AUTORITÉ DE SÛRETÉ NUCLÉAIRE

FOLLOW-UP TO
THE FRENCH NUCLEAR POWER PLANT STRESS TESTS

UPDATED NATIONAL ACTION PLAN OF THE FRENCH NUCLEAR SAFETY AUTHORITY

December 2014

TABLE OF CONTENTS

Legend:

General recommendation from the 2012 Peer Review

Peer Review:

Recommendation from the 2nd extraordinary meeting of the CNS in 2012

CNS:

Recommendation specific to France from the 2012 Peer Review

ASN requirement or letter

ECS xx : ASN requirement / ASN Letter

State of progress of actions monitored by ASN

State of progress : Study expected before…

INTRODUCTION

Information on the context and conclusions of the 2013 ENSREG seminar

On 26 April 2012, one year after the Fukushima Daiichi power plant accident, a joint statement by ENSREG (the European Nuclear Safety Regulators' Group) and the European Commission concluded the stress tests conducted on the European nuclear power plants. This statement emphasised the need to implement a global action plan to ensure that these stress tests would be followed by safety improvement measures at national level and that these measures would be implemented in a consistent manner.

The conclusions of the European Council meeting of 28 and 29 June 2012 confirmed the wish to see the creation of such a global action plan.

The global action plan developed by ENSREG dated 25 July 2012 provides for the nuclear safety regulator of each member country to publish a national action plan by the end of 2012, to make all these actions plans available to the public and to analyse each one of them in the course of a seminar attended by the safety regulators concerned.

This process was held under the auspices of ENSREG and the European Commission, who on 28 May 2013 adopted a report on the actions undertaken further to the Fukushima Daiichi accident.

This report was the result of a peer review of the national action plans prepared by the regulatory bodies of the 17 participating countries. This review, held between January and April 2013, mobilised experts from 24 countries and from the European Commission and was concluded by a seminar organised by ENSREG which brought together these experts in Brussels from 22 to 26 April 2013. Each regulatory body presented its national action plan and answered the questions raised by its counterparts and the public.

ENSREG's statement on the publication of its report is available on the ENSREG website[1]. For France, this report emphasized in particular the comprehensive nature of the action plan presented, the importance that ASN attached to the transparency of the stress test process, the ambitious nature of the content and the implementation times for the measures to improve safety in the nuclear power plants decided further to the Fukushima Daiichi accident, and the taking into account of organisational and human factors, including subcontracting conditions, in the stress test.

The report underlined the particular implications associated with the improvement of the existing reactor containment venting-filtration procedure and system, on which ASN will adopt a position once it has analysed the studies that EDF is to submit to it before the end of 2014.

Updating of ASN's national action plan

Further to the seminar organised by ENSREG in spring 2013, it was decided to organise a similar exercise two years later in order to conduct a first assessment of the implementation of the actions undertaken at national level as of 2012 following the stress tests.

For the regulatory bodies the aim is to update the action plan drawn up at the end of 2012 applying the recommendations of ENSREG. For France this update chiefly concerns the state of progress of the actions undertaken for the various prescriptions issued by ASN (text in red). Furthermore, in order to facilitate the work of the peer reviewers, the main changes have been summarized the beginning of section 1 and 2 of the action plan.

Consequently, this document follows the same structure as the action plan for France drawn up by ASN in 2012[2]. Moreover, in accordance with the guidelines defined by the ENSREG members for the updating of the action plans, France has voluntarily decided to present the transposition of the WENRA reference levels for the existing reactors in its regulatory framework (section 4).

---

[1] http://www.ensreg.eu/node/1343

[2] http://www.french-nuclear-safety.fr/Information/News-releases/European-stress-tests-ASN-publishes-its-national-action-plan

As with the preceding exercise, this updated action plan is intended to undergo a European-level peer review which will end with a seminar organised by ENSREG in spring 2015.

The main changes in the national action plan for France established by ASN, the French Nuclear Safety Authority.

ASN notes that to date EDF has met all the regulatory deadlines that have reached term, and its various commitments. Nevertheless, ASN has supplemented the prescription it issued in 2012 by a set of resolutions dated 21 January 2014 aiming to clarify certain design provisions of the "hardened safety core" (see § 1.1.1). These clarifications will lead to the organisation of several meetings of ASN's Advisory Committees of Experts as of 2015 in order to examine in detail the various studies carried out by EDF and enable ASN to adopt a position on those ones.

The summary report for France resulting from the seminar organised by ENSREG in 2013 underlined the ambitious nature of the implementation times for the measures to improve safety in the nuclear power plants decided further to the Fukushima Daiichi accident. To allow for the constraints associated with the engineering of these major works and the need to introduce the corresponding safety improvements as early as possible, their implementation is planned in three phases. Deadlines have been set for the accomplishment of phases 1 and 2, but the discussions on the implementation of the phase 3 provisions are not yet finalised and involve several meetings by the end of 2014 - early 2015.

Furthermore, this same report underlined the particular implications associated with the improvement of the existing reactor containment venting-filtration procedure and system. The studies demanded by ASN on this subject were submitted by EDF in compliance with the set deadlines. ASN moreover asked for the study of a solution enabling these filters not to be used in a severe accident situation. ASN will give an overall ruling after analysing these two studies (see § 1.2.9).

Since the 2013 seminar, France has continued to integrate the lessons learned from the Fukushima Daiichi accident and has undertaken work on nuclear emergency management which has resulted in a new national response plan for a major nuclear or radiological accident. This new plan reflects the government's determination to enforce tightened requirements in terms of safety of nuclear facilities and transport operations.

ASN has devoted considerable efforts to the work in the area of international management of radiological emergency situations through the task force created by HERCA and WENRA. This working group has the ambitious goal of harmonising population protection measures on either side of national frontiers.

As was the case with the Three Mile Island and Chernobyl accidents, it will very probably take several more years to acquire the in-depth experience feedback from the Fukushima Daiichi accident.

