ASN Opinion 2018-AV-0300 of 11 January 2018 concerning the safety options file presented by Andra for the Cigeo project for deep geological disposal of radioactive waste

The French nuclear safety authority (ASN)

Having regard to the Environment Code, in particular its articles L. 542-1-1, L. 542-1-2, L. 542-10-1, L. 542-12, L. 592-27 and L. 593-7;

Having regard to decree 2007-1557 of 2 November 2007 amended, relative to basic nuclear installations and to the regulation of the transport of radioactive materials in terms of nuclear safety, and its article 6 in particular;

Having regard to decree 2017-231 of 23 February 2017 implementing article L. 542-1-2 of the Environment Code and establishing the prescriptions of the National Plan for Radioactive Materials and Waste Management;

Having regard to the order of 7 February 2012, amended, setting out the technical rules relative to basic nuclear installations;

Having regard to the order of 15 January 2016, amended, relative to the objective cost of the implementation of long-term management solutions for high-level and intermediate-level long-lived radioactive waste;

Having regard to the order of 23 February 2017 pursuant to decree 2017-231 of 23 February 2017 implementing article L. 542-1-2 of the Environment Code and establishing the prescriptions of the National Plan for Radioactive Materials and Waste Management;

Having regard to ASN Resolution 2015-DC-0532 of 17 November 2015 relative to the safety analysis report for basic nuclear installations, more specifically its article 3.1.6;

Having regard to ASN Resolution 2017-DC-0587 of 23 March 2017, relative to the packaging of radioactive waste and the conditions of acceptance of the radioactive waste packages in the disposal BNIs;

Having regard to the ASN Safety Guide of February 2008 on the final disposal of radioactive waste in deep geological formations;

Having regard to the ASN opinion of 1 February 2006 on research into the management of high level, long-lived waste (HLW-LL) conducted within the context of the 30 December 1991 Act, and links with the PNGDR-MV;

Having regard to ASN opinion 2011-AV-129 of 26 July 2011 on the dossier relative to the reversible deep disposal of high and intermediate level long-lived waste submitted by Andra in accordance with Article 11 of Decree 2008-357 of 16 April 2008;

Having regard to ASN opinion 2013-AV-0179 of 16 May 2013 on the documents produced by Andra since 2009 concerning the project for deep geological disposal of radioactive waste;

Having regard to ASN opinion 2013-AV-0187 of 4 July 2013 on the transmutation of long-lived radioactive elements;

Having regard to ASN opinion 2015-AV-0227 of 10 February 2015 concerning the evaluation of the costs of the Cigeo radioactive waste deep geological disposal project;

Having regard to ASN opinion 2016-AV-0256 of 9 February 2016 on the studies submitted concerning the evaluation of the reusable nature of radioactive materials, pursuant to the National Plan for Radioactive Materials and Waste Management 2013-2015, with a view to drafting the National Plan for Radioactive Materials and Waste Management 2016-2018;

Having regard to ASN opinion 2016-AV-0259 of 25 February 2016 on the studies submitted concerning the management of high level and intermediate level long-lived waste (HLW and ILW-LL), pursuant to the National Plan for Radioactive Materials and Waste Management 2013-2015, with a view to drafting the National Plan for Radioactive Materials and Waste Management 2016-2018;

Having regard to ASN opinion 2016-AV-0264 of 29 March 2016 on the studies submitted concerning the management of low level long-lived waste (LLW-LL), pursuant to the National Plan for Radioactive Materials and Waste Management 2013-2015, with a view to drafting the National Plan for Radioactive Materials and Waste Management 2016-2018;

Having regard to ASN opinion 2016-AV-0267 of 31 May 2016 on the reversibility of radioactive waste deep geological disposal;

Having regard to the National Plan for Radioactive Materials and Waste Management (PNGMDR) 2016-2018;

