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Value of Burnup Credit Beyond Actinides

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I. Introduction

DOE has submitted a topical report[1] to the NRC justifying burnup credit based only on actinide isotopes (U-234, U-235, U-236, U-238, Pu-238, Pu-239, Pu-240, Pu-241, Pu-242, and Am-241). When this topical report is approved, it will allow a great deal of the commercial spent nuclear fuel (SNF) to be transported in significantly higher capacity casks. A cost savings estimate for shipping fuel in 32 assembly (burnup credit) casks as opposed to 24 assembly (non-burnup credit) casks was previously presented.[2] Since that time, more detailed calculations have been performed using the methodology presented in the Actinide-Only Burnup Credit Topical Report. Loading curves for derated casks have been generated using actinide-only burnup credit. The estimates of cost savings due to burnup credit for shipping fuel utilizing 32, 30, 28, and 24 assembly casks where only the 24 assembly cask does not use burnup credit have been created.

II. Approach

Figure 1 shows the loading curve for a 32 assembly PWR shipping cask applying actinide-only burnup credit. The 32 assembly cask design used for this analysis is the Holtec Hi-Star 100/MPC-32.[3] Also shown on Figure 1 are the loading curves if the cask is derated to contain only 30 assemblies and 28 assemblies. Figure 2 shows the 32 assembly PWR shipping cask loading curve applying actinide-only burnup credit and curves that include additional burnup credit of 1% and 2% in k_{eff}. Similar curves were generated for the 30 and 28 assembly cases.

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To help understand the significance of the loading curves in Figures 1 and 2, the number of PWR fuel assemblies projected for delivery to the Mined Geological Disposal Repository is put on the enrichment/burnup grid. The data on the projected PWR SNF inventory is available to 1 MWD/MTU and 0.1 wt.% U-235. The calculation of the number of SNF shipments used this more detailed data.

To interpret Figure 1, all of the assemblies above and to the left of the top loading curve can be placed in 32 assembly packages. The assemblies that are between the top two curves would be placed in 30 assembly packages. The assemblies between the bottom two curves would be placed in 28 assembly packages. Finally, assemblies below the bottom curve would be placed in 24 assembly packages. Using the projected SNF inventory, the number of shipments using actinide-only burnup credit is 4311. It is assumed that the cost of each shipment will be about $100,000.[2] Thus, the cost of shipping the fuel with the current actinide-only burnup credit is $431.1 millions.

To evaluate the cost savings of additional burnup credit, the same process (including use of derated casks) was performed for 1%, 2% and 5% (in k_{eff}) more burnup credit. If 1% reactivity can be gained by additional burnup credit there would be 60 fewer shipments than with actinide-only burnup credit with a resulting cost savings of $6 millions. If a 2% increase in burnup credit can be gained, the total reduction in shipments is 108 with a total savings of $10.8 millions. If 5% more burnup can be found the total reduction in shipments is 172 with a savings of $17.2 millions over the actinide-only case.

III. Discussion and Conclusions

A previous paper[4] discussed the conservatisms in the actinide-only burnup credit methodology. At the burnups important to the loading curves, the fission products ignored are worth about 10% in k_{eff}; the use of the most limiting isotopic correction factors is worth about 2%; the use of bounding depletion parameters is worth about 1%; and the use of the most limiting axial profile is worth another 1%. The method for taking credit for an additional 1 to 2% of reactivity is still being reviewed but it is clear there are a number of potential ways. For example, it may be possible to gain credit for Sm-149 which has a reactivity worth that is easily observable as part of power reactor operations. This isotope alone would be worth more than 1% in k_{eff}.

Most of the benefits from burnup credit come from reduced shipments. In addition to the financial benefits described, the reduced shipments provide for improved public safety by reducing the chance of non-radiological, traffic accidents. Additional burnup credit could also be used to reduce the cost of absorbers in the cask.

Clearly, use of actinide-only burnup credit casks reduces the shipments greatly (1166 less shipments than if non-burnup credit casks using 24 assemblies were used) and the payoff per effort for additional burnup credit will not be as large. However, as seen in this study, there still is significant value to additional burnup credit.

References:

1) "Topical Report on Actinide-Only Burnup Credit for PWR Spent Fuel Packages," DOE/RW-0472, Rev. 1, Office of Civilian Radioactive Waste Management, US Department of Energy, May 1997 (Rev. 0 May 1995).