Nearly four years after the Fukushima Daiichi accident, the decision to put in place both permanent equipment to reinforce the robustness of the French nuclear facilities against beyond-design-basis external hazards and complementary external mobile equipment brought by the FARN can be considered to be a good practice.

In this spirit, ASN will continue to be particularly vigilant in monitoring the implementation of all the requirements it has prescribed and which are presented below. It will also continue to be actively involved at international level, particularly in the works undertaken on the European scale addressing the management of radiological emergency situations.

1 IMPLEMENTATION OF THE RECOMMENDATIONS RESULTING FROM THE EUROPEAN PEER REVIEW IN 2012

Further to the Fukushima Daiichi accident, ASN issued a set of resolutions dated 5 May 2011 asking the operators of major nuclear facilities to perform stress tests.

These were carried out on the basis of specifications which were consistent with the ENSREG specifications developed for the European stress tests.

The results of these stress tests were presented to the Advisory Committees of Experts for Reactors and for Laboratories and Plants which met on 8, 9, 10 November 2011, and ASN issued a position statement on them on 3 January 2012. This position was itself examined under the European stress tests which were completed in April 2012.

On the basis of the options of the Advisory Committee and the conclusions of the European stress tests, ASN issued a series of resolutions dated 26 June 2012 requiring EDF to set up firstly:

- a hardened safety core of material and organisational provisions aiming at:
  a) preventing an accident with fuel melt, or limiting its progression,
  b) limiting large-scale radioactive releases,
  c) enabling the licensee to perform its emergency management duties.
- a local emergency centre allowing emergency management of the nuclear site as a whole in the event of an extreme external hazard,
- a nuclear rapid intervention force (FARN) which, using mobile means external to the site, can intervene on a nuclear site in a pre-accident or accident situation.

And secondly, a set of corrective actions or improvements (notably the acquisition of communication and complementary radiological protection means, the implementation of complementary instrumentation, extensive consideration of internal and external hazard risks, improvement of the addressing of emergency situations), and studies of modifications and additional means enabling ASN to take a stance on future safety options.

ASN notes that EDF has met all the commitments and regulatory deadlines that have reached term.

Nevertheless, ASN has supplemented its demands with a set of resolutions dated 21 January 2014 aiming to clarify certain design provisions of the hardened safety core.

ASN's demands are part of a continuous process to improve nuclear safety with regard to the targets set for the 3rd-generation reactors, and aim in addition to be able to cope with situations far beyond those normally considered for this type of installation.

These demands are issued in application of the defence-in-depth approach and as such concern measures to prevent and mitigate the consequences of an accident, based on both additional fixed means and external mobile means planned for all the installations on a site beyond their initial design basis.

Given the nature of the required works, the licensee must carry out studies for the design, construction and installation of new equipment structures, which require firstly time and secondly a schedule to optimise their implementation on each nuclear power plant. Insofar as these major works are carried out on nuclear sites which are in service, it is also necessary to ensure that the safety of the power plants is not reduced during the work phases.

To take account of both the engineering constraints involved in these major works and the need to introduce the post-Fukushima improvements as soon as possible, their implementation by EDF is planned in three phases.

Phase 1 (2012-2015): implementation of temporary or mobile measures to enhance protection against the main situations of total loss of the heat sink or electrical power supplies:

- reinforcing of the existing on-site emergency equipment (pumps, generator sets, hoses, etc.),
- installation of medium-capacity ultimate backup diesel-generator sets,
- reinforcing of the earthquake resistance (SSE) and flood resistance (maximum thousand year flood) of the emergency management premises,
- installation of tappings for connecting mobile equipment, particularly FARN's equipment,
- deployment of the FARN (it is already capable of intervening on a 4 plant-unit site, and by the end of 2015 it will have a 6 plant-unit intervention capability),
- implementation of an automatic reactor trip in the event of an earthquake,
- installation of electrically backed-up level measurement instrumentation in the pools.

The progress of the work on the sites is in phase with this deployment programme and the deadlines set by the ASN prescriptions.

Phase 2 (2015-2020): implementation of definitive design and organisational means that are robust to extreme hazards, such as the fundamental elements of the hardened safety core designed to respond to the main situations of total loss of the heat sink or electrical power supplies beyond the baseline safety requirements in force:

- installation of a large-capacity ultimate backup diesel-generator set, including the construction of a dedicated building to house it,
- setting up of a dedicated ultimate water source,
- setting up of an ultimate water makeup source for each reactor (on the PTR[3] reservoir and the steam generator auxiliary feedwater supply systems) and each pool,
- reinforcing of the earthquake resistance of the containment venting filter,
- installation of sodium tetraborate baskets to reduce the emission of gaseous iodine in a severe accident situation on reactors that do not have SIC (silver-indium-cadmium alloy) control rod clusters,
- installation of the first protections against extreme flooding (high-intensity rainfall and earthquake-induced rupture of tanks) in addition to the existing protected volume measures,
- implementation of means for detecting reactor vessel melt-through or the presence of hydrogen in the containment
- start of installation of passive tightness systems for the seals of the reactor coolant motor-pumps,
- installation of the first devices to prevent, in the event of a break in the transfer tube or the pool compartment drainage pipes, exposure of the fuel assemblies during handling and enable them to be placed in a safe position using the emergency manual controls,
- reinforcing of the operating teams to be capable of managing all the extreme situations studied in the stress tests,
- construction on each site of an emergency centre capable of withstanding extreme external hazards (functionally independent in an emergency situation).

EDF has already started the majority of the studies necessary for the implementation of these measures (level of seismic risk to take, ultimate backup diesel-generator sets, electrical distribution and instrumentation & control of the hardened safety core, on-site pumping tests for the ultimate heat sink, on-site emergency centre, etc.). ASN has adopted a position on the options chosen by EDF for the design and construction of these elements on the basis of the available information, prior to submission of the modification notifications by EDF. Nevertheless, discussions on the implementation of the phase 2 provisions on each of the EDF reactors are not yet finalised and involve several meetings by the end of 2014.

