Agenda
March 26, 2003 Meeting
Nuclear Energy Institute (NEI)

9:00 a.m.	Introductory Comments	
9:10 a.m.	ESP-8:	Use of a bounding approach for providing fuel cycle and transportation information required by NEPA (Tables S-3 & S-4)
10:20 a.m.	ESP-12:	Severe accidents issues
11:30 a.m.	Opportunity for public comment	
11:50 a.m.	Summary	
12:00 Noon	Adjourn	

March 7, 2003

Discussion Paper on ESP-8 (Tables S3 and S4)

Background: ESP-8 concerns the methodology that ESP applicants will use to determine the environmental impacts associated with the fuel cycle and transportation activities for ESP environmental reports.

Industry Approach: Based on information obtained for several types of advanced reactors, ESP applications will identify bounding fuel cycle and transportation parameters. These parameters will be assessed against the values assumed in determining the environmental impacts identified in Tables S3 and S4 to demonstrate that bounding fuel cycle and transportation impacts for ESP fall within those of Tables S3 and S4.

Attachment 1 to this letter provides examples and shows how this methodology would be applied. Bounding ESP fuel cycle parameters will either be less than or greater than the corresponding values assumed for Tables S3 or S4. If the bounding parameters for ESP are less than those assumed for Tables S3 or S4, the associated environmental impacts will fall within those of Tables S3 and S4. Where a bounding fuel cycle parameter for ESP is higher than the value assumed to prepare Tables S3 or S4, further evaluation will be performed to determine whether advances in fuel cycle technology can be shown to limit the associated environmental impacts to less than the Table S3 and S4 values. Additional evaluations would only be performed if improved fuel cycle and transportation practices cannot be shown to limit environmental impacts to within the Table S3 and S4 values. In this event, an alternative environmental impact value would be proposed.

For discussion with NRC: NRC discussion and feedback are requested on (1) the methodology outlined above and described in the attachment and (2) the following understandings and expectations that the industry would propose to establish with respect tot ESP-8.

1. Subject to NRC review in ESP applications, mitigating factors associated with modern fuel cycle and transportation practices may be credited in evaluations to demonstrate that environmental impacts identified in Tables S3 and S4 are representative of the bounding fuel cycle and transportation parameters identified for ESP.

2. Like other bounding parameters in ESP applications, and consistent with understandings established in connection with the PPE approach (ESP-6), it is expected that the NRC staff would review bounding fuel cycle and transportation parameters for ESP to determine that they are not unreasonable. Detailed NRC technical review for ESP would focus on applicant evaluations demonstrating that bounding fuel cycle and transportation impacts for ESP fall within those of Tables S3 and S4.

3. Subject to review and acceptance of the evaluations presented in ESP applications, the NRC would be expected to conclude in its Final EIS that applicants have adequately addressed the requirements of NEPA/Part51 and that fuel cycle and transportation impacts evaluated for ESP are bounded by those of Tables S3 and S4.

4. At COL, actual fuel cycle and transportation requirements for the proposed plant(s) would be presented in the COL application and subject to NRC technical review and approval. For a COL that references an ESP, if actual fuel cycle and transportation requirements are bounded by the parameters evaluated at ESP, then Tables S3 and S4 bound the environmental impacts for the proposed plant(s), and NEPA consideration fuel cycle and transportation impacts would be considered a matter resolved within the meaning of 10 CFR 52.39. Pending completion of rulemaking to update Tables S3 and S4, the methodology described in the attachment is appropriate for use in determining in a COL that actual fuel cycle and transportation requirements are bounded by fuel cycle and transportation parameters evaluated for ESP, and are thus bounded by Tables S3 and S4.

5. At COL, if one or more fuel cycle or transportation requirements are not bounded by the parameters evaluated at ESP, those requirements would be subject to further evaluation and review to demonstrate that associated environmental impacts are nonetheless bounded by Tables S3 and S4, or are otherwise acceptable.

