Latest Studies Related to the Use of Burnup Credit in France

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Abstract

In France, criticality safety analysis for nuclear fuel cycle facilities and transport casks usually consider fresh fuel. In some cases, however, limited to PWR UOX fuel, Burnup Credit is taken into account with some pessimistic hypothesis (only actinides are considered and the value of burnup used in the studies is equal to the mean burnup in the 50-least-irradiated centimetres) [1]. As the UOX fuel initial enrichment and the storage needs for spent fuel increase, operators have wished to develop a less penalizing method to implement Burnup Credit in criticality studies, by taking into consideration some fission products (the most neutron absorbent, stable or with a long half-life and not volatile) and a suitable bounding axial burnup profile.

In this context, a working group composed of the main French nuclear companies, CEA and IRSN was formed to study the conservatism of all steps of the process to take fuel burnup into account in the criticality studies considering fission products and an axial burnup profile. These steps are: the definition of the axial profile of burnup in the studies, the depletion calculations, the criticality calculations (particularly regarding the knowledge of the cross-sections of the isotopes that are being taken into account). This paper proposes to give an outlook of the present state of knowledge of the working group.

To date, the discussions of the working group have focused on PWR UOX fuels. The early studies are presented in reference [2]. The latest ones mainly concern: the determination of a conservative axial profile for most of the profiles already measured, the determination of correction factors for the isotopic composition in Burnup Credit applications, and the validation study of depletion code performed with a Monte Carlo code.

In addition, studies on Burnup Credit for PWR MOX fuels are now under way. One of the main difficulties of a Burnup Credit implementation for PWR MOX fuel is the wide range of parameters compared to PWR UOX fuel (initial plutonium composition, plutonium content, uranium composition, presence of ^{241}Am, zoning of assemblies). Contrary to PWR UOX fuel, for PWR MOX fuels, a fresh fuel with a conservative isotopic vector (of plutonium) will not inevitably lead to the most reactive fuel after irradiation. Therefore, to simplify MOX burnup implementation, it was necessary to set up a method to determine, for a given ratio of Pu/(U+Pu), a bounding plutonium vector for the fresh fuel that gives, after irradiation, the most reactive fuel, whatever the irradiation history. At present, the studies on PWR MOX fuels concern the determination of a conservative inventory of the irradiated fuel.

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Moreover, in the framework of optimization in some parts of the fuel cycle, namely reprocessing plants, Burnup Credit implementation for BWR UOX fuels is being investigated.

Finally, this paper gives results of criticality calculation for storage configurations and transport casks obtained when applying the different conservatisms studied by the working group.

References

[1] L. Maubert, "The Burn-Up consideration in the criticality safety of irradiated LWR fuel cycle plants", Proc. International Seminar on nuclear Criticality Safety, ISCS87, Tokyo, Japan, Oct. 1987.

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