The baseline requirements produced by EDF will be examined during meetings GP1 and GP2 of the Advisory Committee of Experts for Reactors (GPR), described below.

[3] PTR: three-letter code for "Reactor cavity and spent fuel pool cooling and treatment system"

Phase 3 (as from 2019): this phase supplements phase 2, in particular to improve the level of coverage of the potential accident scenarios considered. EDF indicates that these means have also been defined with a view to continuing operation of the reactors beyond forty years:

- removal of the residual power by the steam generators by means of an independent ultimate backup feedwater system supplied by the ultimate heat sink,
- addition of a new makeup pump to the primary system,
- finalisation of the ultimate makeup connections - through fixed circuits - to the steam generator auxiliary feedwater supply system, to the PTR tank and to the spent fuel pool,
- installation of an ultimate instrumentation & control system and the definitive instrumentation of the hardened safety core,
- installation of a reactor containment ultimate cooling system (that does not require opening of the containment venting-filtration system),
- implementation of a solution for flooding the reactor pit to prevent corium melt-through of the basemat,
  (EDF still has to conduct feasibility studies on these latter two points).

The discussions on the implementation of the phase 3 provisions on each of the EDF reactors are not yet finalised and will form the subject of several meetings in 2015.

The baseline requirements produced by EDF will be examined at the GPR's meetings (GP3 and GP4) described below.

Planned examination for the reactors in operation

The setting up of this hardened safety core, and the provisions of phase 2 and 3 in particular, requires validation of the design hypotheses for the material provisions, verification that the solutions proposed by the licensee will meet the safety objectives set and they are technologically achievable.

On the basis of the file submitted by EDF and the studies still to be carried out, ASN will ask the GPR for its opinion on the most important points in these files. To date, 5 meetings of the GPR are envisaged

Extreme natural hazards (meeting GP1)

The GPR will be consulted on the defining and justification of the levels of the natural hazards adopted by EDF for the hardened safety core of the PWRs. The natural hazards considered on the basis of the stress test specifications are earthquakes, flooding and "other natural hazards".

Projected date of meeting: mid-2015

Control of accidents (GP2)

The examination will focus primarily on the strategies for operational management of accidents that can occur on the reactor, the pool and on the functional adequacy of the equipment (new or existing) for the accidents.

Projected date of meeting: mid-2015

Control of severe accidents (GP3)

The examination will focus on the new measures proposed by EDF to mitigate the consequences of a core meltdown accident in the short and long term.

The GPR will be required to give its opinion on the principle of these modifications, in relation to the objective of integrating the lessons learned from the Fukushima Daiichi accident and the reduction in the difference in the level of safety between the reactors in operation and the safety objectives adopted for generation 3 nuclear reactors.

The principles of the new measures proposed by EDF will be presented:

- measures adopted to remove the residual power from the reactor containment and the functional and design requirements of the systems used (containment venting-filtration system, containment ultimate spraying system, etc.),
- measures adopted by EDF to limit as far as reasonably possible the risk of basemat melt-through in the event of a core meltdown accident,

- accident situations covered by the measures (robustness against hazards, situations that might be excluded, etc.),
- optimisation of the measures adopted to limit as far as reasonably possible radioactive discharges into the environment and the possibilities of cliff-edge effects during the progression of an accident.

Projected date of meeting: early 2016

Ability to manage complex accident situations (GP4)

The Fukushima Daiichi accident highlighted the difficulties inherent to the management of a nuclear accident under extreme conditions (destruction of part of the facilities, loss of backup and operational control systems, intervention in a radiation-emitting environment, management of contaminated waters, etc.). Appropriate management of the accident is dependent on the possibility of making efficient use of robust equipment and on the management of the teams dealing with the situation. The GPR will be consulted on the questions relating to the effectiveness of the material and organisational measures implemented by EDF on each nuclear power plant site.

The following will be presented at this meeting of the GPR:

- the organisational and managerial measures planned by EDF to cope with a complex accident situation (in particular the prioritised management of the different types of action to be accomplished on the nuclear power plant site, the adequacy of the procedures and the operational control guides, the complementarity between the means of the site and those of the FARN),
- the sufficiency and robustness of the fixed and mobile equipment,
- the measures planned for human intervention under adverse conditions, the link between each site's own resources and the FARN resources, and the management of contaminated waters.

Projected date of meeting: 2017

Assessment of the stress tests(GP5)

It would in principle seem necessary to have one or more meetings of the GPR, in the same way as for a periodic safety review, to assess the actions resulting from the stress tests.

Projected date of meeting: 2018

Planned examination for the Flamanville 3 EPR reactor

For the EPR reactor under construction in France, the examination concerning the defining of the extreme natural hazards to be considered for the hardened safety core will be carried out in conjunction with the GP1 planned for the reactors in operation. The subjects covered by meetings GP2 to GP5 will mainly be taken into account in the examination (planned) of the commissioning authorisation application for this reactor.

1.1 NATURAL HAZARDS

1.1.1 Hazard frequency

Peer Review: *The use of a return frequency of 10^{-4} per annum (0.1g minimum peak ground acceleration for earthquakes) for plant reviews/ back-fitting with respect to external hazards safety cases.*

CNS: *Re-evaluating the hazards posed by external events, such as earthquakes, floods and extreme weather conditions, for each nuclear power plant site through targeted reassessment of safety.*

Recommendation specific to France from the 2012 Peer Review

The review team recommends ASN to consider introducing probabilistic studies on the seismic hazard in France for the design of new reactors and for the next seismic hazard reviews for reactors in operation in order to have information on the probability of the event (annual frequency of occurrence) and to establish more robust bases for defining the design-basis earthquake.