Having regard to deliberated opinion 2016-036 of 20 July 2016 of the environmental authority concerning the National Plan for the Management of Radioactive Materials and Waste (2016-2018);

Having regard to the report from the Parliamentary Office for the evaluation of scientific and technological choices of 9 March 2017 on its assessment of the National Plan for Radioactive Materials and Waste Management 2016-2018;

Having regard to the results of the public debate on the radioactive waste reversible deep disposal facility project in Meuse/Haute-Marne (Cigeo) drawn up by the President of the National Public Debates Commission and published on 12 February 2014;

Having regard to ASN letter CODEP-DRC-2014-039834 of 19 December 2014 concerning the safety options of the Cigeo project;

Having regard to ASN letter CODEP-DRC-2015-004834 of 7 April 2015 concerning the "operational risks management" file;

Having regard to ASN letter CODEP-DRC-2016-034029 - ASND/2016-00930 of 26 September 2016 concerning the PNGMDR study: technico-economic assessment of a process for treatment of bituminous sludges by incineration/vitrification;

Having regard to Andra letter DG/17-0097 of 27 April 2017 transmitting its commitments with a view to the creation authorisation application for Cigeo;

Having regard to the safety options file submitted by Andra in letters DG/16-0105 of 6 April 2016, DG/16-0141 of 13 May 2016, DG/16-0156 of 24 May 2016 and DISEF/DIR/16-0116 of 6 July 2016;

Having regard to the review by experts from foreign safety regulators, organised by IAEA, of the safety options file for the radioactive waste deep geological disposal project: Cigeo - November 2016;

Having regard to the report from the national committee for research and studies on the management of radioactive materials and waste concerning analysis of the Cigeo 2016 documents and recommendations – November 2016;

Having regard to the opinion and recommendations of the Advisory Committees for waste and for laboratories and plants, regarding the Cigeo project's safety options file, drawn up following its meeting of 18 and 19 May 2017 on the basis of IRSN report 2017-00013;

Having regard to the results of the public consultation on the project organised from 1 August to 15 September 2017;

Having heard the Andra representatives on 6 July 2017;

Having heard the CEA representatives on 9 October 2017;

Whereas the management of radioactive waste is a nuclear safety issue and all of these wastes must have a safe management solution,

Issues the following opinion:

1) Concerning the radioactive waste inventory to be considered for the creation authorisation application of a deep geological disposal facility and for any applications for modification during operation

Whereas:

- Article L. 542-1-2 of the Environment Code states that *"ultimate radioactive waste which, for nuclear safety or radiation protection reasons, cannot be disposed on or near the surface, shall require deep geological repository";*
- Article L. 542-10-1 of the Environment Code states that *"Reversibility is implemented through incremental construction, the adaptability of the design and the flexibility of operation of a deep geological repository for radioactive waste, capable of incorporating technological progress and adapting to possible changes in the waste inventory, more specifically as a result of changing energy policy. It includes the possibility of retrieving waste packages from the repository under conditions and during a period of time that are consistent with the operating strategy and the closure of the repository";*

- Article D. 542-90 of the Environment Code states that *"The inventory to be considered by the National Radioactive Waste Management Agency with regard to the studies and research carried out for the design of the repository stipulated in article L. 542-10-1 comprises a reference inventory and a reserve inventory.*
  "The reserve inventory takes account of uncertainties, more specifically linked to the deployment of new waste management routes or changes in energy policy.
  "The repository is designed to accept waste from the reference inventory.
  "It is also designed by the National Radioactive Waste Management Agency, together with the owners of the substances in the reserve inventory, to be able to accept the substances which appear in this inventory, provided that, if necessary, changes could be made to its design during operation at an economically acceptable cost."

