OSART Good Practices
TECHNICAL SUPPORT
Reactor Engineering

Angra 2, Brazil

Mission Date; 12-31 October, 2002

Regular fuel integrity meetings.

A monitoring program was established to continuously evaluate fuel integrity. The program includes regular meetings conducted on a three months frequency to discuss current cycle performance based on reactor physics, on radiochemistry, on radiation protection, on core design, and on future cycle expectations. These meetings are chaired by the Plant manager and attendance includes managers and technical representatives from Technical Support, Operations, Maintenance, Chemistry, Radiation Protection, Core Design Calculations, Thermal Hydraulic Calculations, Nuclear Safety Group, Systems Engineers and invited Specialists. The program provides guidance for discussions on inspection equipment, debris control, fuel handling, radiochemistry and actions to be taken in the event of fuel failures. The meeting frequency is shortened at any sign of fuel degradation. The program has demonstrated the corporate support capability in cases of fuel failure in support of the Plant needs.

Nogent, France

Mission Date; 20 Jan.-6 Feb., 2003

Action plan "Optimisation of fuel processes" and monitoring the activities during start-up tests after refuelling.

The plant has developed very comprehensive complete and accurate action plan "Optimisation of fuel processes", with the following objectives:

- Clarify roles and responsibilities including quality assurance (departments, plant, corporate level)
- Guarantee the quality of all activities
- Training, skills development and ensure their sustainability
- Implement a programme for the integration of operating experience
- Integration of corporate activities

The action plan includes a comprehensive set of indicators and trend analysis.

As part of this plant-wide action plan, the Testing Section of the plant Technical Department has set up an organisation designed to monitor and manage all activities carried out during physical start-up tests, particularly emphasizing the right understanding and control of actions implemented by the Operations shift team.

So as to improve interface management and clarifying everybody's responsibilities, a testing manager is appointed within the Testing Section. He coordinates activities and their sequence based on a clear, efficient and rigorous document structure that integrates required check points, the comprehensive identification of risks and user-friendly testing procedures.

Combined to this, a highly innovative approach has led to the testing manager being the coordinator of and chairing the shift turnover (primary side) during tests after refuelling. (In addition to normal shift turnover). He uses a shift turnover form briefly describing the background and status of tests underway, the tests to be carried out during the next shift; a reminder to the operator of the criteria and rules to apply as part of the REPR (start-up test rules), the errors and traps to avoid and the appropriate monitoring methods. The operator can require additional input or reminder if he needs to. This system provides better sharing of knowledge with operators who, at this specific stage, act upon request by the Testing Section (which is the entity having the necessary skills in the area of physical testing).

Philippsburg, Germany

Mission Date; 11-28 Oct., 2004

KKP have taken additional steps (beyond regulatory requirements) to ensure proper reactivity management and minimize fuel damage during fuel movement.

KKP engineering has developed a program called CAPHAS that allows them to calculate the theoretical K-eff of the core during each fuel move. This allows them to analyze the proposed loading pattern to see if they can maximize the level of safety with respect to reactivity management.

This program currently calculates the theoretical K-eff, but UP plans to incorporate the ability to measure actual physics data, during the fuel movement to calculate a real time K-eff while the fuel is being moved. This will provide an additional barrier in the effort to prevent an improper reactivity manipulation.

KKP have also developed a sub-routine in this program that minimizes possible grid damage from two fuel assemblies interacting during fuel movement, by only allowing fuel to be lowered or raised when the proper configuration of the surrounding fuel assemblies is obtained.

Quinshan3, China

Mission Date; 5-24 May, 2005

Software package for operational reactor physics calculation.

In operation, Reactor Physics engineers have to perform a significant amount of calculations. To facilitate calculations, the Reactor Physics Group at TQNPC has developed a package of calculation software, including the following small programs developed under excel programme to:

-approach to criticality test to predict criticality and calculate Doubling Time;

-calculate calibration factors for Reactor Regulation System Platinum detector calibration;

-do Flux Mapping Regional Power Target Value “Phinom” value calculation;

-calculation of Vd detector Kj, S factors;

-do channel flow verification;

-do thermal power calculation;

-analyze Failed Fuel Location scan data and locate defect fuel channel;

-keep a record of and stat. refueling information;

-complete Channel Power Peak Factors value calculation.

