Question: Are there any vendor designs that would produce fuel that is "outside the envelope" of the specifications analyzed in the recent EPRI topical report on TRISO fuel performance?

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Answer: Yes, some vendors' Tri-structural Isotropic (TRISO) fuel particle designs do fall outside of the envelope specification provided in Table 5-5 of the Electric Power Research Institute (EPRI) topical report, and the fuel forms and matrix composition also deviate in various ways from the conventional Advanced Gas Reactor (AGR) Program fuel.

Some applications propose the use of more novel designs (such as a uranium nitride fuel kernels, silicon carbide matrix, or varying particle geometry), to apply TRISO coated particle fuel technology to their designs, which have core physics and thermal requirements that differ from the modular high temperature gas-cooled reactors (HTGRs) that have been the focus of the AGR program. The early successes of the AGR program resulted in broader interest with government and vendors, who have subsequently sought to customize TRISO technology for new applications.

Similarly, as was noted during the meeting, the EPRI topical report covered the TRISO coated fuel particles themselves and remained as neutral as possible regarding the impact of the graphitic-matrix fuel elements. All applicants will be responsible for qualification needs associated with their respective fuel element designs.

The following are examples of vendors who have expressed intent to use a TRISO configuration that differs from the conventional AGR Program fuel.

1. BWXT Advanced Nuclear Reactor (BANR) uses TRISO fuel with a uranium nitride (UN) fuel kernel in a silicon carbide (SiC) fuel matrix instead of graphite. A driver for using UN versus uranium oxy carbide (UCO) for this application is the higher power density that can be achieved with a UN kernel. BWXT also has stated that the UN-in-SiC fuel form is also driven by microreactor economics.

2. Ultra Safe Nuclear Corporation (USNC) Micro Modular Reactor (MMR) intends to use a SiC fuel matrix instead of graphite. USNC believes that a SiC fuel matrix will prove more rugged and show higher temperature stability. Thus, USNC might be elect to credit the SiC matrix as an additional fission product retention barrier.

3. Kairos Power uses an annular fuel pebble design with characteristics specific to application in fluoride high temperature reactors (FHRs). Pebble attributes, including smaller size, variable matrix density, and definition of the annular fueled region are provided in Kairos Power's topical report *Fuel Qualification Methodology for the Kairos Power Fluoride Salt-Cooled, High Temperature Reactor*. This topical report cites the following as drivers for the aforementioned characteristics:

    a. Variable density of the sphere is needed so that the pebbles will float in the coolant.
    b. Use of AGR UCO TRISO particle design leverages as much as possible from the AGR program fuel qualification experience.

c. Reduced pebble size is needed to account for higher power density in FHRs as compared to HTGRs. The associated higher temperatures also drive the annular fuel distribution within the pebble.

In addition to the above, it is important to acknowledge that all the companies actively working on TRISO-fueled reactor designs use a fuel form that differs from the AGR form in some capacity. The only exception is Framatome, whose reference design (SC-HTGR) is the Next Generation Nuclear Plant (NGNP), which is the basis for the AGR Program. The following are some additional examples to illustrate this point:

1. X-energy uses the same AGR UCO particle but in a standard 60-mm diameter sphere instead of a cylindrical compact.

2. Radiant Nuclear is looking at small changes to particle geometry, such as kernel size and buffer layer thickness, as well as cylindrical compact dimensions to improve microreactor core neutronics while minimizing such changes to avoid the need for additional fuel qualification data.

3. Westinghouse (eVinci) is looking at modest changes to kernel size and cylindrical compact dimensions, while maintaining the UCO kernel and basic fuel matrix formulation. The use of heat pipes is unique among TRISO-fueled reactor designs.