May 12, 2006

MEMORANDUM TO: Chairman Diaz
Commissioner McGaffigan
Commissioner Merrifield
Commissioner Jaczko
Commissioner Lyons

FROM: Luis A. Reyes ***/RA/***
Executive Director for Operations

SUBJECT: STATUS OF BURNUP CREDIT FOR SPENT FUEL ANALYSIS AND CERTIFICATION IN TRANSPORTATION AND DRY STORAGE

In response to the Staff Requirements Memorandum dated March 7, 2006, for M060214, "Staff Requirements - Briefing on NMSS Programs, Performance, and Plans - Waste Safety," staff is providing an update to the Commission on the near-term actions and milestones for expanding the use of burn-up credit in spent fuel analysis and certification in transportation and dry storage. This report reflects the staff's currently accepted burnup credit methodology for spent fuel analysis for transport and dry storage, and outlines efforts by the U.S. Nuclear Regulatory Commission (NRC) and other organizations to soon develop the basis for expanding burnup credit methodologies. NRC's Spent Fuel Project Office (SFPO) guidance has accepted burnup credit since 1999, to the extent justified by the limited data available, and has expanded the guidance for its use as more information has become available.

1. OVERVIEW

Even though there are provisions in NRC guidance for partial burnup credit, spent fuel assemblies have typically been analyzed for criticality safety, in storage, under 10 CFR Part 72, and in transportation, under 10 CFR Part 71, using a conservative fresh fuel assumption. This assumption has resulted in the design of spent fuel casks with smaller capacities and/or high boron-loading neutron absorbers, to offset the additional reactivity provided by assuming fresh fuel. Crediting burnup of spent fuel in storage and transportation criticality analyses increases the capacity of spent fuel casks, thereby reducing the overall costs associated with storage and transport, and potentially reducing the radiological risk associated with transport by reducing the overall number of shipments.

There is domestic and international recognition that the relative scarcity of experimental and validation data is the limiting factor for burnup credit. Improving the data base of spent fuel isotopic-assay samples and critical experiments will allow straightforward, accurate assessment of the sub-critical margin and support clarity and efficiency in the preparation and review of the safety basis for expanded burnup credit.

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2. BACKGROUND

The Office of Nuclear Reactor Regulation allows the use of burnup credit in the spent fuel storage pools at reactor plants. However, use of burnup credit for storage and transportation casks requires more in depth technical evaluation because:

- Spent fuel in a pool is handled under 6 meters (20 feet) or more of water in a closed, confined, and controlled environment isolated from the public, whereas transportation casks are in an open environment close to the public. Thus, the potential public consequences of a criticality in a pool are less than for transportation accidents.

- The design and controls for spent fuel pools are approved on a case-by-case basis, whereas storage and transportation casks are typically approved generically. Where spent fuel pool analyses can consider plant-specific design features and performance history, generic cask designs must be more conservative and typically bound a wider range of conditions, fuel characteristics, and loading processes.

- Spent fuel pools are subject to continuous local area and personnel radiation monitoring, allowing for detection and an opportunity for corrective action before a potentially dangerous situation develops, such as boron dilution. Protections for spent fuel casks are passive, and generally do not allow the same kind of detection capability and corrective actions before the development of potentially dangerous situations.

Guidance on the application of burnup credit to spent fuel analyses for storage and transportation has been available since the initial version of SFPO Interim Staff Guidance No. 8 (ISG-8), “Burnup Credit in the Criticality Safety Analyses of PWR Spent Fuel in Transport and Storage Casks,” which was issued in May of 1999. The ISG applied to intact uranium dioxide (UO_2) commercial pressurized water reactor (PWR) fuel with enrichments up to 4.0 weight percent uranium-235 (^{235}U), burnup levels up to 45 giga-Watt days per metric ton of uranium (GWd/MTU), and considered the reactivity effects of major actinides only, based on the available critical experiments and assay data. The ISG also recommended assuming only 50 percent of the burnup level from plant records. As additional data became available, staff updated the guidance in ISG-8.

Revision 1 to ISG-8 was issued in July 1999, and included a loading offset, for assemblies with initial enrichments between 4.0 and 5.0 weight percent ^{235}U, to acknowledge the lack of data in this range. Additionally, this revision removed the recommendation to consider only 50 percent of the actual burnup level, and defined the assigned burnup loading value of an assembly to be the reactor record value, reduced by the combined uncertainties in the records and the burnup measurement. In order to facilitate a risk informed review, Revision 1 to ISG-8 also recommended determining an estimate of the additional reactivity margin from fission product and actinide nuclides not included in the application.

The current revision to ISG-8 (Rev. 2) was issued in September 2002, and further expanded actinide-only burnup credit to include PWR assemblies enriched up to 5.0 weight percent ^{235}U and with burnup values up to 50 GWd/MTU, removing the loading offset of the previous ISG revision. This revision also expanded the range of assembly cooling times to between 1 and 40 years out of the reactor. Additionally, Revision 2 contained more detail regarding the determination of bounding axial burnup profiles, and included the presence of burnable absorbers or control rods (fully or partially inserted) during irradiation.