The above described approach provides for demonstration at ESP that bounding fuel cycle and transportation impacts fall within those of Tables S3 and S4. In addition, the approach calls for NRC staff review of design specific (LWR or non-LWR) fuel cycle and transportation impacts at COL to support determination that those impacts are bounded by those evaluated in a referenced ESP, and thus by Tables S3 and S4. Accordingly, we conclude that this approach is consistent with the staff position identified in SECY-01-0207 (as follows):

> For other-than-light-water-reactor applicants, the staff must review design-specific environmental impacts, in the absence of generic rulemaking, to update Tables S-3 and S-4. The impacts should be discussed in a manner similar to that presented in 10 CFR 51.51 and 51.52; the discussion would serve as a starting point for the NRC independent assessment and should provide sufficiently detailed information on the cumulative, environmental, socioeconomic, and human health impacts of the fuel cycle and fuel transportation. The fuel cycle and fuel transportation impacts for non-light-water power reactors could be different from those addressed in 10 CFR Part 51; absent a rule, these impacts would have to be addressed in each application.

ESP- 8 – Attachment 1
February 21, 2003

Examples of the Methodology for ESP Application
Environmental Report Preparation for Tables S3 and S4

Environmental impacts are typically measured by impacts to environmental media and health impacts to workers and the public. In the case of the uranium fuel cycle, these impacts manifest themselves as land use, water use, chemical and radioactive emissions to both air and water, and waste disposal. There are also impacts to the worker and the public from the processing and transport of materials from each step of the process. Tables S3 and S4 were developed to provide an estimate of the environmental impacts from the nuclear fuel cycle and transportation. These tables were developed in a generic and non-site specific. The environmental impacts of the nuclear fuel cycle do not depend significantly on the location chosen for the reactor. They depend primarily on the fuel cycle and transportation requirements for materials and services.

The fuel cycle and transportation activities listed below are used to define fuel cycle requirements. The environmental impacts shown in Tables S3 and S4 were determined from these fuel cycle requirements. For each activity, the metric used in determining the fuel cycle requirements is identified. This list was basically taken from NUREG-0116, Table 3.2, and assumes no recycling.

Mining	ore supply in metric tons
Milling	U_3O_8 in metric tons
UF6 production	natural UF_6 in metric tons
Enrichment	enriched UF_6 in metric tons and the separative work units
Fuel Fabrication	fuel loading in metric tons
Reprocessing	not considered
Solid radwaste	Curies from operations
Decontamination & Decommissioning	Curies and cubic meters of LLW
Transportation	Number of shipments for initial core loading
	Number of reload shipments per year
	Fission product inventory in Curies per MTU
	Actinide inventory in Curies per MTU
	Kr-85 activity in Curies per MTU
	Total radioactivity in Curies per MTU
	Decay heat in watts per MTU
	Number of shipments of irradiated fuel
	Heat per cask shipment
	Truck density in trucks per day
	Rail density in cars per month

The approach proposed for evaluating the environmental impacts for the ESP applications is not inconsistent with what has been done previously (e.g., to address burnup limits) and is considered appropriate pending update of Tables S3 and S4 by the NRC. The approach relies on the environmental impacts shown in Tables S3 and S4 and compares the fuel cycle requirements for a range of reactor types to those used to arrive at the values in the current Tables. The purpose of this evaluation is to determine whether the environmental impacts shown in the Tables are bounding for additional reactor types, considering only a uranium fuel cycle only. ESP applicants do not at this time intend to extend this approach to the evaluation of plutonium, mixed oxide and other potential fuel cycles are not part of this approach. For cases where the fuel cycle requirements exceed those used to calculate the environmental impacts in Tables S3 and S4, an evaluation will be performed to determine whether fuel cycle technology improvements [for example, reduced energy consumption for uranium enrichment] mitigate the environmental impact from the increased fuel cycle requirement. If fuel cycle requirements are identified that show increases without an identified mitigating technology improvement, alternatives for estimating the associated environmental impacts will be presented.

Activities and associated requirements for the fuel cycle and transportation process have been obtained from the vendors of the technologies used to establish the Plant Parameter Envelope [PPE] for the ESP applications. These requirements will be compared to the requirements for the reference LWR that formed the basis for Tables S-3 and S-4. Since several of the new reactor technology configurations provide more electricity than the referenced plant, these requirements are normalized as appropriate. Based on the results of these comparisons, there will be one of two outcomes: (1) A fuel cycle requirement associated with the new reactor technologies is less than the referenced plant requirement, therefore the associated impacts shown in Tables S3 and S4 are bounding. (2) A fuel cycle requirement is greater than the referenced plant and further examination is needed, including consideration of mitigating factors that offset increases in environmental impacts implied by the greater fuel cycle requirements.

