ANS Answers Inquiries on ANSI/ANS-18.1-1999 (W2009)

Radioactive Source Term for Norman Operation of Light Water Reactors
(Nuclear News, August 2013)

The ANS Standards Committee received two separate inquiries on ANSI/ANS-18.1-1999 (R2009). The inquiries and their respective responses are provided below:

Inquiry #1:

Does the committee think that the adjustment factors supplied in this standard are applicable to adjust the coolant concentrations from the reference power level of 3400 MWt to a lower thermal power level, such as the 400 MWt as is being proposed for the B&W mPower reactor?

Response:

ANS notes that the B&W mPower reactor's power level is 530 MWt, not 400 MWt as stated in the inquiry; this response is nonetheless applicable to mPower and other small light-water reactors.

Considering the various uncertainties in the projected concentration values and, in particular, the level of fuel defects, which have been constantly improving (decreasing) with time, it is considered reasonable to apply the ANSI/ANS-18.1-1999 (W2009) scaling methodology in cases where high activity is conservative, subject to various cautions discussed below.

The U.S. Nuclear Regulatory Commission has noted in Revision 1 of Regulatory Guide 1.112, Regulatory Position C.4:

> For new reactor applications filed under the provisions of 10 CFR Part 52, an applicant may use the methodology described in ANSI/ANS-18.1-1999, *Radioactive Source Term for Normal Operation for Light-Water Reactors*. When using that standard, the applicant should describe and justify all adjustments made to the reference boiling water reactor or pressurized water reactor plant parameters in developing radionuclide concentrations in BWR reactor coolant and reactor steam, as well as PWR primary coolant and secondary water and steam.

As further cautions:

- It should be noted that the addition, subtraction, or modification of components or features (e.g., fuel type or performance, coolant chemistry, startup sources) from those of the reference PWR could impact the nuclide concentration in the smaller reactor.
- Activity concentrations associated with long-lived nuclides could increase with longer cycle times, but the increase is certainly not in proportion to the cycle time, and the equilibrium values are typically determined by purification and boron dilution flow rates. If detailed long-lived nuclide concentrations are deemed necessary, they would be the responsibility of the user.
- The 1999 update of the standard reflects fuel performance through that time, and it should be noted that fuel performance has continued to improve. Given that the historical data were based on older fuel performance, the resultant reactor coolant system (RCS) activities tend to be higher compared to recent operational experience.
- Caution should be used if the ANSI/ANS-18-1 methodology is to be used in applications where lower RCS activity is conservative and appropriate. See U.S. NRC Regulatory Issue Summary 2009-02, Revision 1, for an example.

This reply addresses the applicability of the scaling method to a small reactor. As ANSI/ANS-based coolant concentrations rely on empirical data, both published and unpublished data from the large LWR operating reactors, it is up to the user to determine whether the standard is entirely appropriate for the B&W mPower reactor or other small LWRs.

Inquiry #2:

Is it possible for ANSI/ANS-18.1 to be used for a nuclear plant with a 36-month fuel cycle?

Response:

At the time the 1984 version of the standard was issued, the cycle lengths of the operating plants that formed the basis for the standard was a mix of 12 and 18 months. The 1999 version included updates to the major noble gas, iodine, and cesium nuclides based on operating plant data at the time, which were almost exclusively 18-month cycles.

If the cycle time is increased to 24 months or longer, considering the various uncertainties in the projected concentration values and, in particular, the level of fuel defects, which have been constantly improving (decreasing) with time, it is considered reasonable to apply the ANSI/ANS-18.1-1999 methodology in cases where high activity is conservative (see below for further cautions). The concentration values associated with short-lived nuclides tend to be dictated by the nuclide half-life and would thus be somewhat independent of cycle time. The activity concentrations associated with long-lived nuclides could increase with longer cycle times. However, the increase is certainly not in proportion to the cycle time, since the higher burnup fuel operates at a much less than average core power and the equilibrium values are determined by purification and boron dilution flow rates.

The previously mentioned improvement in fuel performance has generally led to significantly lower reactor coolant system (RCS) activities. The 1999 update of the standard reflects fuel performance through that time, though it should be noted that fuel performance has continued to improve. Since the historical data were based on older fuel performance, the resultant RCS activities tend to be higher compared to recent operational experience. Caution should be used if the ANSI/ANS-18-1 methodology is to be used in applications where lower RCS activity is conservative and appropriate. See U.S. NRC RIS 2009-02, Revision 1, for an example.