EFFICIENCY IMPROVEMENT OF NUCLEAR POWER PLANT OPERATION: THE SIGNIFICANT ROLE OF ADVANCED NUCLEAR FUEL TECHNOLOGIES

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For a number of years the power producers' market has been experiencing far-reaching changes world-wide. Increasing liberalisation of the power markets is resulting in fiercer competition in sectors which were once monopolies for power producers.

Nuclear power generation in particular is being exposed to high cost reduction pressure. This is being caused by the improved efficiency of fossil-fuelled power generating plants and by decreasing nuclear fuel prices. The cost situation is being further burdened by the high expenditures for licensing, monitoring and the establishment of reserves, and by plant depreciation. Therefore, cost reduction in nuclear power generation is the common goal of the utilities and their suppliers.

Nuclear fuel cycle costs account for 25-40% of the total power generation costs. Although the cost of nuclear fuel fabrication only amounts to around 10% of the fuel costs, advancements in nuclear fuel technology are the key factor to cost savings and efficiency enhancement in the entire nuclear fuel cycle. Further developments in nuclear fuel technology are therefore focused not only on the reduction of fuel fabrication costs but primarily on the by far greater savings potential which can be tapped in the uranium supply sector, and in the management and disposal of spent fuel. Here, the trend in development is clearly being dictated by the more efficient utilisation of fuel, so that significant savings can be achieved via the contingent volume effect.

The boundary conditions for these further developments represent a rather complex network of requirements which always combine economic benefit with safety-related aspects. This demands for both fuel manufacturers and nuclear power plant operators a comprehensive knowledge of all technical, economic and licensing details of the entire plant system. The expertise of both the power plant operator and its suppliers is being optimally utilised through jointly initiated developments, resulting in innovative products with a high level of acceptance.

At Siemens, the developments focusing on the reduction of fuel cycle costs are currently directed on

- further batch average burnup increase,
- improvement of fuel reliability,
- enlargement of fuel operation margins,
- improvement of methods for fuel design and core analysis.

These items will be presented in detail in the full paper and illustrated by the global operating experience of Siemens fuel for both PWRs and BWRs. Highlights are (i) the replacement of Inconel with Zirkaloy as spacer and guide tube material, (ii) the transition to low-leakage core loads, based on the development of Gadolinum absorbers, (iii) the integrated code system for in-core fuel management and accident analysis, and (iv) the advanced product lines FOCUS and HTP (High Thermal Performance) for PWRs, and ATRIUM 10 for BWRs, with a burnup potential of 60 and 50 MWd/kg HM, respectively.

As a result, the nuclear fuel cycle costs for a typical LWR have been reduced during the past decades by almost US$38 million per year.

The estimated impact of further burnup increases on the fuel cycle costs is expected to be an additional saving of US$10 – 15 million per year. Due to the fact that the fuel will operate closer to design limits, a careful approach is required when introducing advanced fuel features in reload quantities. Trust and co-operation between the fuel vendors and the utilities is a prerequisite for the common success.