For example with respect to mining, a key environmental impact is the amount of land that is impacted by the mining technology. If the new reactor technology requires less ore, then the expected amount of land used will be less because WASH 1248 used conservative assumptions on uranium mining techniques compared with current practice. Even if the uranium ore requirements have increased, the Table S3 associated environmental impacts may nonetheless bound the expected values. The "Red Book" *Uranium 2001: Resources, Production and Demand* states that at the end of 2000 the only production in the United States was by *in situ* leaching (ISL). This technology has a very low environmental impact compared with the open-pit and underground mining that was assumed in the WASH 1248 report.

The key activities for the uranium fuel cycle are mining, milling, and conversion to uranium hexafluoride, enrichment, fabrication, waste disposal and transportation. These are the same activities identified in WASH-1248 as the main contributors to any environmental impacts. Reprocessing is not currently being considered and as such is excluded from the ESP fuel cycle analysis. These are the same activities identified in WASH 1248 as the main contributors to any environmental impacts.

The parameters needed to calculate annual fuel cycle requirements, regardless of technology, are the annual fuel loading [mass of uranium] and the enrichment [percent U235]. Annual uranium ore [mass of natural uranium], enrichment services [SWU] and other fuel cycle requirements are determined and compared to the requirements assumed in WASH 1248, "Environmental Survey of the Uranium Fuel Cycle," and NUREG 0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle." More specifically if annual reactor fuel uranium mass and enrichment requirements are known, then the quantity of UF_6 required can be determined, the SWU can be calculated, the U_3O_8 that is needed can be specified and lastly the quantity of uranium ore required can be computed.

For the fuel and radioactive waste transportation activity, the key characteristic is the number of shipments. Existing NRC cask design and transportation licensing regulations assure that the other matters of potential concern, such as shielding and transport safety are properly addressed.

Most of the activities and environmental impacts associated with the nuclear fuel cycle and transportation are independent of reactor design. For fuel cycle activities, uranium ore recovery, milling, UF_6 conversion and enrichment are independent of reactor technology. Only fuel fabrication is dependent on reactor design. The only major technology-dependent difference for transportation would be the cask design differences required for various fuel assembly types and source terms. However, all cask designs have to meet NRC licensing regulations.

Conditions for use of Table S-4 [reactor power level, fuel form, enrichment, fuel cladding, burnup, modes of transport, and irradiated fuel decay time prior to shipment] are evaluated by calculating annual fuel cycle requirements to determine whether the Table S-4 environmental impacts are bounding.

In summary, based on the results of the comparison of the above fuel cycle requirements with the reference LWR, the following steps will be taken. If an ESP fuel cycle requirement is less than the reference LWR, then it will be stated that based on the conservative analysis of the WASH reports, the associated environmental impacts shown in Tables S3 and S4 are suitable for use in ESP applications. If an ESP fuel cycle requirement is greater than the reference LWR, then a further analysis will be conducted. If there are other mitigating factors, practices and changes from the original WASH assumptions, then it may be possible to show that the associated environmental impacts are still less than the values in Tables S-3 and S-4. If it can't be shown that the impacts are bounded, alternatives for estimating the associated environmental impacts will be presented.

The following two examples illustrate use of this approach to evaluating the suitability of Tables S3 and S4 to represent the environmental impacts of additional reactor types. ESP applications will present a complete discussion of such evaluations and conclusions for NRC review and approval.

1) Transportation example: The transportation of fuel and waste for the reference LWR required 18 truck shipments for initial core load, 6 reload shipments per year, 60 spent fuel shipments per year, and 46 radwaste shipments per year for a total of 130 truck shipments per year. This value is translated into Table S-4 as less than 1 truck shipment per day. The approach used is to determine the total number of shipments (fuel and LLW) for each of the reactor technologies. If the requirement is less than the reference case, then Table S-4 is appropriate for estimating the associated environmental impacts for the ESP applications.

2) Enrichment services example: The reference LWR required 127 units of enrichment services (MTU of SWU) annually. Based on the annual fuel mass and enrichment requirements provided by the reactor vendors, the annual SWU requirements for the ESP applications are higher than those assumed in the WASH reports. Environmental impacts associated with enrichment services are part of the overall fuel cycle environmental impacts shown in Table S3. However, a close look at the original analysis (WASH 1248) shows the impacts are almost totally from the electrical generation needed for the gaseous diffusion enrichment process. These impacts are the emissions from the electric generation that is assumed to be from coal plants and from the associated water use to cool the plants. A significant fraction of the enrichment services to US utilities today is provided from European facilities using centrifuge technology rather than the fifty-year-old gaseous diffusion technology. Two companies have now announced plans to develop centrifuge technology enrichment in the US. Centrifuge technology requires less than 10 % of the energy needed for the gaseous diffusion process. The gas reactor technology with the highest annual

