



DIRECTION DES ÉQUIPEMENTS  
SOUS PRESSION NUCLÉAIRES

Montrouge, 26<sup>th</sup> September 2016

Chairman of AREVA NP  
For the attention of Madame De Bois  
Tour AREVA  
92084 PARIS LA DEFENSE CEDEX

**Subject:** Flamanville 3 EPR – Interim review of the approach to demonstrate the adequate toughness of the reactor pressure vessel upper and lower domes.

**References:** See appendix 1.

Dear Chairman,

For the purposes of technical qualification of the Flamanville 3 EPR reactor pressure vessel (RPV) upper and lower domes, the toughness values obtained, that were below the criteria set in point 4 of appendix 1 to the order in reference [1], led you in 2015 to propose an approach to ASN designed to demonstrate the adequate toughness of the material of these components with respect to the loadings to which they will be subjected or could be subjected in the event of an accident, as well as with respect to the manufacturing flaws potentially affecting them.

This approach was reviewed by ASN and IRSN, as written up in the report in reference [2] and was examined by the Advisory Committee for nuclear pressure equipment (GP ESPN) on 30<sup>th</sup> September 2015, which issued an opinion in reference [3].

On the basis of this review and this opinion, ASN issued a position statement regarding this approach and informed you of its requirements in the letter of 14<sup>th</sup> December 2015 in reference [4].

ASN informed you that, provided that its comments and requests are taken into consideration, it considered the demonstration approach to be appropriate, on condition that the phenomenon concerned is identified and explained and that the mechanical properties are sufficiently well understood. This approach was based on an experimental programme performed on scale-one replica domes (UK upper dome and UA lower dome).

The initial test results in early April 2016 led you to modify four aspects of your demonstration approach:

- extension of the test programme to a third scale-one replica dome (UA upper dome);

- extension of the tests to three-quarters wall thickness of the UA lower and upper scale-one replica domes;
- the situations and loads to be taken into account in the demonstration approach;
- the demonstration of the representativeness of the scale-one replica domes with respect to those of the Flamanville 3 EPR RPV.

The GP ESPN has been notified of the progress made on this subject since the GP ESPN session of 30<sup>th</sup> September 2015, and the changes you have made to the demonstration approach, via the summary note drawn up by ASN and IRSN in reference [5]. These points, along with the initial results of the experimental programme, were presented to the GP ESPN during its session on 24<sup>th</sup> June 2016. The GP ESPN informed ASN of its remarks (reference [6]).

The resulting detailed requests from ASN are appended.

**Examination of this dossier has aroused considerable interest on the part of the public, who have contacted ASN on numerous occasions to obtain documents issued by Areva NP. Given the high expectations expressed by the stakeholders during the course of the work of the HCTISN and discussions held with the representatives of the local information committees, I feel that it is vital that you prepare a public version of the dossier that you will be submitting to ASN, from which any confidential matters protected by law have been removed. I would ask you to ensure that the fact of removing information from the dossier in no way impairs its legibility.**

Yours sincerely,

**The Deputy Director General**

**Julien COLLET**

## Appendix 1 to letter CODEP-DEP-2016-031435

### References

- [1] Order of 30<sup>th</sup> December 2015 relative to nuclear pressure equipment
- [2] ASN/IRSN report reference CODEP-DEP-2015-037971 – IRSN/2015-00010 – Report to the Advisory Committee for Nuclear Pressure Equipment of 30<sup>th</sup> September 2015 - Analysis of the approach proposed by AREVA to demonstrate the adequate toughness of the Flamanville 3 EPR vessel bottom head and vessel closure head domes
- [3] ASN letter reference CODEP-MEA-2015-040055 of 1<sup>st</sup> October 2015 – Opinion and recommendations of the Advisory Committee for Nuclear Pressure Equipment of 30<sup>th</sup> September 2015
- [4] ASN letter reference CODEP-DEP-2015-043888 of 14<sup>th</sup> December 2015 – ASN position statement on the approach to demonstrate the adequate toughness of the Flamanville 3 EPR vessel bottom head and vessel closure head domes
- [5] ASN/IRSN report reference CODEP-DEP-2016-019209 – IRSN/2016-00005 – Summary report to the Advisory Committee for Nuclear Pressure Equipment of 24<sup>th</sup> June 2016 - Approach proposed by AREVA to demonstrate the adequate toughness of the Flamanville 3 EPR vessel bottom head and vessel closure head domes – Interim review
- [6] ASN letter reference CODEP-MEA-2016-027702 of 7<sup>th</sup> July 2016 – Observations of the Advisory Committee for Nuclear Pressure Equipment of 24<sup>th</sup> June 2016
- [7] AREVA letter reference ARV-DEP-2016-00532 of 20<sup>th</sup> July 2016 – FA3 vessel head domes – test specimens assessment protocol

## Appendix 2 to letter CODEP-DEP-2016-031435

### Requests

#### A. Mechanical analysis

##### 1. *Flaws analysed*

In the light of the initial results of the experimental programme, you completed the inventory of design transients, studying cold shock transients with a flaw at three-quarters thickness.

I consider that it is impossible to rule out the possibility of the impact strength values being significantly lower than 60 joules at 0°C over the entire thickness of the Flamanville 3 domes.

**Demande n° 1: In addition to the hypothetical flaw at three-quarters thickness, I would ask you to examine a hypothetical flaw under the inner skin.**

##### 2. *Specific mechanical analysis conditions*

I note that the initial  $T_{\text{NDT}}$  (nil ductility transition temperature) results in the segregated zone are higher than the values in the acceptance zone. The impact of the positive macrosegregation on the nil ductility transition reference temperature  $RT_{\text{NDT}}$ , to be examined in the light of requests 10 to 12 in the ASN letter in reference [4], is still to be determined.

I consider that the nature of the drop-weight tests used to determine  $T_{\text{NDT}}$ , which are crack propagation and not crack initiation tests, raises questions regarding the need to reinforce the conservative nature of the mechanical analyses for fourth-category situations, insofar as these situations lead to the transients which exert the highest loads on the equipment while at the same time being given the lowest safety coefficients.

**I consider that according to the  $RT_{\text{NDT}}$  values which will be determined in the segregated zone, the conservatism of the mechanical analyses for the fourth-category situations will need to be reinforced.**

#### B. Condition of the Flamanville 3 EPR reactor vessel domes

I consider that the analysis of the flaws close to the inner skin, requested earlier, must be supplemented by a check on the absence of such flaws in the components, by means of non-destructive testing.

You informed me that the vessel head on the Flamanville 3 EPR reactor had already undergone inspections to detect flaws under the skin.

**Demande n° 2: I would ask you to run non-destructive inspections to look for flaws under the inner skin of the Flamanville 3 EPR reactor vessel bottom head dome.**

### **C. Assessment of experimental programme test specimens**

I note that the initial toughness results at one quarter thickness of the UK upper dome that you presented to the GP ESPN at its session on 24<sup>th</sup> June 2016 meet the design values in accordance with the first paragraph of request n° 9 in the ASN letter in reference [4]. I note that these results still need to be supplemented by the material analysis at the different thicknesses adopted for each of the scale-one replica domes.

In addition to request n° 5 in the ASN letter in reference [4], I consider that the use of the toughness and impact strength results must include extensive metallographic and chemical assessments on broken test specimens.

**In this respect, I note your commitment to implement the assessment protocol described in the document in reference [7], on the selected toughness and impact strength test specimens and on the basis of precise criteria.**