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HI-STAR 180 - Misloading / Burnup Verification

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A Presentation to the SFST

by

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Misloading / Burnup Verification

- Fresh Fuel Misloading
  - Administrative Control
  - Number of Assemblies
  - Bounding Results
- Under-Burned Assemblies
  - Administrative Control
  - Number of Assemblies
  - Choice of Burnup / Results

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Fresh Fuel Misloading

- Administrative Control
  - The proposed CoC contains the requirement of visual inspection to ensure no fresh assemblies are loaded. This is based on the fact that fresh assemblies look different than burned assemblies. Based on this check, misloading of fresh assemblies should be considered non-credible.

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Fresh Fuel Misloading (cont'd)

- Number of Assemblies
  - The studies were performed with the lower bound (one) and upper bound (all) number of misloaded assemblies
  - There are a total of 42 possible misloading conditions for a single fresh assembly (9 loading configurations and several potential misloading locations for each configuration). Analyzing multiple assembly misloading conditions would require extensive amount of work in order to identify the conservative or bounding combinations.
- Bounding Results
  - By now, all 42 possible misloading conditions for a single fresh assembly have been analyzed. The maximum k-eff for all of them is 0.9601 (initial 7 conditions had a maximum of 0.9573). The bounding value is marginally higher than the value determined initially, but the principal conclusions remain unchanged.

Under-Burned Assemblies

- Administrative Control
  - The burnup requirement for burnup credit is between 22 and 35 GWd/mtU, depending on the configuration. This is low compared to the expected maximum assembly burnup of 66 GWd/mtU.
  - The number of assemblies in the spent fuel pool that are at or below the minimum required value would be small.
  - An additional administrative control could be proposed requiring that all assemblies below the required burnup have to be accounted for in the Spent Fuel Pool before and after a cask is loaded.
  - Note that during cask loading a misloading event would be inconsequential since PWR spent fuel pools require a substantial amount of soluble boron.
  - Number of assemblies to be verified could be further reduced by a loading curve (burnup vs enrichment) instead of a fixed burnup value.
  - Misloading of an under-burned assembly should be considered non-credible based on this administrative control.

Under-Burned Assemblies (cont'd)

- Number of Assemblies
  - Each of the 9 loading configurations have both fresh and burned assemblies
  - For the under-burned misloading condition, only the burned assemblies in each configuration are assumed to be replaced by the under-burned assembly. The fresh assemblies remain fresh.
    - Configuration 7 (previously analyzed, 12 GWd/mtU, max k-eff ~ 0.99) contains 17 burned assemblies
    - Other configurations contain up to 29 burned assemblies
  - Bounding results for all configurations:
    - 12 GWd/mtU: max k-eff < 0.99
    - 20 GWd/mtU: max k-eff < 0.975
  - Note that if ALL assemblies were considered under-burnup assemblies, the maximum k-eff would be even lower

Under-Burned Assemblies (cont'd)

- Burnup of Under-Burned Assemblies
  - Burnup and enrichment of under-burned assemblies were selected to be very conservative, based on engineering judgment: 12 GWd/mtU @ 5% initial enrichment
  - Comparison with published fuel data ("Axial Burnup Profile Database for Pressurized Water Reactors", R. J. Cacciapouti and S. Van Volkinburg, Yankee Atomic Electric Company Report YAEC-1937, 1997) confirms the large conservatism (see next page)
  - A burnup up to 20 GWd/mtU for 5 % initial enrichment could be justified