November 30, 1999

MEMORANDUM TO: Gary M. Holahan, Director
Division of System Safety and Analysis
Office of Nuclear Reactor Regulation

FROM: John N. Hannon, Chief
Plant Systems Branch
Division of System Safety and Analysis
Office of Nuclear Reactor Regulation

SUBJECT: PLANNED ALTERNATIVE TO HIGH-EXPANSION FOAM EXPERIMENT FOR POTENTIAL ZIRCONIUM FIRES AT DECOMMISSIONED PLANTS

In June 1999, the Technical Working Group (TWG) completed the, "Draft Technical Study of Spent Fuel Accidents for Decommissioning Plants." The TWG assessed potential mitigative options for extinguishing a potential zirconium fire and limiting the potential for airborne release. The draft TWG report recommended that the use of high-expansion foam, applied to the top of the assemblies, could be considered as an alternative to the use of unborated water due to slower leakage rates and the low water requirement for foam. Since the effectiveness of high-expansion foam on bulk zirconium fires is not known at this time, we (Plant Systems Branch) decided to look into the possibility of conducting a high-expansion foam experiment that would determine if a sufficient amount of foam would penetrate down the length of the assembly, prevent the assembly from reaching its critical temperature, or serve as an effective fire suppression agent.

As a result of internal discussions after the TWG report was issued, we decided that our emphasis on the potential use of high-expansion foam to mitigate a zirconium fire may be too narrowly focused to ensure that the fire concern receives thorough treatment. Therefore, as discussed in the attachment, we have changed our approach for addressing the concern.

If you have any questions regarding our plans, please contact Tanya Eaton at 415-3610.

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## 1 BACKGROUND

In June 1999, the Technical Working Group (TWG) completed the, "Draft Technical Study of Spent Fuel Accidents for Decommissioning Plants." The TWG assessed potential mitigative options for extinguishing a potential zirconium fire and limiting the potential for airborne release. The draft TWG report recommended that the use of high-expansion foam, applied to the top of the assemblies, could be considered as an alternative to the use of unborated water due to slower leakage rates and the low water requirement for foam. Since the effectiveness of high-expansion foam on bulk zirconium fires is not known at this time, we (Plant Systems Branch) decided to look into the possibility of conducting a high-expansion foam experiment that would determine if a sufficient amount of foam would penetrate down the length of the assembly, prevent the assembly from reaching its critical temperature, or serve as an effective fire suppression agent.

As a result of internal discussions after the TWG report was issued, we decided that our emphasis on the potential use of high-expansion foam to mitigate a zirconium fire may be too narrowly focused to ensure that the fire concern receives thorough treatment. Therefore, as discussed below, we have changed our approach for addressing the concern.

## 2 BASIS FOR MODIFYING THE APPROACH

The fire protection staff has raised a number of technical issues regarding the scope of the high-expansion foam project, heat transfer aspects of the foam on the assemblies, and difficulties associated with plant implementation. The concerns primarily centered around difficulties in the foam application and the fact that a water supply, after a beyond design-basis earthquake, most likely would not be available. There were also concerns that the foam could not sufficiently coat the fuel assemblies to starve the oxidation process or extinguish a zirconium fire. Furthermore, even if the foam blanket were successfully applied to cut off air supply, a beyond design-basis seismic event could potentially create cracks approximately 2' in length and ½" in width around the sides and bottom of the spent fuel pool (SFP). The cracks would be equivalent to having five or six 5" diameter holes. This would allow outside air to be entrained into the SFP and provide a constant supply of air to progress towards a zirconium fire. In addition, although willing to perform the experiment, the National Institute of Standards and Technology, our proposed contractor, has raised similar technical issues about this proposed application of high-expansion foam. It has also expressed reservations about whether or not the experiment would work, and, if so, whether the results of the experiment would conclusively demonstrate that high- expansion foam is a viable option for cooling spent fuel or mitigating an actual zirconium fire in a spent fuel pool.

As a result of these technical issues and the time constraints of the project, we have changed our approach for looking at the mitigative options for a potential zirconium fire. The approach that we plan to follow involves the three steps described below.

## 3 MODIFIED APPROACH

### 3.1 Preventative Measures

First, focus on ensuring that preventative measures are in place to reduce the risk of a catastrophic spent fuel pool failure by including heavy loads and seismic preventative measures. Seismic and heavy loads are the two events that could cause catastrophic failure of the spent fuel pool leading up to heat up of the spent fuel and a zirconium fire. Therefore, we looked at preventative measures that are currently in place for seismic and heavy loads issues. For seismic issues, we are working on the seismic checklist to ensure our TWG evaluation assumptions are valid when applied to a specific plant. For heavy loads, we are considering NEI's proposed measures to decrease the probability and consequences of a SFP heavy load accident. Both of these measures go beyond what is currently required for operating plants.

### 3.2 Expand Project Scope

Second, we have expanded the scope of the project to consider other potential mitigative options, other than high-expansion foam and will discuss these alternatives in the final report. Two possible alternatives were already discussed with respect to operating plants in NUREG-1353[1] and NUREG/CR- 5281[2]. They include installing a water spray system or developing a generic contingency plan to cover the SFP with debris. A water spray system was discounted in these NUREG's because they were not considered cost-effective for operating plants and a Seismic Category I water source is not guaranteed to withstand a beyond design-basis earthquake. The development of a generic contingency plan to cover the spent fuel pool with debris (sand, dirt, lead, clay) was also determined not to be cost-effective for operating plants. There were technical concerns that debris could not be transported to the site and into the SFP in a timely manner to decrease radiological release or to mitigate a zirconium fire. We have canceled our plans to conduct tests on the high-expansion foam alternative and will not conduct tests on any other option at this time (see Step 3.3, below).

### 3.3 Mitigative Measures

Third, some plants may need to do more then the preventative measures previously stated due to unique plant features. In order to decrease the consequences of a zirconium fire, these plants may consider increasing the defense-in-depth through implementation of mitigative methods. If a need develops in industry to consider alternative mitigation methods for a SFP in decommissioned plants, we recommend that industry take the lead to develop and implement mitigation methods acceptable to the staff.

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[1]Throm, E.D., "Regulatory Analysis for the Resolution of Generic Issue 82, "Beyond Design Basis Accidents in Spent Fuel Pools," NUREG-1353, April 1989.

[2] Jo, J.H., et. Al., "Value/Impact Analyses of Accident Preventative and Mitigative Options for Spent Fuel Pools," NUREG/CR-5281 (BNL-NUREG-5281), March 1989.

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