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Subject: Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP

Dear Sirs,

We are now facing in Belgium a potential problem on the reactor pressure vessel (RPV) of the Doel 3 NPP. Non-destructive examination revealed a lot of "indications" that need to be confirmed by another inspection technique (ongoing).

We would like to have your feedback, experience and advice regarding this potential problem. You will find hereunder a more comprehensive background and some questions we would like to answer.

Best regards,

Pierre Briegleb
National Project Coordinator
Bel V – Subsidiary of the Federal Agency for Nuclear Control (Belgium)

Potential problem on the reactor pressure vessel

Belgian pressure vessels are inspected according to ASME XI. Volumetric inspections of the beltline zone are normally limited to the circumferential welds and surrounding heat affected zone and base material, within the limits settled by the code.

Additionally, as a result of the experience at Tricastin, inspections aiming at detecting possible underclad defects in the pressure vessel beltline region are planned for all Belgian plants. The first inspection of this kind took place at Doel 3 this summer.

These inspections are performed with a qualified method and encompass the whole height of the vessel beltline region. This means that we inspect clad base material in zones where no volumetric in-service inspection was performed up to now.

At Doel 3, according to the Owner, no underclad defects were detected.

Nevertheless, lot of defect indications of an apparently different type were detected by this UT-inspection aiming at detecting underclad defects, especially in one of the three forged rings (SA-508-cl.3). These indications appear to be laminar flaws, more or less parallel to the inner/outer surface of the pressure vessel, located in- and outside the inspected zone where underclad defects were looked at. Obviously, it is not possible to justify those indications on a one-by-one basis by means of an analytical evaluation according to the App. A of ASME XI code requirements.

The inspection method which revealed the presence of those defects has been qualified for detecting underclad defect.

An inspection of the whole height with the qualified method used to control the beltline welds started on the 16th of July; the results should not be available before begin of August. Similar inspections will be performed at Tihange 2 during the month of August.

In the absence of any other explanation at this stage, the Owner supposes to be in presence of fabrication defects.

The Doel 3 and Tihange 2 RPVs were forged by Rotterdam Dockyards (RDM), which according to the Owner provided some 24 vessels in Europe and the US. NUREG 1511 – Suppl. 2, p. 7-3, identifies 8 US units with RDM forged rings. Other European countries possibly concerned are Spain, Switzerland, the Netherlands (Borssele, Dodewaard), and probably others, not identified by Bel V at this stage.

Some questions:

1. Are there in your country RPVs (forged rings) fabricated by Rotterdam Dockyards (RDM)?
2. Is there any known concern with respect to fabrication defects in those rings?
3. Did you perform volumetric inspections in the beltline region which could have detected laminar defects in the beltline base material (a) during fabrication (b) in-service? If the answer is yes, describe which inspection (type, extent, frequency) and the corresponding results.
4. Do you perform inspections aiming at detecting underclad defects? If so, describe which inspection (type, extent, frequency) and the corresponding results.

Flaws indications in the reactor pressure vessel

Background

Belgian reactor pressure vessels (RPV) are inspected according to ASME XI. Volumetric inspections of the beltline area are normally limited to the circumferential welds (there are no axial welds in the Belgian RPVs) and surrounding heat affected zone and base material, within the limits set by the code.

Additionally, as a result of the experience at Tricastin, inspections aiming at detecting possible underclad defects in the pressure vessel beltline region are planned for all Belgian plants. The first inspection of this kind took place at Doel 3 this summer.

These inspections are performed with a qualified UT-method for detection of underclad defects, and encompass the height of the vessel beltline region. This means that clad base material was inspected where no volumetric in-service inspection was performed up to now.

Results of the inspection performed

At Doel 3, no underclad defects were detected.

Nevertheless, defect indications of an apparently different type were detected by this UT-inspection, especially in one of the three forged rings (SA-508-cl.3). These indications appear to be of a laminar type of flaw, more or less parallel to the inner/outer surface of the pressure vessel, located in and outside the inspected zone where underclad defects were looked at. Obviously, it is not possible to justify those indications on a one-by-one basis by means of an analytical evaluation according to the App. A of ASME XI code requirements.

Current investigations

In the absence of any other explanation at this stage, the Owner supposes the presence of fabrication defects.

Considering the limitations of the inspection method which revealed the presence of those defects, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV. Results will not be available before beginning of august.

The Owner is currently investigating the inspection results.

In parallel additional studies are being performed to analyze and, if possible, to validate and confirm the structural integrity of the vessel.

Similar inspections will be performed at another Belgian reactor vessel (unit 2Tihange NPP) during the upcoming outage within a few weeks (see hereunder).

Further information

Upper and lower vessel rings of the Doel 3 and Tihange 2 RPVs were forged by the Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM), at the same time and under the same contract.