**ASME BPVC.XI.1-2021 NONMANDATORY APPENDIX G**

(U.S. Customary Units)

\[
p = (33.2 + 20.734 \times \exp[0.02(T - RT_{NDT} - 110)]) - K_{fr} \times t/R_{f} \times 1/M_{m}
\]

where

- \( p \) = pressure (ksi)
- \( RT_{NDT} = RT_{NDT(u)} + \Delta RT_{NDT} \), and is the reference nil ductility temperature adjusted for irradiation effects at the maximum depth of the postulated quarter thickness flaw stipulated in G-2214.3, °F
- \( RT_{NDT(u)} \) = equivalent to the unirradiated \( RT_{NDT} \) calculated in accordance with NB-2300, °F
- \( \Delta RT_{NDT} \) = an adjustment for irradiation effects, °F
- \( T \) = temperature at the maximum depth of the postulated quarter thickness flaw stipulated in G-2214.3, °F

(SI Units)

\[
p = (36.5 + 22.783 \times \exp[0.036(T - RT_{NDT} - 61)]) - K_{fr} \times t/R_{f} \times 1/M_{m}
\]

where

- \( p \) = pressure, MPa
- \( RT_{NDT} = RT_{NDT(u)} + \Delta RT_{NDT} \), and is the reference nil ductility temperature adjusted for irradiation effects at the maximum depth of the postulated quarter thickness flaw stipulated in G-2214.3, °C
- \( RT_{NDT(u)} \) = equivalent to the unirradiated \( RT_{NDT} \) calculated in accordance with NB-2300, °C
- \( \Delta RT_{NDT} \) = an adjustment for irradiation effects, °C
- \( T \) = temperature at the maximum depth of the postulated quarter thickness flaw stipulated in G-2214.3, °C

\( K_{fr} \) is as stipulated in G-2214.3, and \( t, R_{f}, M_{m} \) are as stipulated in G-2214.1. The analytical evaluation is to be performed for all conditions, materials, and locations as described in G-2215.

The operational pressure–temperature limits are based on the temperature at the reactor coolant inlet temperature, which is assumed to equal the temperature at the vessel inner surface. Figure G-2214-1 (Figure G-2214-1M) and Figure G-2214-2 can be used to determine the temperature at the vessel inner surface corresponding to the temperature at the maximum depth of the postulated quarter thickness flaw stipulated in G-2214.3.

\( \Delta RT_{NDT} \) is determined from plant-specific surveillance data, or the irradiation degradation model used to compute the risk-informed allowable pressure as shown in eq. (2), or other irradiation degradation models.

\[
\Delta RT_{NDT} = MF + CRP
\]  \( (U.S. Customary Units) \)

(U.S. Customary Units)

\[
MF = A(1 - 0.001718T_{i}) \left[1 + 6.13P \left(Mn^{2.471} \phi_{e}\right)^{1/2}ight]
\]

where

- \( A \) = 1.140 × 10^{-7} for forgings
- \( = 1.561 \times 10^{-7} \) for plates
- \( = 1.417 \times 10^{-7} \) for welds
- \( Mn \) = bulk material manganese content, wt. %
- \( P \) = bulk material phosphorus content, wt. %
- \( T_{i} \) = irradiation temperature, °F

\[
\phi_{e} = \begin{cases} 
\phi & \text{for } \phi \geq 4.39 \times 10^{10} \\
\phi \left(4.39 \times 10^{10}\right)^{0.2595} / \phi & \text{for } \phi < 4.39 \times 10^{10}
\end{cases}
\]

\( \phi = \text{neutron fluence, cm}^{-2} \)
\( \phi = \text{neutron flux, cm}^{-2}\text{s}^{-1} \)

Lower case phi is missing
(U.S. Customary Units)

\[ MF = A(1 - 0.001718T_i)(1 + 6.13P_{Mn}^{2.47})(\Phi_e)^{0.52} \]

where

\[ A = \begin{cases} 1.140 \times 10^{-7} & \text{for forgings} \\ 1.561 \times 10^{-7} & \text{for plates} \\ 1.417 \times 10^{-7} & \text{for welds} \end{cases} \]

\[ T_i = \text{irradiation temperature (°F)} \]

\[ P = \text{bulk material phosphorus content (wt.%)} \]

\[ Mn = \text{bulk material manganese content (wt. %)} \]

\[ \Phi_e = \text{effective neutron fluence (cm}^{-2}) \]

\[ \Phi = \text{neutron fluence (cm}^{-2}) \]

\[ \phi = \text{neutron flux (cm}^{-2}\text{s}^{-1}) \]

\[ \text{Cu}_{\text{e}} = \text{effective material copper content (wt. %)} \]

\[ \text{Cu} = \text{bulk material copper content (wt. %)} \]

\[ \text{Cu}_{\text{max}} = \begin{cases} 0.243 & \text{for Linde 80 welds with } Ni > 0.5 \\ 0.301 & \text{for all other materials.} \end{cases} \]

\[ f(Cu, P) = \begin{cases} [Cu - 0.072]^{6.68} & \text{for } Cu > 0.072 \text{ and } P \leq 0.008 \\ [Cu - 0.072 + 1.35(P - 0.008)]^{6.68} & \text{for } Cu > 0.072 \text{ and } P > 0.008 \end{cases} \]

\[ g(Cu, Ni, \Phi_e) = \frac{1}{2} + \frac{1}{2} \tanh \left[ \log_{10}(\Phi_e) + 1.139Cu_e - 0.448Ni - 18.120 \right]^{0.629} \]

(SI Units)

\[ MF = A(0.945 - 0.003092T_i)(1+6.13P_{Mn}^{2.47})(\Phi_e)^{0.52} \]

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