ANS Issues a Response to an Inquiry on ANSI/ANS- 19.6.1-2011 (R2016), "Reload Startup Physics Tests for Pressurized Water Reactors," (revision of ANSI/ANS-19.6.1-2005) (Nuclear News, August 2018)

The ANS Standards Committee received an inquiry with multiple questions on ANSI/ANS-19.6.1-2011 (R2016). The questions and responses are provided below. Some editorial changes have been made for clarity.

Background: Korea Hydro & Nuclear Power (KHNP) is currently using ANSI/ANS-19.6.1-1997 (W2005), "Reload Startup Physics Tests for Pressurized Water Reactors," for the light water reactor (Combustion Engineering type), and we are considering upgrading to the current standard, ANSI/ANS-19.6.1-2011 (R2016) (same title), according to the requirement of the Korea Institute of Nuclear Safety. KHNP has performed the Flux Symmetry Test (FST) at the low reactor power (30%) and the Power Distribution Test (PDT) at the 80% and 100% reactor power. However, as updated from the 1997 and 2005 versions, the 2011 version suggests performing the PDT before reaching over 50% reactor power. PDT requires equilibrium xenon (Eq-Xe), however FST does not. Thus if we use ANSI/ANS-19.6.1- 2011 (R2016), it needs extra power stabilization time to satisfy the Eq-Xe condition. It seems hard to neglect the overhaul schedule delay, and it is difficult to predict the operation conditions prior to 30% and difficult to produce design values based on the actual operation conditions. The following questions are asked considering these factors:

Question 1:
Why do you require the PDT to be performed before 50% reactor power?

Response 1:
The direct power distribution measurement was lowered from 80% to 50% to provide more margin to the safety limits when there was something wrong that could be revealed only by a direct power distribution measurement. For example, suppose there was a local peaking problem that could not be inferred from the FST. If the local peaking exceeded the requirement by over 20% and the measurement was performed at 80% power, there might be safety consequences. In ANSI/ANS-19.6.1-2011 (R2016), the local peaking could exceed the requirement by up to 50% (a very rare situation) and no safety limits would be violated.

Question 2:
Can the FST replace the PDT before 50% reactor power?

Response 2:
The FST is intended to readily identify gross core configuration problems such as misloaded fuel assemblies or damaged/misaligned control rods and thus preclude exceeding fuel design limits and causing possible fuel damage when an asymmetric core configuration is present. The FST is unlikely to identify fuel assembly design and manufacturing issues at the level detectable through a detailed in-core power distribution measurement.

Question 3:
There is no significant relative power density difference between Eq-Xe condition and Non Eq-Xe condition at low power, why should xenon condition be applied to the low power PDT?

Response 3:
The xenon condition is not a requirement of the standard for intermediate power distribution measurements. The xenon condition as recommended in the User Guide [an appendix of ANSI/ANS-19.6.1-2011 (R2016) which is not a formal part of the standard] provides typical values for rates of change and stability to help the user perform the test and evaluate the results accurately.

Although the difference between an Eq-Xe and a non Eq-Xe relative power distribution at low power may not be significant from a calculation perspective, it can affect the interpretation of a comparison between measured results to calculated design values depending on the core's actual power history in going from a hot zero power condition to an intermediate power condition.

Please note that the Eq-Xe condition was suggested primarily to accommodate movable detector systems which require a relatively long time to complete the measurement of the whole core. The Eq-Xe condition is less important for fixed detector systems in which the measurement of the whole core can be made very quickly.