SWU use requires approximately 30% greater that the SWU assumed in the WASH reports. Therefore, the environmental impacts shown in Table S3 associated with SWU services are still expected to be bounding for the ESP applications. The ESP applications will present a complete discussion of this analysis and conclusion for NRC review and approval. Additionally, if a COL applicant decided to use a design with a high SWU requirement and gaseous diffusion enrichment, the environmental impact of enrichment services would be subject to review at COL.

ESP-12 Follow-Up Discussion for March 5 Public Meeting w/NRC

The NRC staff's February 12 letter on ESP-12, "NEPA Consideration of Severe Accident Issues," said while SAMAs could be deferred to COL if detailed design information was not available for ESP, the staff expects that ESP applications will address the environmental impacts of severe accidents. The staff letter indicated that this is consistent with the staff position articulated in SECY-91-041.

Based on the staff's feedback, we have reviewed the following generic analyses with respect to their use in addressing severe accident impacts at ESP:

- NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Plants," which provides a detailed evaluation of the accident risks for five U.S. nuclear power plants based on detailed level 1, 2 and 3 PRA studies for these plants and associated sites.
- NUREG/CR-2239, "Technical Guidance for Siting Criteria Development," which evaluates the impact of severe accidents on a generic basis, independent of reactor design, for all 91 reactor sites as of 1982 [including the three ESP application sites].

We are considering an approach that would provide a generic discussion of severe accident impacts in ESP applications based on these NRC generic analyses. For example, NUREG/CR-2239 demonstrated that severe accident environmental impacts were not significantly dependent of site meteorology or emergency planning, but were sensitive to population distribution. Thus, the ESP/ER would focus on demonstrating that the population distribution assumed in the generic analyses remains applicable for the site. Other potential environmental impacts are still under evaluation.

The discussion in ESP applications would demonstrate that severe accident environmental impacts at the proposed site are bounded by the results of the generic analyses based on existing plant designs. The Commission concluded in its 1985 Policy Statement on Severe Reactor Accidents Regarding Future Designs and Existing Plants that existing plants pose no undue risk to public health and safety. The Commission Policy Statement also identifies the expectation that new plants will achieve a higher level of severe accident safety performance than existing plants. This expectation has been realized in each of the three standard designs certified by the NRC to date. Thus severe accident impact evaluations for ESP based on existing plant designs will bound those for future plant designs that are expected to satisfy the Commission's Severe Accident Policy Statement.

At COL, for an applicant referencing a certified design and an ESP, severe accident impacts would, absent a significant new environmental issue associated with the design or site, be considered resolved for purposes of the COL proceeding.

We note that draft RS-002 indicates that ESRP Section 7.2 is applicable to the ESP review. However, portions of Section 7.2, (e.g., Review Interfaces) require use of detailed design information that may not be available at time of ESP, as well as consideration of SAMAs, a topic that may be deferred to COL.

Please provide your feedback on our interpretation of your Feb. 12 letter and the approach outlined above.

EXCERPTED FROM SECY-01-0207, "LEGAL AND FINANCIAL ISSUES RELATED TO EXELON'S PEBBLE BED MODULAR REACTOR (PBMR)," (DATED NOVEMBER 20, 2001)

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Staff Assessment of Exelon's Legal and Financial White Papers

As part of the pre-application review, Exelon Generation (Exelon) has submitted nine white papers on selected legal and financial issues for Commission response. Exelon is currently performing a detailed feasibility study of the Pebble Bed Modular Reactor (PBMR). If the results are favorable, Exelon intends to seek a license to operate a PBMR facility as a merchant power plant in the United States. Exelon has identified several regulations that could pose undue and unintended burden when applied to gas-cooled reactors, modular facilities, or merchant plants. Exelon believes that certain regulations were not designed for and do not contemplate gas-cooled, modular facilities operated as merchant plants. Exelon will use the staff's assessment of these white papers in its feasibility study. In addition to addressing the proposals by Exelon, the staff identifies other issues related to Exelon's proposals that may affect the PBMR application (Items H.2, H.3, I.2 and K). The following issues and regulations are addressed in this assessment:

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B. Fuel cycle impacts: Tables S3 and S4 in 10 CFR 51.51 and 51.52

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The detailed discussions of these issues on the following pages summarize the issues, the current regulations, Exelon's position, the staff's considerations, and the staff's preliminary positions.