ASN position and progress

The methodology used in France to assess natural hazards is based essentially on a deterministic approach. The most penalising historical event based on a given period of observation - usually one hundred or one thousand years – is considered, to which large conventional margins are added. This approach is supplemented by probabilistic safety assessments (PSA) based on a systematic investigation of the accident scenarios to evaluate the probability of them leading to unacceptable consequences.

The external hazards are reassessed periodically in the periodic safety reviews conducted every 10 years. Moreover, the external hazards, particularly earthquakes and flooding, were the subject of a targeted reassessment as part of the stress tests conducted in France in 2011.

In view of the available elements of comparison and the improvements made to the reactors during the safety reviews, implementation of the chosen methodology for earthquakes and flooding leads to a very demanding level of safety for the identification of the need and nature of the modifications considered.

With regard to earthquakes, the methodology currently used to determine the seismic risk in France complies with the methodology and criteria prescribed by the IAEA. Pursuant to the IAEA recommendations, its sets a minimum overall site response spectrum of 0.1 g peak ground acceleration (PGA) value with infinite frequency. In the framework of the current periodic safety reviews (third safety reviews of the 1300 MWe plant units), ASN has asked EDF to supplement this procedure by using probabilistic methods to complement the seismic hazard analysis.

In 2013 the methodology proposed by EDF (for the development of an experimental probabilistic seismic safety study for the Saint-Alban NPP) was discussed in the meetings of the Advisory Committees of Experts, which concluded that the works should be continued with the aim of developing a method that can be used in the next periodic safety reviews. The Advisory Committee has more specifically underlined the need for additional analyses concerning the seismic hazard evaluation, the defining of the various equipment and structure failure modes and the extent of the equipment that must be covered by fragility curves taking into account the various failure modes.

ASN shall moreover ensure that the overall seismic design or justification process for the facilities – with regard to the definition of the hazard and the design and inspection methods for the equipment and specific structures - is conservative and cautious. Where seismic risks are concerned, the demonstration of safety comprises two separate steps (the definition of the hazard at the design and inspection for the equipment and specific structures); the conservatism of the paraseismic justification approach must be assessed on the basis of these two steps. A specific feature of the French approach in the paraseismic domain consists, as a conservative measure, in not voluntarily using methods that allow the impact of the earthquake on the equipment and structures to be reduced, even if these factors are founded on experimental or scientific bases (for example, the non-use or partial use of behaviour coefficients). The prudence introduced by this approach allows a conservative delineation of the first areas of the facility that would be affected by an earthquake so that their reinforcement can be requested.

In addition, within the framework of the post-Fukushima measures, ASN has asked EDF to establish a hardened safety core of material and organisational provisions aiming at:

- preventing an accident with fuel melt, or limit its progression,
- limiting large-scale radioactive releases,
- enabling the licensee to perform its emergency management duties.

Through a set of resolutions dated 21 January 2014, ASN has set the seismic hazard, defined by a response spectrum, to be considered for the SSCs (systems, structures and components) of the hardened safety core as :

- encompassing the safe shutdown earthquake (SSE) for the site, plus 50%;
- encompassing the probabilistic site spectra with a return period of 20,000 years;
- and taking into account the particular site effects, in particular the nature of the soil, in its definition.

For the new hardened safety core SSC, the licensee adopts a spectrum higher than the response spectrum defined above.

ASN has therefore introduced a probabilistic component with a return period of 20,000 years into the definition of this hazard;

With regard to the flood risk, ASN published in 2013 a new guide concerning the external flood risk for nuclear facilities. The principles adopted for the development of these guides follow on from those of RFS I.2.e[4] and the approach resulting from experience feedback from the Blayais site flood in 1999. This guide substantially reinforces the recommendations for the protection of BNIs against flooding with respect to RFS 1.2.e. The hazards to take into consideration are defined on the basis of an in-depth assessment of knowledge in the different areas concerned, and in hydrology and meteorology in particular; the guide thus recommends considering 11 different phenomena. It is based on deterministic methods, incorporating allowances and combinations integrated in the hazards, taking into account a "probabilistic" exceedance target of 10^{-4} per year.

The return period considered for other extreme climatic conditions is more variable.

As part of the design approach for the hardened safety core, EDF specified the hypotheses it was adopting for hazards other than earthquakes and flooding. ASN will ask the GPR for its opinion on the risk levels of the extreme natural hazards considered for the hardened safety core; The GPR is to give its opinion by the end of June 2015.

ASN notes that a WENRA sub-group has been set up to define a methodology framework which could be followed in the reference levels for taking the natural hazards into account. ASN and the IRSN are active members of this sub-group.

State of progress:

Therefore, in 2013 and 2014 ASN:

- set the seismic level of the hardened safety core SSCs (envelope of deterministic criteria and a probabilistic definition with a return period of 20,000 years).
- published a new guide on taking account of the external flood risk for nuclear facilities.
- adopted a position on the procedure proposed by EDF for the probabilistic seismic safety studies. The methodological developments must be continued so that such a study can be implemented in the framework of forthcoming periodic safety reviews.
- examined the necessary changes in the regulations to integrate the new WENRA reference levels for external hazards.

[4] Fundamental safety rule (RFS) No. 1.2.e of 12/04/1982 relative to consideration of the risk of flooding of external origin.

1.1.2 Secondary effects of seismic events

Peer Review: *The possible secondary effects of seismic events, such as flood or fire arising as a result of the event, in future assessments.*

The indirect (secondary) effects of seismic events have been examined as of the second 10-year outage of the 900 MWe reactors in the framework of the periodic safety reviews. They were the subject of additional studies as part of the French stress tests, focusing on the "seismic interaction" approach[5], loss of the off-site electrical power supplies, the conditions of site access after an earthquake, the fire and explosion risks induced by an earthquake, and the flooding risks induced by an earthquake (failure of dams, embankments, circuits or equipment). The analysis of this work led ASN to set the following requirements and formulate demands complementary to those expressed during the periodic safety reviews, and particularly to study the behaviour of these structures beyond their design baseline requirements.

