framatome

Framatome GmbH, P.O. Box 11 09, 91001 Erlangen

N.V. EPZ
To: [redacted]
Zeedijk 32
4454 PM Borssele

NETHERLANDS

Framatome GmbH

Name [redacted]
Department [redacted]

Telephone [redacted]
Fax
Mobile
E-mail [redacted]@framatome.com

Your letter of
Our reference [redacted]
Date 30.03.2020

Consideration of HAZ for RPV safety assessment of NPP Borssele

Dear [redacted],

According to the standards KTA3203 and ASTM E185 heat affected zone (HAZ) specimens are no longer required in the RPV irradiation surveillance program. This is based on the assumption that the HAZ is covered conservatively by the base material (BM) with respect to RT_{NDT} what is verified by experimental data, e.g. in "Forschungsprogramm Kom-ponentensicherheit (FKS), Einfluss der Neutro-nenbestrahlung auf die Eigenschaftsänderungen der Werkstoffe von Reaktordruckbehältern für Leichtwasserreaktoren, Zusammenfassende Bewertung des Vorhabens, Abschlussbericht, Kenn-zeichen: 1500304, Einzelvorhaben: Bestrahlung EV 05, MPA Stuttgart 10/1996", p. 59ff.. The mechanical properties of the unirradiated HAZ of the core weld W03 (of the production control test coupon) in terms of Charpy data and RT_{NDT} are assumed to be better than the ones of the BM Ring 03. Therefore, it can be excluded that the HAZ is the leading material for RPV integrity assessment concerning irradiation.

However, the HAZ used for the test coupon of SOP 0 has the highest RT_{NDT} = -5 °C of the monitored materials in the unirradiated state and is besides not considered as representative for the RPV rings with respect to its irradiation behavior due to its higher copper content compared to the RPV rings (the higher copper content results in conservative surveillance results at EOL). This may cause that the real HAZ of one of the RPV rings may be the leading material with the highest RT_{NDT} at EoL due to the highest initial RT_{NDT}. Even if this is not an issue for the surveillance program it might be an issue for the brittle fracture assessment of the RPV. Hence, this issue should be clarified, e.g. by data from the production control tests of the original weld if available.

In the following it is shown that the RT_{NDT} of the representative HAZ in the unirradiated condition is covered by the RT_{NDT} = -10°C of the BM Ring 03 which is the limiting material in the unirradiated condition and with respect to the irradiation behavior.

After a review of the manufacturing documentation (see attachment) following data were revealed for the representative HAZ in the PRV:

- In the acceptance test of the production control test coupon for the weld W03 the T_{NDT} of the “mitlaufende” coupon was ≤ -12 °C; the real T_{NDT} might be smaller since only a yes/no-testing at -7°C was performed (see page 5).

- The Charpy test results for the representative HAZ (e.g. at 0 °C SFA = 100 % and Kv = 22.7 kgm/cm^2 (=181.6 J), see page 5) are better as the HAZ of SOP 0 (at 0 °C SFA = 77 %, see page 8, and Kv = 148 J, see page 6). Thus the T_{68J} and $T_{0.9mm}$ (needed beside the T_{NDT} to determine RT_{NDT}) of the representative HAZ are lower than for the HAZ of SOP 0 with T_{KV} = -30 °C (see pages 6 and 7). *Remark: T_{68J} and $T_{0.9mm}$ are not determined for the representative HAZ since only tests at = 0°C were performed, see page 5.*

Based on the data above $T_{NDT} \leq$ -12 °C is the limiting temperature[1] and becomes RT_{NDT} for the representative HAZ. Therefore it is concluded that the RT_{NDT} at the initial state of the representative HAZ (≤ -12 °C) is smaller than the RT_{NDT} of the HAZ of SOP 0 (-5 °C) and particularly smaller than the one of BM Ring 03 (-10 °C) which is limiting in irradiation behavior. Thus the representative HAZ is not limiting neither for the unirradiated condition nor for the irradiated condition at EOL and needs not to be considered for the brittle fracture assessment of the RPV. The same conclusion can be drawn for the application of the RT_{T0}-concept because of the very low values of $RT_{T0j\ ART}$ based on the RT_{T0}-concept resulting in significant additional margins that is therefore not a critical issue as well.

Best regards,

[redacted]

Attachment
KCB Compliation HAZ base line data.pdf

[1] Following requirement of KTA 3203 is met: At a temperature not greater than T_{NDT} + 33 K each specimen of the notched-bar impact test (Charpy-V-notch specimen) shall normally exhibit at least 0.9 mm lateral expansion and not less than 68 J absorbed energy. When these requirements are met, T_{NDT} is the reference temperature RT_{NDT}.