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B. Environmental Impacts of the Fuel Cycle and Transportation: 10 CFR Part 51, Tables S-3 and S-4

Issue

Based upon resolution of the environmental impact issues for the first PBMR application, should the NRC initiate rulemaking to create PBMR-specific tables for environmental impacts?

Current Regulations

In accordance with 10 CFR 51.41, 51.45, 51.50, 52.17(a)(2), and 52.79(a)(2), an environmental report prepared by the applicant for a construction permit, early site permit, or combined license should provide sufficient information regarding any applicable environmental impacts associated with all stages of the production and transportation of reactor fuel. However, light-water power reactor applicants are expected to rely on the regulatory framework at 10 CFR 51.51 and 51.52 by including Tables S-3 and S-4 in their environmental report. For other-than-light-water-reactor applicants, the environmental impacts of the production and transportation of fuel must be described in the environmental report in sufficient detail to provide information on the cumulative, environmental, socioeconomic, and human health impacts associated with the fuel cycle and fuel transportation. That information serves as a starting point for the NRC's environmental impact statement (EIS).

Exelon's Position

As part of the first application, Exelon proposes to identify the environmental impacts attributable to the fuel cycle and fuel transportation for a set of modular reactors that constitute a PBMR facility. Exelon suggests that the impacts are expected to be generic for all PBMR nuclear power reactors and therefore, Exelon proposes that the results for the first application should form the underlying bases for rulemaking. Exelon proposes that rulemaking be initiated to create tables similar to 10 CFR Part 51, Tables S-3 and S-4, for the PBMR, or that the issue be generically resolved for the PBMR during a design certification rulemaking.

Discussion

The PBMR is not a light-water power reactor, and therefore the PBMR applicant currently cannot rely upon Tables S-3 and S-4.

The fuel cycle and fuel transportation impacts for non-light-water power reactors could be different from those addressed in 10 CFR Part 51. Absent a rule, each COL and early site permit applicant referencing a PBMR would have to submit information on these impacts. The NRC staff would have to address the impacts in the EIS.

Independent of issues raised by Exelon, the NRC staff has previously identified the need for rulemaking to revise Tables S-3 and S-4 in 10 CFR 51.51 and 51.52. However, the staff believes that any effort to undertake generic rulemaking on PBMR-specific fuel cycle and fuel transportation issues would be premature, inasmuch as the PBMR is still a prospective design.

Exelon's suggestion that the design certification rulemaking for a PBMR serve as a platform for resolving the attendant generic environmental impacts could result in changes to Part 51 that would be too narrowly focused by limiting the changes to a particular technology. For example, the current 10 CFR Part 51 considers light-water power reactors as a class of plants; it does not distinguish between a pressurized-water reactor (PWR), a boiling-water reactor (BWR), and the recently approved designs under Part 52. The PBMR could be considered part of a class of other-than-light-water power reactors (e.g., the gas turbine-modular helium reactor) that present similar challenges and a similar need for a regulatory solution. In addition, different parts of the egulations are involved (i.e., Parts 51 and 52); a change to a generic rule concomitant with a new rule governing a specific design could unnecessarily complicate a design certification rulemaking.

Staff Position

For other-than-light-water-reactor applicants, the staff must review design-specific environmental impacts, in the absence of generic rulemaking, to update Tables S-3 and S-4. The impacts should be discussed in a manner similar to that presented in 10 CFR 51.51 and 51.52; the discussion would serve as a starting point for the NRC independent assessment and should provide sufficiently detailed information on the cumulative, environmental, socioeconomic, and human health impacts of the fuel cycle and fuel transportation. The fuel cycle and fuel transportation impacts for non-light-water power reactors could be different from those addressed in 10 CFR Part 51; absent a rule, these impacts would have to be addressed in each application.

The NRC has only limited experience in licensing other-than-light-water power reactors; at this time all operating power reactors are light-water reactors. Inasmuch as the PBMR is a prospective design, the staff believes that any effort to undertake a generic rulemaking on these issues would be premature. When the staff has gained more experience in the issues associated with the PBMR, or other non-light-water power reactor designs, through a design certification or an adjudicatory proceeding (e.g., combined license), the staff can determine whether it has sufficient information to proceed with a generic regulatory solution.