ASN requirement

ECS – 11: Robustness of the Fessenheim and Tricastin embankments

ASN has asked EDF to submit a study to it before 31 December 2013, stating the level of seismic robustness of the embankments and the other structures protecting the facilities against flooding and, according to this level of robustness, presenting:

- the consequences of a failure of these structures,
- the technical solutions envisaged to protect the equipment of the hardened safety core which is the subject of requirement [ECS-1].

State of progress:

The licensee submitted the synthesis of its studies at the end of 2013. The studies necessitated additional analyses, including more specifically surveys of the *in situ* structures to ascertain that the studies were appropriate for the structures such as they actually exist. ASN has tasked IRSN, its technical support organisation, with conducting an appraisal of these elements relating to the robustness of the embankments and other protective structures against earthquakes, the conclusions of which should be available at the end of the first quarter of 2015.

ASN requirement

ECS – 9: Reinforcement of the seismic interaction approach

No later than 31 December 2012, the licensee shall take the necessary steps to prevent equipment whose operational availability is required for the safety demonstration from being damaged by other equipment items in the event of an earthquake.

The licensee shall submit to ASN an intermediate review of application of this approach before 20 June 2013, and a final review before 31 December 2013.

State of progress:

In addition to applying the seismic interaction approach already in effect since the second ten-year outages of the reactors (and which has already been subject to ASN inspections), EDF has extended its approach to include additional phases, such as certain site preparation phases. This new baseline is gradually coming into effect on the sites after an adaptation phase to allow the personnel and 1st-tier subcontractors to embrace the change in practices.

In addition, EDF has drafted specific guides for its sites to enable them to orient the on-site inspections on the seismic interaction approach to take into account beyond design conditions.

[5] The "seismic interaction" procedure aims to prevent, in the event of an earthquake, necessary equipment from being damaged by non-seismic classified equipment or structures.

ASN requirement

ECS - 12: Verification of the seismic design basis of the fire-fighting system

Before 30 December 2012, the licensee shall submit to ASN:

- a study evaluating the resistance to a safe shutdown earthquake (SSE) of the structures and equipment contributing to nuclear safety, fire sectoring, fire detection and fixed extinguishing systems, subject to an operating basis earthquake resistance requirement,
- for items for which the ability to withstand the SSE cannot be proven, a programme of modifications to guarantee protection of fire safety functions in the event of an SSE.

State of progress:

EDF has submitted the required studies and proposed a programme of modifications aiming to ensure the seismic resistance of its facilities at these increased levels. These modifications will be carried out during the periodic safety reviews of the reactors concerned.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

Seismic resistance of hydrogen systems and lines carrying hydrogen

Application of the safe shutdown earthquake (SSE) design requirement to the hydrogen systems and integration of the "seismic interaction" approach for lines carrying hydrogen in the nuclear island is scheduled (in progress on the N4 plant series).

Fleet-04: ASN asks you to speed up application of the SSE design-basis requirement to hydrogen systems and the integration of the "seismic interaction" approach for lines carrying hydrogen. Before the end of 2012, you will send me a revised implementation schedule.

Fleet-05: ASN asks you to guarantee the SSE resistance of this equipment and to supplement the future baseline requirements accordingly.

State of progress:

Schedule submitted, the upgrading deadlines have on average been met 3 years earlier than specified in the initial programme (the work is finished on the CP0 & N4 plant series and will be completed in 2017 on the CPY series, 2018 on the P4 series and 2020 on the P'4 series).

Flooding caused by an earthquake

For the Gravelines site, the retaining walls along the sides of the intake channel need to remain stable in order to guarantee the heat sink flow. This point was evaluated on the occasion of the 3rd ten-year outages.

GRA-07: ASN asks you to perform additional studies to examine the behaviour of this channel beyond the SSE, for the fixed-level earthquakes used in the design sizing of the hardened safety core.

State of progress:

The studies have demonstrated the stability of the intake channel to the SSE.

For the Flamanville, Paluel and Penly sites, EDF has studied design-basis flood scenarios such as a flood caused by loss of integrity of the raw water ponds (SEA – demineralisation plant water supply system). EDF considers that the stability of the ponds is guaranteed for an earthquake larger than the SSE.

ASN considers that EDF needs to guarantee the ability of these ponds to withstand an earthquake larger than the SSE, in particular as they are relied on as the ultimate make-up source.

FLA-08 PEN-08 PAL-08: ASN asks you to justify the leak-tightness of these ponds for an earthquake larger than the SSE, and for the fixed-level earthquakes used in the design sizing of the hardened safety core.

State of progress:

These points will be verified as part of the validation of the choice of ultimate heat sink required for the setting up of the hardened safety core.

Risk of emptying of a channel onto the site

For the Tricastin, Fessenheim and Bugey NPPs, where the heat sink is at a higher elevation than the site platform, there is a risk of a major leak in the event of rupture of the cooling systems (CRF) of the facilities connected to it.

Even though, during the investigation, EDF stated that the valves can in all situations isolate the system from the heat sink, a study programme was initiated in order to improve the robustness of these shut-off valves up to a beyond-baseline level to be defined.

TRI-13 FSH-13 BUG-13: ASN asks you to take account, in the above-mentioned study, of all elements (sensors, automation, valves, part upstream of valves, etc.) designed to guarantee stoppage of emptying of the channel onto the site in the event of failure of the cooling system.

State of progress:

In the first half of 2015, as part of the examination of the hardened safety core, ASN will adopt a position on the studies submitted by EDF. The time frame is linked in particular to the need to take additional measurements on the structures to verify their conformity with the safety justification file.

1.1.3 Protected volume approach

Peer Review: *The use a protected volume approach to demonstrate flood protection for identified rooms or spaces.*

Following the flooding of the Blayais site in 1999, EDF put in place a protected volume perimeter[6] on all the sites. The conformity of this protected volume was specifically inspected by ASN during the targeted inspections conducted in 2011, resulting in demands from ASN. In spring 2012 the licensee submitted an overall analysis of the responses to the observations raised by ASN, which ASN judged satisfactory.

