

# Recommendation

# WENRA

## Recommendation in connection with flaw indications found in Belgian reactors

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WENRA  
Summer 2013

## 01 Background

1. Doel 3 and Tihange 2 are Pressurised Water Reactors (PWR) owned and operated by Electrabel in Belgium. During summer 2012 Electrabel completed the 30-year in-service inspection of the reactor pressure vessel (RPV) at Doel 3. These inspections identified a large number of flaw indications in the vessel wall, located principally in the base material of the lower and upper vessel ring forgings. These nearly laminar indications are mostly planar in orientation and have been assessed by Electrabel as originating from, “hydrogen flaking”, a metallurgical phenomenon that can occur during the steelmaking process.
2. FANC informed the WENRA members at the plenary meeting of 23-24 October 2012 on the state of the on-going investigations. It was decided that WENRA should decide on possible actions or recommendations as soon as the results of the Belgian investigations are available.
3. As soon as detailed and confirmed results were made available about the indications found at Doel 3, the Belgian nuclear safety authority (FANC) informed its counterparts in other countries. To increase transparency and cooperation between potentially interested countries and to benefit from external insights on the case, FANC decided in August 2012 to set up several national and international working groups. Three working groups were constituted of international experts made available by foreign nuclear safety authorities or related organizations and explored the following topics:
  - a. Non-destructive testing techniques;
  - b. Metallurgical origin of flaw indications;
  - c. Structural mechanics and fracture mechanics.
4. The suggestions, observations and conclusions of national and international working groups were evaluated by FANC. Wherever appropriate and relevant, FANC decided to use this input in the formulation of their conclusions and specific requirements for the licensee.

## 02 Safety verification of European RPV's in the light of findings in Doel 3 and Tihange 2

5. Based on the reports from Belgium<sup>1</sup>, some nuclear safety authorities have decided to request a safety verification of RPVs in their countries.
6. With the purpose of harmonizing the RPV related activities in Europe, WENRA recommends the nuclear safety authorities in Europe to take actions as outlined below.

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<sup>1</sup> <http://www.fanc.be/nl/page/dossier-pressure-vessel-doeel-3-tihange-2/1488.aspx?LG=2>

## 03 Recommendations to WENRA members

7. WENRA recommends the following two-step verification of materials quality and structural integrity of the RPV:

### Step 1: Comprehensive review of manufacturing and inspection records

8. The national nuclear safety authorities shall request the licensees to review and compile a chronological and comprehensive documentation of all processes and steps of the manufacturing and controls of the RPV forgings and to evaluate this documentation with respect to the hydrogen flaking issue. This evaluation shall cover at least:
  - a. All records and certificates of intermediate and final heat treatment, chemical analysis and impurity content requirements, material testing, and pre and in-service inspection results.
  - b. Identification of any potential non-conformity or gap in the documentation.
  - c. Records of the workshop and site inspections as required by the national nuclear safety regulations.
  - d. Surveillance approach in the workshop and on site; and inspection findings if required by the national nuclear safety authority.
  - e. The applied quality management system.

### Step 2: Examination of the base material of the vessels

9. WENRA recommends performing additional non-destructive testing to reassess the quality of RPV forging base material of the vessels. The decision as to whether this should be undertaken rests with the national nuclear safety authorities and will depend upon the strength of the information presented from the Step 1 review. This decision should also take account of the results of in service inspections, if any, and national or foreign experience feedback. The national nuclear safety authorities shall agree with the licensee, or specify, the testing scope, volume and non-destructive test method.
10. The following information should be taken as guidelines for the national nuclear safety authorities regarding additional non-destructive testing. The additional testing may be carried out in connection with the regular in-service inspection of the RPV. The inspections should cover a representative volume of RPV forging base material in areas known to be potentially susceptible to hydrogen flaking. If these inspections reveal evidence of hydrogen flaking the inspections should be extended appropriately. For inspection of the RPV forging material, a method should be used which has been demonstrated to be sufficiently sensitive to detect hydrogen flaking.

### Final considerations

11. Further measures are up to the national nuclear safety authority to decide upon. For example, extending the scope of analysis to other primary equipment (Steam Generators, Pressurizer).
12. The national nuclear safety authority should review the outcome of the work to address these recommendations.

**WENRA**

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WORKING GROUP ON WASTE  
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