2) W. Lake, "Cost-Savings Potential for Transport and Storage of Spent Nuclear Fuel Available from Burnup Credit," *Trans. Am. Nucl. Soc.*, **76**, 52 (1997).

3) "Safety Analysis Report, Holtec Report HI-951251," NRC Docket No. 71-9261.

4) D. B. Lancaster, M. Rahimi, and J. Thornton, "Conservatism in the Actinide-Only Burnup Credit for PWR Spent Nuclear Fuel Packages," *Trans. Am. Nucl. Soc.*, **74**, 318 (1996).

Figure 1: Loading Curve for a 32 Assembly Cask with Derated Cases Developed Using Actinide-Only Burnup Credit (Numbers Shown On Grid Are the Expected Inventory of Assemblies)

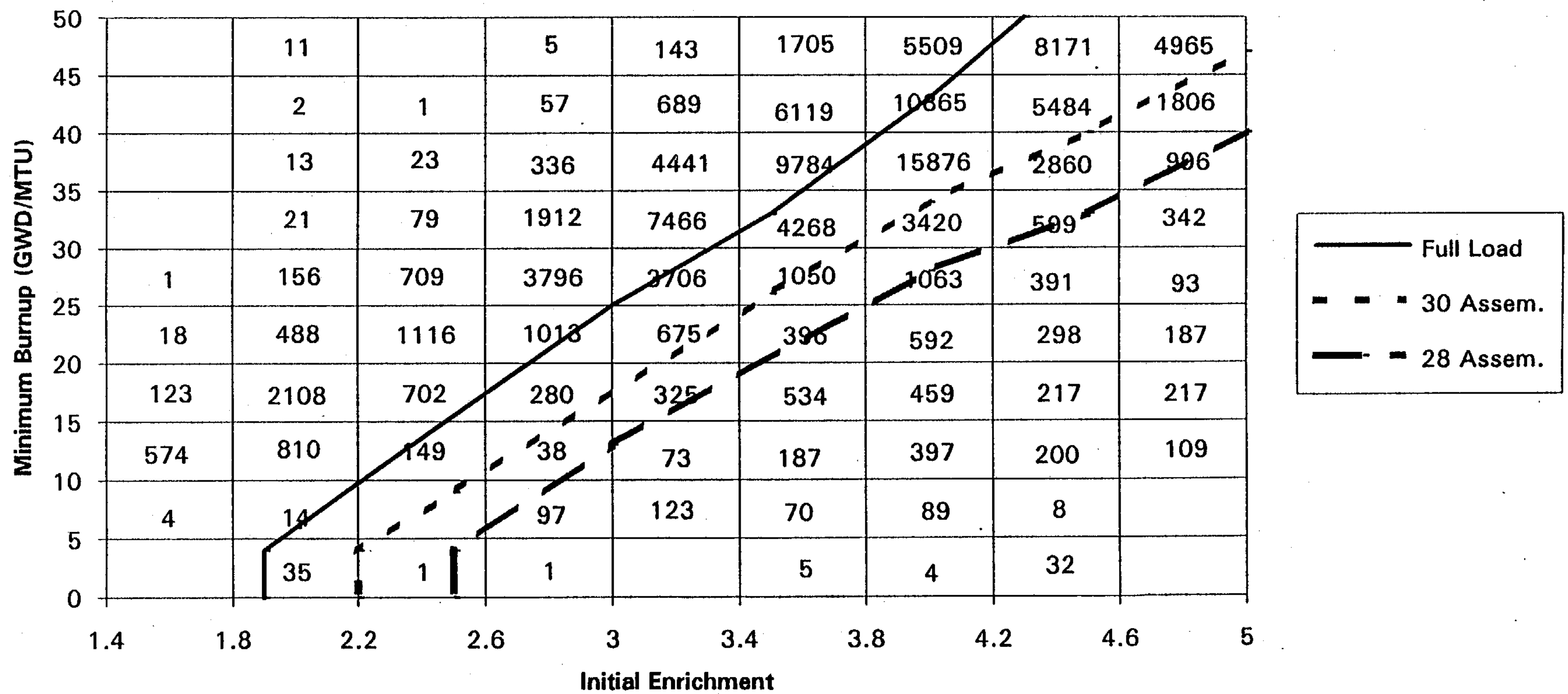

Figure 2: Loading Curve for a 32 Assembly Cask Using Actinide-Only Burnup Credit Plus Additional Burnup Credit (Numbers Shown On Grid Are the Expected Inventory of Assemblies)