In the framework of the stress tests, ASN has set the following requirements.

ASN requirement

ECS - 4: End of the work relating to the Blayais experience feedback (Blayais, Bugey, Cruas, Dampierre, Gravelines, Penly, Saint-Laurent-des-Eaux, Tricastin sites)

Before 31 December 2014, the licensee shall carry out work to protect the facilities against flooding, as mentioned in note ETDOIL080038 G.

State of progress:

- 31/12/2013: End of the works on the Saint-Laurent-des-Eaux site further to the Blayais experience feedback (REX)
- 31/12/2014: End of the works scheduled further to the Blayais experience feedback on the Blayais, Bugey, Cruas, Dampierre, Gravelines, Penly, and Tricastin sites

ASN requirement

ECS – 5: Conformity of the protection volume

No later than 30 June 2012, the licensee shall carry out work to ensure conformity of the protection volume mentioned in report D4550.31-12/1367- Revision 0. The licensee shall implement the organisation and the resources as described in the above-mentioned document D4550.31-06/1840 revision 0 of 12/10/2007 to ensure that, with the passage of time, the protection volume retains its efficiency as assigned in the safety demonstration.

[6] The protected volume perimeter, which encompasses the buildings containing the equipment guaranteeing the safety of the reactors, has been defined by EDF so as to guarantee that water ingress from outside this perimeter does not lead to flooding of the premises situated within this perimeter.

State of progress:

Work to restore conformity completed on 30/06/2012. In addition, EDF has updated its baseline requirements for the periodic internal inspection of the protection volume.

1.1.4 Rapid alert notifications

Peer Review: *The implementation of advanced warning systems for deteriorating weather, as well as the provision of appropriate procedures to be followed by operators when warnings are made.*

The licensee has applied operating measures aiming to protect the sites against extreme meteorological conditions (floods, heat waves, extreme cold weather, drought, etc.), including alert systems in the event of a foreseeable hazard (failure of a retaining structure upstream of the site, riverside or coastal flooding, possibly combined with extremely high winds, rainfall) and agreements with outside organizations such as Météo France and the Prefecture. ASN checked that these systems were operational during the targeted inspections carried out in 2011. The conclusions of these inspections led ASN to set the following requirement for the Cruas and Tricastin sites.

ASN requirement

ECS - 7: Measures to cope with site isolation in the event of flooding (Cruas, Tricastin sites)

Before 31 December 2012, the licensee shall demonstrate to ASN that it has implemented an organisation and resources able to deal with site isolation in the event of flooding.

These measures serve to overcome the lack of resources and provide for the monitoring of certain meteorological and hydrological parameters, among other things. The use of special operating rules is decided on the basis of predetermined meteorological or hydrological criteria (monitoring or rivers levels or sea level) to allow the safe shutdown of the reactors.

State of progress: Action completed.

1.1.5 Seismic instrumentation

Peer Review: *The installation of seismic monitoring systems with related procedures and training.*

Recommendation specific to France from the 2012 Peer Review

The seismic instrumentation could be improved to reach a level corresponding to the state of the art. It is recommended to consider revising the corresponding basic safety rule RFS 1.3.b (1984).

The operating conditions of the seismic instrumentation installed on the sites were specifically verified by ASN during the targeted inspections conducted in 2011. The findings led ASN to set requirements obliging the seismic instrumentation to bring into conformity with the recommendations of RFS I.3.b[7]. ASN moreover asked EDF to conduct a comparative study of the instrumentation currently used in France with that used internationally, to determine whether the French instrumentation is still suitable for measuring the seismic hazard or whether it needs to be replaced, in the light of more recent scientific knowledge.

ASN requirement

ECS – 8: Conformity of seismic instrumentation with RFS 1.3.b

Before 30 September 2012, the licensee shall check the conformity of its facilities with the provisions of RFS I.3.b, the application of which is stipulated in the safety analysis report. The licensees shall submit to

[7] Basic safety rule (RFS) I.3 b of 08/06/1984 concerning seismic instrumentation;

ASN an exhaustive summary of this review and the corrected deviations, plus a plan of action listing the correction time-lines for any remaining deviations.

State of progress: Action completed.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

Fleet 09: ASN asks you, before 30 June 2013, to carry out a study to compare the seismic instrumentation currently used in France with that used internationally. This study shall enable you to determine whether the instrumentation used in France is still suitable for measuring the seismic hazard or whether it needs to be replaced, in the light of more recent scientific knowledge.

By the same deadline, you will present the conclusions you draw from your study and will, as necessary, propose an appropriate plan of action along with time-lines.

State of progress:

EDF's studies have been submitted. ASN considers that the technology used enables these equipment items to fulfil their assigned safety function satisfactorily.

Revision of RFS I.3.b

ASN will also consider revising the basic safety rule in the light of the results of EDF's ongoing seismic instrumentation evaluation.

State of progress:

In view of the files submitted by EDF, the bringing into conformity of the noncompliant instrumentation and the fact that the safety function of this measurement is a simple threshold measurement, ASN considers that updating of the basic safety rule relative to the seismic instrumentation is not a priority.

1.1.6 Specific inspections and verifications of facilities

Peer Review: *The development of standards to address qualified plant walkdowns with regard to earthquake, flooding and extreme weather – to provide a more systematic search for non-conformities and correct them (e.g. appropriate storage of equipment, particularly for temporary and mobile plant and tools used to mitigate beyond design basis (BDB) external events).*

At the request of ASN, the licensee has set up processes for detecting deviations during normal reactor operation, periodic checks, maintenance operations, conformity reviews and safety assessments during the periodic safety reviews. These processes particularly concern the material and organisational measures implemented in the event of an earthquake, flooding, or other hazards. These processes for systematically seeking deviations have resulted in hazard protection reinforcements. For example, in 2009 EDF informed ASN of the presence of noncompliant plugs on metal gratings in the operating buildings of several 900 MWe reactors. Correction of these deviations was completed in August 2010. More recently, in November 2012, EDF informed ASN of a deviation in earthquake resistance concerning the electrical cabinets of some of the 900 and 1300 MWe reactors. If these cabinets were to fall in the event of an earthquake, they could affect important electrical cabinets, some of which monitor the state of parameters necessary for incident operational management after an earthquake. The licensee has undertaken to take compensatory measures in these NPPs to protect the important equipment against the falling of these cabinets.

