to develope diagnostic methods for boiling supervision and
- to verify thermohydraulic codes and if occasion arises to improve the codes.

Since 1980 three EFA's have been inserted into the Rheinsberg reactor. During an effective operation time of 800 days 126 experiments have been made without any perturbation of electricity generation.

Some results con cerning the thermohydraulic of the primary coolant loop are already used at the WWER-440 units of the Greifswald NPP.

Concerning boiling diagnosis the following results could be obtained [9, 10]:

- verification of axial dependence of coolant temperature noise signals at one- and two-phase flow
- contributions to the verification of the well-known local global model by investigation of the axial bubble motion
- verification of a new noise source characterizing the local coolant boiling.

This noise source results from low-frequency fluctuations of integral vapour content in the local boiling region caused by fluctuations of reactor parameters as for example inlet temperature, coolant flow, reactor power. The effect can be used as basis for boiling surveillance at WWER-1000 cores.

4. Loose part detection

The detection of loose parts in the primary coolant is an important safety task on NPP's. In the frame of the noise diagnostic system RAS-II which has worked since 1979 at the units 3 and 4 of Greifswald NPP results have been obtained also on the problem of loose part detection [11]. Piecoelectric acceleration detectors and charge preamplifiers have been developed and successfully tested.

Now the development of an industrial computerized loose part monitor has been started. There are two operation kinds which will be investigated in more detail:

- a fast supervision of the 16 channels with a reaction time smaller than 50 ms
- a detailed supervision of one channel by statistical methods.

It is foreseen to integrate into the monitor such tasks as

- data recording
- alarm signalization
- dialog operation
- inherent test of measuring lines and devices.

By the first version of the loose part monitor tested at the Greifswald NPP the detection of parts with a minimal weight of 100 g is possible.

The industrial production of the monitor will begin in the next year.

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