Whereas the principles presented by ASN in its above-mentioned opinion of 16 May 2013 concerning the radioactive waste inventory to be considered for the examination of a future creation authorisation application file remain valid;

Whereas the total quantity of waste to be disposed of in the Cigeo facility is assessed taking account of the inventory of waste produced until 2010 and an estimate of that produced after this period,

ASN considers that:

a) the method chosen for establishing the inventory of waste to be disposed of in the Cigeo facility adopted by Andra at the DOS stage is satisfactory;

b) this inventory, based on a 2011 industrial scenario, will nonetheless inevitably change and that the waste inventory to be used for the design of the facility and to be presented in the creation authorisation application shall be updated taking account of the work done within the framework of the PNGMDR and the above-mentioned ASN opinion of 16 May 2013, which more particularly states that *"this inventory should take account of all industrial strategies today being envisaged by the producers, in particular with regard to the operating life of the reactors and their power, as well as spent fuel management at CEA, incorporating wastes resulting from the processing of these fuels and, as necessary, fuels which would not be reprocessed"*.

c) at the facility creation authorisation application stage, Andra must present the reserve inventory adopted, in accordance with the abovementioned ASN opinion of 31 May 2016 and demonstrate that there is nothing to rule out the disposal of the waste from this reserve inventory.

2) Concerning the safety options file for the Cigeo radioactive waste deep geological disposal project

Whereas following the public debate prior to submission of the creation authorisation application file held in 2013 and stipulated by article L. 542-10-1 of the Environment Code, Andra decided to submit a safety options file to ASN as defined in article 6 of the above-mentioned decree of 2 November 2007 and whereas this approach is part of an incremental development process for the facility, consistent with the recommendations of the above-mentioned ASN Safety Guide of February 2008;

2.1) General observations

Whereas the safety options file more specifically shows that Andra has:

- acquired detailed knowledge of the Meuse/Haute-Marne site, enabling it to confirm the pertinence of the zone selected for siting of the repository;
- carried out numerous studies to characterise the evolution of the various components of the repository (packages, metal, cement and clay materials) and has acquired extensive knowledge on this subject;
- correctly identified and studied the disturbances (bacterial, organic, saline, etc.) which could affect the host rock, as well as the phenomena occurring during transients (thermal, hydraulic, mechanical, etc.), which would result from the siting of the repository. The results presented tend to indicate that their extent should be limited when compared with the thickness of the host rock;
- adopted principles that are on the whole satisfactory in the in-service and post-closure safety approach, consistently with the above-mentioned ASN Safety Guide of February 2008 and the work done by international organisations;

Whereas however there are still uncertainties, which are inherent at this stage of project development; additional studies and demonstrations are required in various fields, in particular concerning the representativeness of the hydrogeological model, corrosion phenomena, low-pH concretes, acceptable damage criteria for the rock and the evolution of clayey materials during the hydraulic-gas transient phase,

ASN considers that:

a) the project has on the whole reached satisfactory technological maturity at the safety options file stage;
b) the safety options file is documented and substantiated and constitutes a significant step forward by comparison with the "Clay 2005" and "Milestone 2009" files, which were the subject of the above-mentioned ASN opinions of 1 February 2006 and 26 July 2011 respectively.

2.2) Bituminous waste packages

Whereas bituminous waste packages represent 18% of the number of packages in the facility's reference installation; whereas uncertainties remain concerning the physico-chemical and thermal behaviour of these packages in the repository, in particular in an incident or accident situation leading to a temperature rise;

Whereas the design options adopted by Andra at this stage can neither preclude nor mitigate the risks to an acceptable level in the event of an exothermal reaction inside a bituminous waste package;

Whereas at this stage two main routes have been identified for the management of bituminous waste packages already conditioned: 1° the development of a process to neutralise the chemical reactivity of the packages, 2° substantial changes to the design options of the disposal facility to preclude the risk of runaway exothermal reactions in the event of a fire or temperature rise;

Whereas, in any case, the second solution could only be used for sufficiently characterised bituminous waste packages allowing modelling of their behaviour in the repository;

Whereas the management of bituminous waste packages is the subject of study requests covered by the above-mentioned order of 23 February 2017, in particular its articles 46, 47 and 48;