Following the Fukushima Daiichi accident, ASN conducted a series of targeted inspections applying specific inspection guides, for which its conclusions and resulting demands can be consulted on its website (www.asn.fr). These demands, which are associated with specific time-lines, concern deviations relative to earthquake resistance, protection against flooding and other hazards. These demands are specifically monitored by ASN, and their implementation is verified during future targeted or routine inspections.

Furthermore, the stress tests gave the licensee the opportunity to conduct specific investigations into the condition of its facilities, including on-the-ground verifications of the true condition of the facility.

Lastly, the order of 7 February 2012[8] has toughened the requirements applicable to the detection and handling of deviations; these regulatory provisions came into force on 1 July 2013. ASN will also publish by the end of 2014 or early 2015 a guide detailing the new requirements introduced by the order of 7 February 2012 related to the remediation of deviations, particularly with regard to the deadlines for remedying the deviations.

1.1.7 Assessment of margins with respect to the flood risk

Peer Review: *The analysis of incrementally increased flood levels beyond the design basis and identification of potential improvements, as required by the initial ENSREG specification for the stress tests.*

For the various hazards considered for each site, the licensee has presented the margins between the flood level reached and the level of the protections, in the framework of the current design, and drawn conclusions regarding the additional measures to be taken, where applicable. The licensee has also studied several situations which it considers representative for evaluating the cliff-edge effects. These situations use assumptions that go beyond the design basis. This work gave rise to the following recommendation to reinforce the robustness of the installations in order to prevent the cliff-edge effects associated with heavy rainfall, or the failure of equipment on the site as a result of an earthquake.

ASN requirement

In addition to the requirement on the hardened safety core presented section 1.2, ASN has also issued a specific requirement to EDF relating to the protection of the facilities against flooding beyond the baseline requirement.

ECS – 6: Reinforcement of protection against flooding

Before 31 December 2013, the licensee shall present ASN with the modifications it intends to make to reinforce, before 31 December 2017, the protection of the facilities against the risk of flooding beyond the baseline requirement in effect on 1 January 2012, for example by raising the protection volume to protect against situations of total loss of the heat sink or electrical power supplies, for the beyond-design-basis scenarios, such as:

- maximum rainfall,
- flooding resulting from failure of on-site equipment under the effects of an earthquake.

State of progress:

- 31/12/2013: Presentation of the modifications, in compliance with the requirement.

Provisional schedule:

- 31/12/2014: Completion of the modifications on the Tricastin and Paluel sites.
- 31/12/2015: Completion of the modifications on the Blayais, Bugey, Cattenom, Cruas, Golfech and Nogent sites.
- 31/12/2016: Completion of the modifications on the Chooz, Fessenheim, Penly, Saint-Laurent-des-Eaux and Flamanville sites.
- 31/12/2017: Completion of the modifications on the Belleville, Chinon, Civaux, Dampierre, Gravelines et Saint-Alban sites.

[8] Order of 7 February 2013 setting the general rules applicable to basic nuclear installations (BNIs)

Recommendation specific to France from the 2012 Peer Review

The peer review team recommends performing a comparative study of the rain hazard as defined firstly according to ASN requirements and secondly according to the methodologies used by the other European countries.

ASN notes that a WENRA sub-group has been set up to define reference levels for natural hazards. ASN and the IRSN are active members of this sub-group. ASN will examine the conclusions of this sub-group's work and update its regulatory requirements if necessary.

1.1.8 Assessment of margins with respect to natural hazards

Peer Review: *In conjunction with recommendation 2.1 and 3.1.7, the formal assessment of margins for all external hazards including, seismic, flooding and severe weather, and identification of potential improvements.*

Recommendation specific to France from the 2012 Peer Review

The peer review team confirms ASN's conclusion on the need to conduct additional studies to determine complete and systematic design criteria and an evaluation of the safety margins with respect to extreme climatic conditions.
ASN indicates in the report that the licencee has been asked to conduct analyses for these types of climatic phenomena which are linked to the flood risk. It has been recommended that these additional studies should also include tornados, heavy rainfall, extreme temperatures and the relevant combinations of extreme climatic conditions. The peer review team recommends considering extreme meteorological conditions in the definition of the hardened safety core.

In the framework of the stress tests, the licensee evaluated the margins with respect to the seismic and flood risks. The licensee also studied the margins in the event of extreme meteorological conditions such as wind, lightning, hail, and their combination, in the event of loss of the heat sink and electrical power supplies. The analysis of the additional studies has led ASN to set requirements and make the demands detailed below.

These additional demands concern complements to the margin evaluations, and the reinforcing of robustness of facilities beyond their current design basis. ASN has favoured the application of modifications that effectively improve the safety of the facilities over detailed studies of margins which can be completed subsequently.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: This requirement aims at giving the facilities the means of coping with extreme situations The licensee has submitted the requirements applicable to this hardened safety core to ASN. In order to define these requirements, the licensee shall adopt significant fixed margins in relation to the requirements applicable on 1 January 2012. The systems, structures and components (SSCs) included in these measures shall be maintained in a functional state, in particular for the extreme situations studied for the stress tests. These SSCs are protected against the on-site and external hazards induced by these extreme situations, such as: falling loads, impacts from other components and structures, fire, explosion.

