Response to Action Item 5-5 Section 5.3.2

MCB Issue List Regarding APR-1400, FSAR Section 5.3.2

Issue #1 (AI 5-5.14)

Based on the information provided in the design certification application and Technical Report ANP APR1400-Z-M-NR-14008-P, Revision 0, the staff understands that the applicant has performed its reactor vessel integrity analyses (pressure-temperature limits, pressurized thermal shock, charpy USE) using a "hypothetical weld" placed in the center of the RV beltline region as the limiting material. The staff believes that this weld is not intended to exist in the construction of an actual APR1400 RV, but has been introduced as a means of providing additional conservatism in the APR1400 RV integrity analyses. Confirm that the aforementioned staff's understanding of is correct. If not, explain why the applicant's RV analyses include a circumferential weld at the center of the active core region that is not a part of the actual RV design.

Response

Yes, the staff's understanding is correct.

Impact on DCD

There is no impact on the DCD.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Reports

Response to Action Item 5-5 Section 5.3.2

MCB Issue List Regarding APR-1400, FSAR Section 5.3.2

Issue #2 (AI 5-5.15)

In Final Safety Analysis Report (FSAR) Section 5.3.2.3, the applicant provided pressurized thermal shock reference temperature (RT_{PTS}) value for the limiting reactor vessel (RV) beltline material, which is a weld conservatively assumed to be in the center of the RV beltline and subjected to a neutron fluence of 9.5×10^{19} n/cm^2 (E > 1.0 MeV). However, Title 10 of the Code of Federal Regulations (10 CFR) Section 50.61 requires that projected values of RT_{PTS} be provided for each RV beltline material. For the APR1400 design, the beltline materials to be considered should include, at a minimum, the lower shell section of the RV adjacent to the active height of the core and the two circumferential welds that connect the RV beltline ring forging (lower shell) to the bottom head and to the upper shell section (nozzles section).

Revise the FSAR to provide all values (i.e., initial RT_{NDT}, chemistry factors, fluence values, margins, ΔRT_{NDT}, etc.) used to calculate the RT_{PTS} for all RV materials which meet the definition in 10 CFR 50.61(a)(3) of being in the APR1400 RV beltline. The staff notes that the information requested is currently provided in Table 8-1 of APR1400 Technical Report APR1400-Z-M-NR-14008-P, Revision 0, "Pressure-Temperature Limits Methodology for RCS Heatup and Cooldown."

Response

The Table 8-1 of the APR1400 Technical Report will be added to the Table 5.3-10, as shown below and the descriptions about the lower shell section will be added in FSAR Section 5.3.2.3.

Impact on DCD

Table 5.3-10 will be added and DCD 5.3.2.3 will be revised as indicated on the attached markup

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specification.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical or Environmental Reports

APR1400 DCD TIER 2

Table 5.3-10

RT_{PTS} for the APR1400 Reactor Vessel Materials at EOL (60 Years)

Material	Initial RT_{NDT} (℃(℉))	Fluence Factor(1)	Chemistry Factor(2) (℃(℉))	ΔRT_{PTS} (℃(℉))	Margin(3) (℃(℉))	RT_{PTS} (℃(℉))	Screening Criterion (℃(℉))
Lower Shell Course (beltline material)	-23.3 (-10)	1.51	11.1 (20)	16.8 (30.2)	16.8 (30.2)	10.2 (50.4)	132.2 (270)
Weld Material (G-2 & G-3)	-12.2 (10)	1.51	20.8 (37.5)	31.4 (56.6)	31.1 (56)	50.3 (122.6)	148.9 (300)
Head Flange	-12.2 (10)	negligible	24.4 (44.0)	NA4)	NA4)	NA4)	132.2 (270)
Vessel Flange	-12.2 (10)	negligible	24.4 (44.0)	NA4)	NA4)	NA4)	132.2 (270)
Inlet Nozzles	-12.2 (10)	negligible	24.4 (44.0)	NA4)	NA4)	NA4)	132.2 (270)
Outlet Nozzles	-12.2 (10)	negligible	24.4 (44.0)	NA4)	NA4)	NA4)	132.2 (270)
DVI Nozzles	-12.2 (10)	negligible	24.4 (44.0)	NA4)	NA4)	NA4)	132.2 (270)

(1) Fluence Factor = $f^{(0.28-0.10\log f)}$, f = Fluence at Limiting Case, 9.5 x 10^{19} n/cm^2.

(2) Chemistry Factor with Chemical Composition of Cu 0.03 wt% and Ni 1.00 wt% for the lower shell course; Cu 0.05 wt% and Ni 0.10 wt% for the weld material; and Cu 0.07 wt% and Ni 1.00 wt% for the flanges and nozzles.

(3) Margin = $2\sqrt{\sigma_u^2 + \sigma_\Delta^2}$

where, $\sigma_u = 0$

σ_Δ = lesser of 17°F or 0.5xΔRT_{PTS} for the forging and lesser of 28°F or 0.5 x ΔRT_{PTS} for the weld material.

(4) Not applicable because fast neutron fluence is not significant.

APR1400 DCD TIER 2

5.3.2.3 Pressurized Thermal Shock

The reactor vessel meets the requirements of 10 CFR 50.61 (Reference 30), and NRC SRP BTP 5-3 (i.e., the PTS screening criteria are not projected to be exceeded by expiration of the operations).

RT_{PTS} is evaluated using the procedure described in 10 CFR 50.61, which is provided below:

RT_{PTS} = (Initial) RT_{NDT} + ΔRT_{PTS} + Margin

The calculated maximum RT_{PTS} satisfies the screening criteria in 10 CFR 50.61(b)(2).

The PTS screening criteria are:

a. 132.2 °C (270 °F) for plates, forgings, and axial weld materials

b. 148.9 °C (300 °F) for circumferential weld materials

The following assumptions are applied in the calculation of RT_{PTS} for limiting beltline material:

a. The limiting case is the weld material subjected to the maximum integrated fast neutron fluence of 9.5×10^{19} n/cm^2.

b. For the weld material, maximum copper content is 0.05 wt% and maximum nickel content is 0.10 wt%, and the maximum initial RT_{NDT} is -12.2 °C (10 °F).

c. The adjustment in the reference temperature caused by irradiation (ΔRT_{PTS}) is calculated to be 31.4 °C (56.6 °F). The margin required by 10 CFR 50.61 is 31.1 °C (56 °F) for the weld materials.

The calculated RT_{PTS} is ~~50.6 °C (123 °F)~~ 50.3 °C (122.6 °F) for circumferential weld materials as shown in Table 5.3-10, which satisfies the above PTS screening criteria.

The calculated RT_{PTS} for lower shell course in Table 5.3-10 is 10.2 °C (50.4 °F), which also satisfies the above PTS screening criteria for forging.