Whereas article 2.3 of the above-mentioned resolution of 23 March 2017 states that *the radioactive waste packaging operations allow the production of final packages of radioactive waste with appropriate physico-chemical stability confining the hazardous radioactive substances they contain. These operations are appropriate to the nature and characteristics of the radioactive waste and the disposal facility for which they are intended and must in particular take account of the risks linked to the action of chemical and biological agents, to the heterogeneity of the waste distribution and to the production of heat in this package".*

ASN considers that particular attention should be given to research on neutralising the chemical reactivity of the packages of bituminous waste. At the same time, studies to modify the design in order to rule out the risk of runaway exothermal reactions should be carried out. In any case, characterisation of these packages of bituminous waste by their producers as rapidly as possible is an essential precondition.

2.3) Subjects which could lead to design changes

Justification of the repository architecture

ASN considers it necessary that Andra study a repository architecture which reinforces the facility's overall confinement capacity, taking account of at least the following lines of defence and the combination thereof: the number and performance of the drift seals, the distance between the disposal areas and the base of the surface-bottom shafts and the positioning of the disposal areas in relation to the surface-bottom shafts.
The architecture adopted in the creation authorisation application will be justified by a study of the advantages and drawbacks of the various options, considering aspects relating to safety and radiation protection during operation and for the long-term.

Designing the facility to deal with hazards

ASN considers it necessary that, in the creation authorisation application, Andra should present and justify the hazard levels it considers, as well as the requirements, criteria and methods used to analyse the behaviour of the equipment and structures exposed to these hazards, both in operation and after closure, notably with regard to seismic hazard in the demonstration of safety after closure of the repository.

ASN considers it necessary that, in the creation authorisation application and for the design and sizing of the surface installation and unless justified otherwise, Andra should adopt a fire involving at least all the contents of the worst-case primary package.

Monitoring of the facility

Whereas the file examined provides little information concerning how Andra intends to exercise monitoring appropriate to the safety requirements in the operating and post-closure phases,

ASN considers it necessary that the creation authorisation application should present and justify the facility monitoring strategy and the means to be implemented.

Post-accident situations

Whereas the option of intervening and, as necessary, rehabilitating the facility is a priority to ensure the durability of the HLW and ILW-LL waste management route, for which Cigeo is the sole solution; whereas the elements presented in the safety options file have not fully addressed ASN's requests concerning the restoration of various functions of the repository following an accident situation, formulated in its above-mentioned letter of 7 April 2015,

ASN considers it necessary that, in its creation authorisation application, Andra should present the safety implications, both in operation and for the long-term, related to the restoration of various functions of the repository following an accident situation, as well as their consideration and implementation in the design of the facility, more specifically identifying:

- the possibility of continuing with disposal operations,
- the possibility of removing packages, whether or not involved in the accident situation,
- the possibility of implementing repository closure operations.

A conventional collapse scenario should also be postulated. The approach presented shall incorporate analysis of existing operating experience feedback on this subject.

3) Concerning the creation authorisation application

ASN considers that the creation authorisation application file should comprise a level of detail which, given the principle of reversibility and the planned development of the facility and in accordance with the provisions of article 3.1.6 of the above-mentioned ASN resolution of 17 November 2015, should provide a reasonable guarantee that the nuclear safety demonstration will be confirmed at the moment of submission of the version of the safety analysis report drawn up for the commissioning authorisation application for the part of the BNI concerned.

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This opinion will be supplemented by a letter sent to Andra specifying the satisfactory safety options and the additional studies and demonstrations necessary for the creation authorisation application.

Done in Montrouge, on 11 January 2018.

The ASN Commission,*

Signed by

Pierre-Franck CHEVET

Sylvie CADET-MERCIER Philippe CHAUMET-RIFFAUD Lydie EVRARD

**Commissioners present at the sitting*