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Project No.: 713

June 3, 2002

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

Subject: Submittal of Position Paper Addressing Selected Significant Observations and Conclusions in D. A. Powers Trip Report Covering the "High-Temperature Gas-Cooled Reactor Safety and Research Issues Workshop," held October 10-12, 2001.

Attached is an Exelon Generation Company (EGC), LLC position paper that responds to an Advisory Committee on Reactor Safeguards (ACRS) member's trip report, "Travel by D. A. Powers to Attend the High-Temperature Gas-Cooled Reactor Safety and Research Issues Workshop Rockville, Md., October 10-12, 2001," dated October 2001. The information contained in this paper provides EGC's position on issues raised by the ACRS member with regard to the Pebble Bed Modular Reactor. This information being provided for information only and not for review and comment.

If you have any questions or concerns regarding this matter, please contact R. M. Krich or me.

Sincerely,

Kevin F. Borton
Manager, Licensing

Attachment

cc: Farouk Eltawila, Office of Nuclear Reactor Research
James Lyons, Office of Nuclear Reactor Regulation
Amy Cubbage, Office of Nuclear Reactor Regulation
Stuart Rubin, Office of Nuclear Reactor Research

D064

Attachment

"Position Paper in Response to an ACRS Member's Trip Report"

Exelon Generation Company

Submitted June 3, 2002

4 Pages

Exelon Generation Company, LLC
Position Paper
Addressing the Significant Observations and Conclusions in D. A. Powers Trip Report
Covering the "High-Temperature Gas-Cooled Reactor
Safety and Research Issues Workshop," held October 10-12, 2001

The objective of this paper is to address the Significant Observations and Conclusions regarding the Pebble Bed Modular Reactor (PBMR) in Dr. D. A. Power's report of his attendance at the October 10-12, 2001, "High-Temperature Gas-Cooled Reactor Safety and Research Issues Workshop," held in Rockville, Maryland. This paper is being submitted to the NRC for information purposes only; no review and/or comment of this paper is being requested.

Significant Observation and Conclusion No. 1: "As currently designed, the Pebble Bed Modular Reactor does not conform with the defense in depth regulatory philosophy of the Nuclear Regulatory Commission and should not be certified."

Exelon Generation Company (EGC), LLC agrees that the objective of a defense in depth design philosophy is to address those unanticipated and unknown events, failures, and human errors that can occur during the operating life of a nuclear power plant. EGC also recognizes that an inherently safe or passive design (i.e., design aspects that rely on first principles of thermo-dynamics, heat transfer, etc.), accomplishes the same objective without the need to add layers of engineered safety features. Loss of coolant accidents as applied to the PBMR must be looked at differently than for Light Water Reactors (LWRs). Due to the design of LWR fuel and the reactor core power density, only fluids with a sufficiently high specific heat and chemical properties, such as water, can be used to mitigate a loss of coolant accident; that is, to prevent core damage (i.e., catastrophic failure of the fuel cladding and/or loss of the core coolable geometry). In the case of a PBMR, the loss of coolant accident in the sense of having a complete loss of cooling fluid is physically impossible, since the design and the helium gas properties will always permit some amount of the gas to be present. More importantly, immediate replenishment of cooling fluid is not essential since the fuel design, and core power density and configuration provide for heat transfer from the reactor to its surroundings to maintain fuel integrity. In other words, the end-state of an event that results in the complete depressurization of the primary pressure is a "safe haven" state due to the inherently passive design of the reactor system.

EGC also agrees that accident prevention as well as mitigation must be available, even for nuclear power plants that rely on first principles for event mitigation. This aspect of the design of the PBMR is described in the "Proposed Licensing Approach for the Pebble Bed Modular Reactor in the United States," submitted by EGC to the NRC by letter dated August 31, 2001.

Significant Observation and Conclusion No. 2: "The Pebble Bed Modular Reactor core may be susceptible to neutronic instabilities."

The neutronic behavior of the PBMR utilizes the extensive testing and operating experience of the German AVR and THTR reactors. Furthermore, there is no significant difference between the geometric and mass centers of gravity within a fuel "pebble." Neutronic instabilities of any type, including the type experienced in Boiling Water Reactors, were not observed during the more than 20 years of testing and operation experience at the two German reactors combined, nor have any neutronic instabilities been observed at the recently commissioned HTR-10 in China.

Significant Observation and Conclusion No. 3: "The shutdown system for the Pebble Bed Modular Reactor is not adequate."

The inherent safety feature of the high negative temperature coefficient design coupled with the passive heat removal and high heat capacity of the fuel results in the inherently safe control of core heat generation. Furthermore, because of the large heat capacity and low power density of the ceramic reactor core, changes in reactivity result in slow temperature transients in the core. These inherent characteristics were demonstrated innumerable times at the German AVR reactor. The operators would routinely shut down the reactor for the weekend by stopping the helium circulators, thereby letting the high core negative temperature coefficient intrinsically cause reactor shutdown, and then later insert control rods. Experience with the AVR demonstrated that the operators had over 20 hours after reactor shutdown by means of the negative temperature coefficient before Xenon decayed to the point that control rods needed to be inserted to avoid re-criticality. Experience also showed that even if control rods were not inserted, re-criticality did not result in excessive fuel temperatures. All of the core behaviors were consistent with well-established German neutronic analysis methods and results.

Regardless of the inherent capability to safely shut the reactor down described above, two redundant systems for shutting down the PBMR and maintaining it shutdown are being investigated.

Significant Observation and Conclusion No. 4: "The Pebble Bed Modular Reactor is not proliferation resistant."

The PBMR approach to proliferation resistance builds on past pebble bed reactor experience. Material control and accounting techniques already exist for on-line refueling processes. The PBMR design has added proliferation resistance aspects including the use of Low Enriched Uranium (LEU) fuel for low front-end proliferation risk and a high burnup fuel cycle that is not worth reprocessing for low back-end proliferation risk. Furthermore, the International Atomic Energy Agency reviewed the PBMR design relative to material control and accounting criteria in February 2001. The results of this review have been made available to the NRC. Although specific recommendations were made, the design and proposed operation of the PBMR were found to be consistent with proliferation resistance objectives.

Significant Observations and Conclusions No. 5 "High temperature radiation damage to graphite."

Further investigation and confirmation of this issue is needed; however, the priority of this issue is low for the following reason. Scoping analyses have shown that the release of high temperature graphite radiation damage energy is an insignificant contributor to decay heat energy generation over the accident temperature range of modular high temperature gas-cooled reactors (HTGRs) like the PBMR. For that matter, it was not a significant contributor to the energy generation for the U.S.-licensed Ft. St. Vrain HTGR which had much higher accident temperatures.

Significant Observation and Conclusion No. 6: "Containment versus Confinement"

The PBMR design includes a high leakage containment building. The PBMR containment building design incorporates several levels of defense against both internal and external challenges, including the long-term retention and filtering of fission products, earthquakes, non-commercial airplane crashes, tornados, flooding, etc. A position paper providing EGC's initial approach to addressing the PBMR containment design relative to applicable NRC regulatory policies was submitted to the NRC by letter dated May 31, 2002, "Submittal of Pebble Bed Modular Reactor Containment Design Position Paper."