NATIONAL PROGRAMMES

A VIEW ON THE PWR FUEL PERFORMANCE STUDY IN BRAZIL

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The brazilian government has recently created a High Level Council (Conselho Superior de Política Nuclear) that dictates the governmental decisions upon the nuclear affairs. It has also been decided that the Brazilian Nuclear Comission (Comissão de Energia Nuclear - CNEN) would centralize all the technical actions of the policy established by the Council. At the same time the government has decided to extinguish Nuclebrás, the previous state-owned nuclear company, and to create the Indústrias Nucleares Brasileiras that manages aspects of the fuel cycle, as the Fuel Element Factory (Fábrica de Elemento Combustível - FEC). All the Brazilian nuclear research institutes are now subordinated to CNEN, including the former Nuclebra's Nuclear Technology Development Center (Centro de Desenvolvimento da Tecnologia Nuclear - CDTN). Project, construction and operation of the nuclear power plants are subordinated to Eletrobrás, the brazilian electricity holding company.

These changes had the purpose to improve the country's research and technological potential and also to give continuity in the construction of the nuclear power plants which had already been decided.

The main goals focused on the decisions were:

- to establish an integrated policy to be applied to the nuclear program.
- to determine specific means and integrated programs that makes it easier to the National Congress appreciation.
- to integrate the country's scientific community and technological sectors.
- to establish a productive channel between the technological and industrial sectors.
- to assure the private capital participation.
- to close companies in deficit, to promote the better use of qualified staffs and to racionalise costs.
- to guarantee electricity by nuclear means with well established resources.

Appendix 6.1.

In the field of fuel performance and technology, it was believed these changes would lead to the increase of research in the institutes and to well established and organized programs.

Considering that PWR fuel performance studies in Brazil are under reorganization I will limit my presentation to the activities in the largest research institue of CNEN, the Instituto de Pesquisas Energéticas e Nucleares, IPEN/CNEN-SP.

IPEN, established in the city of São Paulo, has been developing activities related to fuel cycle and fuel technology for many years. Research had been oriented to materials and process development on the technology of fuel rods for power reactors. With the objective of complementing these activities and developing studies in the field of nuclear fuel engineering it has been created a group of nuclear fuel design and performance analysis within the Reactor Technology Department. This group's main objectives are to study and thefore develop activities related to integrated areas of fuel engineering as: structural analysis and mechanical design, fuel performance analysis, materials specification and fuel qualification.

In the mechanical design and structural analysis special attention has been given to the details of fuel element assembly and its components. The main goal is to develop and increase the understanding of designing a fuel that can fit the functional requirements for each operational condition existing in a nuclear reactor. PWR fuel element type has been studied with emphasis given to special components like spacer grids. Computer codes and applicable standards to fuel elements have been used in order to assure reliability and design quality in the studies. Structural analyses have been done to evaluate structural behaviour for static and dynamic loads. It was developed, for example, a computer code to analyse PWR fuel element structure for any kind of static load. This code, based on a matrix method that takes into account nonlinearities in the spacer grid-fuel rod joints stiffness, is able to calculate an equivalent stiffness matrix of the fuel element and also to estimate fundamental frequencies and modes of vibration. Computer codes based on finite element method have also been used in components structural analysis.

In the fuel performance analysis field the study has been directed for understanding the behaviour of UO_2 fuel rods for PWR's type reactors. Analyses have been performed in steady-state conditions, power ramps and load-following using deterministic computer codes. The effort has been made to understand the physical phenomena and the influence of the technical specifications on the fuel performance under those conditions. Computer codes, such as those from FRAP's series, have been used and their models analysed as well. Computer codes based on finite element method have been used to analyse mechanical pellet-clad interaction. It has also been concerned in comparing the effect of different cladding materials in

the fuel rod performance. A comparison between austenitic stainless steel and zircaloy-4 has been carried out by this group. It's also intended to perform a number of studies under accident conditions.

In the field of materials specification the studies have been directed to the evaluation of fuel cladding materials. Physical, mechanical as well as metalurgical properties of materials and their influence on the fuel rod's performance have been studied. The efforts have been concentrated in comparing zircaloy and austenitic stainless steel. So far attention has been given to the materials specification such as alloying elements, control of impurities, thermal treatment, surface treatment, and so on. These studies have been made in order to understand the influence of such parameters in rod failures originated, mainly, from pellet-clad interaction.

The fuel qualification field has been the experimental basis for design, performance studies and material studies. There is the intention to propose pre-irradiation testes in order to have an experimental evaluation of components, materials properties, and also some experiments to validate the analysis methodology.

As this group is relatively new in the Institute, most of the works which have been done so far are in a conceptual level, based mostly in open literature, trying to cover some of the most important areas of interest concerning fuel engineering. In this aspect, the IWGFPT has been particulary important providing well established methodology and being also a source of reference for the wide range of subjects involved in fuel design, performance and technology.