Nuclear Energy Oversight Project

"Oversight of the U.S. Nuclear Regulatory Commission to protect public health and safety and the environment"

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RE: 10 CFR 2.206 PETITION REQUESTING ENFORCEMENT ACTION BY THE U.S. NUCLEAR REGULATORY COMMISSION

The Nuclear Energy Oversight Project (NEOP) by and through its undersigned Executive Director (hereinafter "Petitioners") submit a 10 CFR 2.206 Petition requesting that the U.S. Nuclear Regulatory Commission (NRC) take enforcement action against all licensees of commercial boiling water reactors and pressurized water reactors including specific actions against licensees of the AP1000 reactors.

Requested Enforcement Action

Petitioners request that the NRC:

1. Require the licensees to develop and validate computer safety models that would be capable of conservatively predicting rates of hydrogen generation in severe accidents. In addition, require the licensees to conduct a series of experiments with multi-rod bundles of zirconium alloy fuel rod simulators and/or (actual) fuel rods as well as study the full set of existing existing experimental data. The licensees objective in this effort should be to develop models capable of predicting with greater accuracy the rates of hydrogen generation that occur in severe accidents.

2. Require the licensees to assess the safety of existing hydrogen re-combiners, and discontinue the use of passive autocatalytic recombiners (PARS) until technical improvements are developed and certified.

3. Require licensees to significantly improve existing oxygen and hydrogen monitoring instrumentation.

4. Require licensees to upgrade current core diagnostic capabilities in order to better signal to plant operators the correct time to transition from emergency operating procedures to severe accident management guidelines. Require that data from overall leak rate tests and local leak rate tests already required by Appendix J to Part 50 and Part 52 for determining how much radiation would be released from the containment in a design basis accident be used to help predict hydrogen leak rates from the primary containment of each reactor licensed by the NRC under different severe accident scenarios. If data from an individual leak rate test indicates that dangerous quantities of explosive hydrogen gas would leak from a primary containment in a severe accident, the NRC should require the licensee to repair the containment.

5. Require licensees of AP1000 reactors to ascertain and calculate the probability that the phenomenon of hydrogen deflagration to detonation transition could occur below the hydrogen concentrations of 10.0 volume percent; and provide reasonable assurance to the NRC that a detonation would not occur during a severe accident such as a core melt down where hydrogen concentrations were below 10.0 volume.

   If licensees of AP1000 reactors cannot provide reasonable assurance to the NRC that hydrogen concentrations below 10.0 volume would not cause a detonation and breach of the containment building, then Petitioners request that the **NRC issue an Executive Order mandating the immediate shut down of all AP1000 reactors**.

6. Require licensees of AP1000 reactors to conduct actual and real-time testing of the AP1000 reactor passive cooling system by intentionally tripping an AP1000 reactor off-line for a period of no less than 30-days to evaluate whether or not the passive cooling system can be maintained and operational by the licensee for such a period of time to adequately protect the reactor core.

Basis and Justification

1. The licensees' and NRC's existing computer safety models appear to under predict the rates of hydrogen generation that occur in severe accidents.

2. Experimentation and research should be conducted in order to improve the performance of PARs so that they would not malfunction and incur ignitions in the elevated hydrogen concentrations that occur in severe accidents. Some experimentation and research has already been conducted; however, the problem of PARs incurring ignitions in elevated hydrogen concentrations **remains an unresolved safety issue**. In a severe accident, plant operators would be able to turn off thermal recombiners in order to prevent them from operating in elevated hydrogen concentrations. However, to safely operate thermal recombiners, operators would be required to have instrumentation providing timely information on the local hydrogen concentrations throughout the containment.

3. After the onset of a severe accident, hydrogen monitors must be functional within a time frame that enables timely detection of quantities of hydrogen indicative of core damage and a potential threat to containment integrity. Hydrogen monitors should be functional within one minute of the injection of coolant water into the reactor vessel to protect public and plant worker safety.

4. Westinghouse has touted the AP1000 as having, in the event of a severe accident, a far lower probability of breaching its containment than currently operating nuclear power plants. However, Westinghouse's probabilistic risk assessment (PRA) for the AP1000 erroneously claims that it would not be possible for a hydrogen detonation to occur in the AP1000's containment if the hydrogen concentration were less than 10.0 volume percent. **A hydrogen detonation could compromise the containment and thus cause a large radioactive release.** In fact, Westinghouse's PRA assumes that the containment would fail "in all cases," in which hydrogen deflagrations transitioned into detonations. Westinghouse's PRA for the AP1000 states that since the lowest hydrogen concentration for which deflagration-to-detonation transition has been observed in the intermediate-scale FLAME facility at Sandia [National Laboratories] is 15 percent, and [NRC regulation] 10 CFR 50.44 limits hydrogen concentration to less than 10 percent, the likelihood of deflagration-to-detonation transition is assumed to be zero if the hydrogen concentration is less than 10 percent." Westinghouse does not consider that the lower concentration limits at which deflagration-to-detonation transition can occur, at temperatures of 68°F and 212°F, are 11.6 and 9.4 volume percent of hydrogen, respectively. According to a 1998 Brookhaven National Laboratory report: "Most postulated severe accident scenarios are characterized by containment atmospheres of about 373K [212°F]… However, calculations have shown that under certain accident scenarios local compartment temperatures in excess of 373K [212°F] are predicted.

