Written Comments on ARDC 26 as Proposed in DG-1330

For: Consideration by the ACRS Subcommittee on Future Plant Designs scheduled to meet February 22, 2017 on advanced reactor design criteria
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Question on advanced reactor design criterion (ARDC) 26 as proposed in DG-1330 (Issued February 2017)

In keeping with NRC's advanced reactor policy statement, how does ARDC 26 allow for, or incentivize advanced reactors to use simplified, inherent, passive or other innovative means for reactivity control?

Basis for question

According to the Commissions Advanced Reactor Policy Statement as addressed in DG-1330, *"the Commission expects that advanced reactors will provide enhanced margins of safety and/or use simplified, inherent, passive, or other innovative means to accomplish their safety and security functions."*

The protection system and reactivity control systems support the safety function of fission product barrier protection. This is captured in the GDC in Section III of Appendix A to Part 50, *Protection and Reactivity Control Systems,* which are written to support the design criteria in Section II, *Protection by Multiple Fission Product Barriers*.

For LWRs:

- In the short term after a reactor trip, the safety function of the protection and reactivity control systems is to protect the fuel and the RCPB barriers.
- In the long term after a reactor trip, the safety function of the reactivity control systems is to protect the fuel and containment barriers.

In contrast, advanced reactors can be designed with inherent reactivity control capability such that heat is removed and fission product barriers are protected without reliance on the protection and reactivity control systems. Inherent means for reactivity control does not need to include maintaining subcriticality, which may not be necessary for fission product barrier protection. A design with inherent protection of fission product barriers with **one** reactivity control system to maintain the reactor subcritical under cold conditions (consistent with the last sentence in GDC 26) would *"provide enhanced margins of safety"* and *"use simplified, inherent, passive, or other innovative means to accomplish"* safety and security functions. Such a design would not be novel, as previous sodium-cooled reactors have relied on inherent reactivity control capability for fission barrier protection in lieu of a second reactivity control system ("Secondary shutdown systems of Nuclear Power Plants," ORNL-NSIC-7, January 1966). ARDC 26 as written would discourage vendors from developing such a design.

Comment on ARDC 26 as proposed in DG-1330

ARDC 26 prescribes that reactivity control systems for advanced reactors exceed the capability required by GDC 26 and GDC 27, without due consideration for the reactivity control system capability needed to support safety functions.

Basis for comment

1. ARDC 26(2) requires two independent and diverse reactivity control systems that can independently achieve and maintain reactor shutdown, whereas GDC 26 only requires one system for maintaining the reactor subcritical under cold conditions. PWRs rely on two reactivity control systems, control rods and means for soluble boron addition, which in combination can achieve and maintain reactor shutdown. PWRs are not required to be able to use either one of these systems independently to achieve and maintain reactor shutdown. Prescribing that advanced designs, which may have less reliance on subcriticality to support adequate core cooling, have two independent reactivity control systems that can independently achieve and maintain reactor shutdown does not necessarily improve or reflect the safety of such designs.
2. ARDC 26(2) requires maintaining shutdown with margin for malfunctions, compared to the last sentence of GDC 26 which requires one reactivity control system that "shall be capable of holding the reactor core subcritical under cold conditions" without specifying margin for malfunctions. Based on a review of the original draft GDC published by the AEC, comments from industry and the final GDC as published, AEC intentionally did not specify that margin for malfunctions should be provided in maintaining shutdown under cold conditions. Based on comments from industry it was envisaged that malfunctions leading to a return to low power would not challenge safety functions. Prescribing that advanced designs provide shutdown capability with margin for malfunctions does not necessarily improve or reflect the safety of such designs.