ISG-8 has recommended in each revision that assembly burnup values be confirmed by measurement, consistent with the recommendations of Regulatory Guide 3.71, “Nuclear

Criticality Safety Standards for Fuels and Material Facilities." Procedures that confirm the reactor records using measurements of a sampling of the fuel assemblies will be considered if a database of measured data is provided to justify the adequacy of the procedure in comparison to procedures that measure each assembly. In a meeting with the Nuclear Energy Institute on March 14, 2006, industry representatives agreed to provide information, to NRC, regarding the accuracy of reactor records in predicting actual assembly burnup levels.

SFPO staff participates regularly in international criticality safety organizations, such as the Organization for Economic Co-Operation and Development's Working Party on Nuclear Criticality Safety, which includes an expert group on burnup credit. Discussions with the representatives of other countries, at these meetings, on the approach to burnup credit outlined in ISG-8, indicate that this approach is comparable to, or beyond, what is allowed internationally in the criticality safety analysis of spent fuel casks.

3. NEAR-TERM ACTIONS (THROUGH 2008)

The staff is currently reviewing a proprietary spent fuel transportation cask application involving burnup credit, under Part 71. This application goes beyond the recommendations of ISG-8, Rev. 2, in that it is attempting to take credit for a number of fission products, in addition to actinides. This application also addresses the requirement for burnup measurements of fuel to be loaded. Staff recently received the applicant's response to a second round of requests for additional information, and will make a decision on design approval in the next several months. Additionally, staff expects to receive an additional application for a spent fuel transportation cask involving burnup credit in June, and another application within the next year.

The U.S. Department of Energy (DOE) Office of Civilian Radioactive Waste Management (OCRWM) has embarked on a program to acquire data from experiments that have been designed specifically to address burnup credit needs for storage and transportation. DOE's program includes acquiring French proprietary data, for actinides and fission products, in the area of critical experiments and chemical assays of the isotopic content of spent fuel. The French nuclear industry has developed an extensive set of such data, to support burnup credit for spent fuel reprocessing and transport activities.

Through DOE funding, Oak Ridge National Laboratory (ORNL) obtained the French actinide critical-experiment data in July of last year, and preliminary fission-product critical-experiment data early this year. SFPO also sent a letter to DOE OCRWM, dated March 10, 2006, encouraging timely acquisition of French burnup credit data. Based on information received in a recent (April 4th) meeting between the staff, DOE, and ORNL, the OCRWM transportation group expects to acquire the remaining fission-product critical-experiment and chemical-assay data in calendar year 2007, provided that they receive funding approval. Finally, efforts are being taken by industry to acquire additional French actinide assay data, along with their reactor operating histories.

ORNL is under contract, with the Office of Nuclear Regulatory Research (RES), to analyze burnup credit data purchased by DOE, to determine their quality and adequacy for spent fuel analysis and certification. The first milestone in this contract is to produce a draft report discussing the extent of preliminary data and the technical basis for expanding the methodology of ISG-8, to include credit for fission products. This report is tentatively due to RES by September 30, 2006, and will primarily be a strawman outline for fission product credit.

Depending on DOE's schedule, funding commitments, and release authorization, ORNL anticipates providing an interim NUREG/CR on newly obtained actinide and fission-product burnup credit data in early to mid-2007. NRC, in coordination with DOE, would begin meeting with industry representatives to discuss and share burnup credit data after this report is

published and the preliminary data are publicly released, tentatively in mid-2007. Such meetings would continue with the public release of the full data set purchased by DOE. ORNL will have a final report, which may consist of a series of NUREG/CRs, on the technical basis for expanding the methodology of ISG-8, once the full data set has been analyzed. This report would be followed by a revision to ISG-8, to incorporate the recommendations of ORNL's final report.

At this time, DOE's agreement regarding use of the French proprietary data does not include provisions for the data to be used for analysis and licensing of a spent fuel repository. Additional funding would be needed to add this provision to the agreement. DOE does not anticipate using the French proprietary data to support its proposed Yucca Mountain high level waste repository license application. NRC staff is interacting with DOE to understand DOE's technical basis for using burnup credit at the proposed repository.

4. LONG-TERM ACTIONS (BEYOND 2008)

In addition to the DOE-funded acquisition of burnup credit data from France, DOE, ORNL, and RES are pursuing several other potential sources of data, to augment the basis for further expansion of the ISG-8 methodology. Sandia National Laboratory (SNL) has completed a criticality experiment with the fission product Rhodium-103 (^{103}Rh). Based on the results of this demonstration, DOE may fund work at SNL on critical experiments involving an additional five major fission products. RES is pursuing burnup credit data from two Belgian experiments, REBUS and MALIBU, and may be able to obtain additional assay data from Spain. ORNL is also investigating the applicability of assay data from Russian-designed spent fuel, which may be available for purchase.

The staff will continue to interact with DOE, ORNL, and other applicable organizations to further investigate potential sources of relevant critical experiment and assay data for the further expansion of NRC guidance and general use by the nuclear industry.

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