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Benefit of Research in Fuel Performance

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Electricity market de-regulation is introducing a new framework for the Nuclear Industry in general and for the Fuel Business in particular. Improving plant availability and operational flexibility so that the expected energy production can be guarantied when required, and, on the other hand, increasing fuel management efficiency to minimise fuel cycle costs are becoming the very key success challenges.

From the fuel vendor prospective, competitiveness can only be kept and re-enforced if those needs are properly understood and translated to adding value features. Main characteristics to take into consideration in order to deliver the adequate answer that today's market is demanding can be described as follows:

- First, fuel must be a **reliable** product. The utilities need to operate the reactors with no surprises, that implies avoiding any event causing a reduction on plant availability, unexpected costs, or any significant issue which creates concern on regulators or public. Robust design concept is becoming vendor natural approach for enhancing reliability, which basically entails a much better understanding of the complex physical mechanisms determining fuel performance, as well as an increased quality of the design verification and validation processes (i. e., advance testing techniques and representative demonstration programs to). As a result, enough robustness is expected to prevent any condition causing loss of fuel rod tightness, particularly a comprehensive knowledge of flow induced effects on the fuel structural dynamic response is essential. Additionally, thorough mechanical and functional compatibility between the fuel and the core mechanical system have to be ensured (i.e., RCCA full functionality, ease fuel handling, …). Finally, sound manufacturing and inspection processes have to preclude manufacturing related defects.

- Secondly, fuel **burnup** capability needs to be extended beyond current values, and bases for expanding actual licensing burnup limits must be ascertained. For such a purpose the development and validation of new advance cladding materials seems crucial since the corrosion margin and its secondary effects (i.e., material hydrating, ductility loss, …) are the most substantial limitation for extending burnup. Besides, two other major aspects have to be addressed: fission gas released and irradiation induced growth, so that can be quantitatively minimised with the implementation of improved materials (i.e., advance pellet and advance cladding), and more margin for accommodating its effects can be engineered.

- Finally, fuel performance capabilities needs to be enhanced to improve fuel **efficiency** through a more effective Uranium utilisation (maximising amount of energy per U mass), providing with added flexibility for an operation under a wider sort of conditions or environments. And last but not least, fuel **costs** have to be trimmed down, therefore fuel manufacturing and fuel management processes require to be optimised.

All in all, the capability for producing, both, the products and the methods to meet those demands necessitate of an efficient research and development plan. Again, fuel business competitiveness cannot be sustained in the medium and the long term at least a substantial amount of resources are devoted to that purpose. Fuel R & D Plans have to address many different areas in order to guarantee the resulting technology potential, driving forces outlining those Plans should consider the following elements:

- development and validation of **new product features** and/or materials

- improving **manufacturing and inspection** processes and techniques
- devising superior engineering **design methodology** (i.e., design codes and procedures)
- accomplishing basic research on **fuel performance mechanisms** and fuel materials properties
- maintaining **surveillance** plans on operating fuel
- promoting (and agreeing with the corresponding utilities) representative **LTA's** fuel irradiation programs that empower the required operating experience to anticipate any unexpected side effect

Finally, two important considerations. First, the integration of the R & D programs in a synergetic way to keep sharp focus on the priorities and on the actual evolving demands. And second, the collaboration and partnership as a way to finance the very costly research an investigation activities where irradiated material are involved.