All these programs are small, and they can be developed by Reactor Physics engineers. In the same time these programs make the calculation work of Reactor Physics much easier, accurate and efficient.

Simulated calculations, manual calculation methods and operation data were used for verification of these programs prior to their application.

These programs have the following features:

-Good interface and protection of calculation formula.

All these programs have good man to computer interface, with all the manually input data set in a single sheet and differently colored. The calculation formula are integrated in calculation sheets which are protected and cannot be changed. Working with these programs should reduce the chances of making mistakes due to human errors.

-Auto load of online operational data.

In Qinshan CANDU plant, the online operational data can be sent to office computers by network. By compiling useful macros in these programs, Reactor Physics engineers make it possible to get required or current operational data in just a minute and also get the calculation results. Because the auto load data are treated and the average value during a certain period is used to do calculations, it is more accurate than just using an instantaneous value.

-Auto preparation and checking of work form.

By correlating the Reactor Physics Operating Manual with these programs, the formal work forms can be printed out after completion of calculation. Since the required calculation data have been printed in the forms, the Reactor Physics engineer can just check and give signatures. Specially, according to some effective rules and criteria, the computer can check the work forms, so it is an effective barrier for work safety.

By using these programs, Reactor Physics calculation work can be done more accurate and at high speeds. They should have contributed to the ahead of schedule completion of Qinshan CANDU commissioning, since there are many Reactor Physics tests at several power levels.

Neckerwestheim, Germany

Mission Date; 8-24 Oct., 2007

Monitoring sub-criticality during fuel handling.

A visual display has been created for fuel loading and unloading in the computerized operation management system to support the shift crew when monitoring sub-criticality. It displays charts (PRISCA) and time graphs.

The purpose of this function is to support the supervision and the communication between the refueling machine operators, shift crew and the reactor physics section during fuel handling. The content of screen image is as follow:
Core cross section:
- Current core loading pattern (core cross section);
- Number of fuel assemblies in core, current step in fuel movement sequence plan;
- Neutron count rate and selectable time curves;
- Neutron count rate limits; and
- Boron concentration and temperature in reactor core.

Graphic content of time curves:
- Evolution of neutron count rates for both chambers of external neutron flux; and
- Associated limits (min./max.).

Sub-criticality of the reactor core is monitored by shift operators and reactor physics during fuel handling with the aid of these two graphs. If limit values are reached, the process computer triggers an optical and acoustic alarm. When a limit signal is given, the Shift Supervisor interrupts fuel loading and initiates the necessary corrective actions according to the operating procedures.

This system provides Control Room Operators with a better method of monitoring refueling status than is generally seen in other NPPs.

Chinon, France

Mission Date; 27 Nov. - 14 Dec, 2007

The plant has developed and used a unique integrated computer data base used by many departments for fuel management. This data base is used for:

− Complete fuel management
− Management of extensive core process parameters, such a pellet-clad mechanical interface, fuel integrity, in-core measurements, etc.
− Management of extended fuel cycle
− Fuel movements and criticality monitoring with forecast capability
− Update of ex-core detectors
− Control rod drop time trending for proactive decision to replace guide tube
− Parameter setting for nuclear instrumentation

The plant can predict, in advance, potential deviations of the core parameters from the safety range and archive the necessary data.
In view of its advantages and efficiency since 2003, and this data base will be deployed on the whole French fleet under the name SILLAGE.

Forsmark, Sweden

Mission Date; 12-28 Feb., 2008

MATSTAB (a full 3-dimensional neutron model in combination with thermal hydraulic model) can provide information on core design for stability prediction and stability optimization. This model features fast calculation speed and high prediction accuracy. MATSTAB was developed by the plant in 2001 and subsequently applied to all BWR Swedish plants.

- MATSTAB is developed in the context to prevent core instability incidents mainly due to thermal hydraulic oscillation occurred in reactor vessel.

- MATSTAB takes full advantage of sparse matrix technology and frequency domain methods to meet with the CPU requirements for a full 3-dimensional reactor representation.

- MATSTAB can predict the behaviour of a global oscillation within 3 minutes, using the interface with the online steady state core simulator (POLCA).

- MATSTAB can display the influence to stability of an individual fuel assembly. This allows new insights into the mechanisms behind instabilities and also to optimize the core design or a control rod pattern with respect to stability.

- The predictions of the code are validated against stability measurements obtained at the plant.