   Westinghouse's PRA for the AP1000 as well as the NRC's regulations rely on outdated assumptions that the phenomenon of hydrogen deflagration-to-detonation transition cannot occur below hydrogen concentrations of 10.0 volume percent. In 1991, Sandia National Laboratories reported that, in an experiment, deflagration-to-detonation transition occurred at 9.4 volume percent of hydrogen. The previous year, the same information was reported at the NRC's Eighteenth Water Reactor Safety Information Meeting. In a September 2011 Advisory Committee on Reactor Safeguards meeting, Dana Powers, a senior scientist at Sandia National Laboratories, expressed concern over the fact that hydrogen detonations occurred in the Fukushima Daiichi accident and stated that in experiments, detonations are… extraordinarily hard to get. However, neglecting to reassess hydrogen-combustion safety issues for the AP1000 after Fukushima, the NRC went ahead and issued licenses for two AP1000s in February 2012. **Two of the AP1000 containment's safety devices employ hydrogen igniters, and passive autocatalytic hydrogen recombiner (PAR) units – which when they malfunction and behave like igniters providing ignition sources that are capable of causing hydrogen detonations**. In a severe accident, hydrogen igniters must be actuated at the correct time, because, as Peter Hoffman wrote in the Journal on Nuclear Materials - the concentration of hydrogen in the containment may be combustible for only a short time before detonation limits are reached. If AP1000 licensees were to actuate the hydrogen igniters in an untimely fashion—after a local detonable concentration of hydrogen developed in the containment—it could cause a detonation. **This very likely to occur because Westinghouse's emergency response guidelines for the AP1000 are flawed**.

Operators are instructed to actuate hydrogen igniters when the core-exit gas temperature exceeds 1200°F. Westinghouse maintains that the core-exit temperature would reach 1200°F before the onset of the rapid zirconium-steam reaction of the fuel cladding, which leads to thermal runaway in the reactor core; however, experimental data demonstrates that this would not necessarily be the case. Westinghouse and the NRC, which approved the AP1000 design, both overlooked data—available for more than a quarter century—from the most realistic severe accident experiment conducted to date (LOFT LP-FP-2), in which core-exit temperatures were measured at approximately 800°F when maximum in-core fuel-cladding temperatures exceeded 3300°F. In LOFT LP-FP-2, when core-exit temperatures were 800°F, the rapid zirconium-steam reaction of the fuel cladding had already occurred and the reactor core had started melting down. Hence, relying on core-exit temperature measurements in an AP1000 severe accident could be unsafe.

In a scenario in which operators re-flooded an overheated core simply because they did not know the actual condition of the core, hydrogen could be generated at rates as high as 5.0 kg per second. If operators were to actuate hydrogen igniters in such a scenario, it could cause a hydrogen detonation. Westinghouse's general description of the AP1000 states that "[PARs] control hydrogen concentration following design basis events." However, in the elevated hydrogen concentrations that occur in severe accidents, PARs are prone to malfunctioning and behaving like hydrogen igniters. **This is an unresolved safety issue.** AP1000 operators would not be able to switch off PARs, because they operate without electrical power. If the AP1000 containment's PAR units malfunctioned and incurred ignitions after a detonable concentration of hydrogen developed in the containment, it could cause a detonation. This could occur in a number of severe accident scenarios, especially those in which the AP1000 containment's hydrogen igniter system was not operational, enabling local detonable concentrations of hydrogen to develop in the containment.

5. The AP1000 reactor employs a passive cooling system to protect the reactor core at all times and during and emergency event to protect the health and safety of the public and the environment from a disastrous release of radioactive particles and radiation. To the extent that the AP1000 reactor passive cooling system is a new and unproven technology, it is paramount that licensees conduct actual and real-time testing of this passive cooling system to provide reasonable assurance to the NRC and to the public that the design is valid and can be operational for extended periods of time.

To the extent that the **NRC was apparently negligent in approving the AP1000 reactors** for licensed operations in the United States of American, Petitioners will refer the matter to the NRC Office of the Inspector (OIG) General to investigate the NRC's actions in so doing.

Conclusion

For all the above stated reasons, Petitioners urge the NRC to take the requested enforcement action against its licensee(s) as described above to protect the health and safety of the public and to protect the environment.

For the Petitioners

Thomas Saporito
Executive Director

**** A copy of this electronic communication is being provided to the NRC Office of the Inspector General to enable that agency to monitor and investigate the actions of the NRC in this important matter to protect the health and safety of the public and to protect the environment from the catastrophic effects of a serious nuclear accident originating from a licensed commercial nuclear power plant regulated by the NRC.***