ASN requirement

ECS - 12: Verification of the seismic design basis of the fire-fighting system

Before 30 December 2012, the licensee shall submit to ASN:

- a study evaluating the resistance to a safe shutdown earthquake (SSE) of the structures and equipment contributing to nuclear safety, fire sectoring, fire detection and fixed extinguishing systems, subject to an operating basis earthquake resistance requirement,
- for items for which the ability to withstand the SSE cannot be proven, a programme of modifications to guarantee protection of fire safety functions in the event of an SSE.

State of progress:

EDF has submitted the required studies and proposed a programme of modifications aiming to ensure the seismic resistance of its facilities at these increased levels. These modifications will be carried out during the periodic safety reviews of the reactors concerned.

ASN requirement

ECS - 13: Study of the implementation of automatic shutdown in the event of an earthquake

Before 31 December 2012, the licensee shall submit to ASN a study of the advantages and drawbacks of implementing automatic scram of its reactors in the event of seismic loading, enabling the reactor to be shut down to the safest state, if the seismic level corresponding to a spectrum with half the amplitude of the design response spectrum of the site is exceeded.

State of progress:

EDF has examined the advantages and drawbacks of implementing a system for automatically shutting down its reactors in the event of an earthquake, and has decided to implement such a system. The modification has been presented by the licensee and has been agreed by ASN (CODEP-DCN-2014-047520 of 17 October 2014).

ASN requirement

ECS – 15: Heat sink design review

Before 30 June 2012, the licensee shall produce and submit to ASN an overall review of the design of the heat sink in relation to hazards with an impact on the flow and quality of water and the risk of clogging of the heat sink.

State of progress:

EDF has submitted these studies. This point has been examined by the Advisory Committee of Experts for Reactors (GPR) and ASN has adopted a position with respect to it (CODEP-DCN-2014-040468 of 23 October 2014). EDF has proposed several changes which bring an improvement in the monitoring of heat sinks and their protection against external hazards. ASN nevertheless considers that further improvements are required, particularly in the identification of hazards and their combinations, in the requirements applicable to equipment for dealing with a massive influx of clogging debris, in the operational control documents and maintenance programmes, and in the monitoring of functions important for safety in the pumping station.

In addition, as part of the implementation of a hardened safety core, EDF will build an alternate heat sink, based on either artesian wells or existing tanks, whose seismic behaviour will be verified for earthquakes beyond the initial design-basis of the facilities (hardened safety core level earthquake).

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All – 14: ASN asks you to submit, for all sites, studies supplementing the stress tests, taking account of the snow-related risks, applying the specifications set by ASN for the meteorological conditions.

All – 15: ASN asks you to carry out a study that also takes account of the specific nature of gusting winds for all sites, before 31 December 2012.

All – 16: ASN asks you to consolidate the windspeed value to be considered in the studies on the indirect effects, before 31 December 2012.

ASN also asks you to check that, for winds of about 200 kph, the only projectiles to be considered are cladding sheets which are not liable to damage outdoor safety-related equipment because of their very low rigidity.

All – 17: ASN asks you to present a more precise definition of extreme hail loading and to conduct a more detailed analysis of the resistance of the equipment on all of the sites.

Fleet – 18: ASN asks you to carry out studies to ensure that an "extreme lightning" loading be defined on the basis of all available experience feedback and taken into account for the reactors in operation, with regard to the equipment needed to manage loss of ultimate heat sink (LUHS), station blackout (SBO), and severe accident situations.

State of progress:

EDF has submitted the design baseline requirement for the hardened safety core against extreme external hazards other than earthquakes and flooding. This subject will be examined by the GPR in June 2015.

ASN letter to EDF to define the orientations of the third periodic safety review of the 1300 MWe reactors, ref ASN CODEP-DCN-2011-00677 of 3rd May 2011

Prevention of climatic hazards: The licensee will reassess the risks induced by external hazards of climatic origin (heat waves, lowest safe water level, frazil ice, extreme winds, extreme flooding, etc.). ASN has also asked the licensee to take into consideration the external risks induced by tornados.

ASN position

- ASN will supplement its position according to the recommendations of the WENRA guide concerning the consideration of external hazards.
- With regard to the hazards associated with the flood risk (heavy rainfall in particular), the beyond-design-basis margins were analysed as part of the stress tests. This analysis led ASN to oblige the reinforcing of protection of the facilities against flooding beyond the current baseline requirement (see § 1.1.7)
- EDF has submitted the design baseline requirement for the hardened safety core against extreme external hazards other than earthquakes and flooding. This subject will be examined by the GPR in June 2015.

Recommendation specific to France from the 2012 Peer Review

The licensee has made an approximate estimate of the safety margins for earthquakes beyond the design-basis earthquake. A more systematic evaluation demanded by ASN and carried out on the basis of a probabilistic safety study or an evaluation of the safety margins would be appreciated.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All - 02 ASN asks you to include in the next periodic safety reviews an assessment of the seismic robustness of the facilities beyond the design baseline. This assessment will aim on the one hand to periodically analyse the risks of a beyond baseline cliff-edge effect, on the basis of updated data and, on the other, to identify the works, structures and equipment necessary for safe shutdown of the reactor and requiring further reinforcement.

ASN asks you by the end of 2012 to specify and justify the methods for assessing seismic robustness beyond the design baseline that you will implement during the forthcoming periodic safety reviews and how they are to be applied per unit, site or plant series.

State of progress:

In response to this demand and as part of the responses to prescription ND 9, EDF submitted 11 guides for verifying the seismic behaviour of equipment beyond their design basis requirements. These guides are currently being examined by ASN and will be applied by EDF in the periodic safety reviews.

Fleet - 03 ASN asks you to propose within six months an action plan aiming to:

- Make a more detailed assessment of the seismic margins;
- Complete the review of equipment liable to suffer cliff-edge effects and initiate the necessary corrective measures.

State of progress:

First elements submitted by EDF in mid-2014 and remaining elements by mid of 2015. The methods of verifying the seismic margins transmitted as part of the response to prescription ND 9 above will be applied to verify the SSCs of the hardened safety core as and when it is implemented on the facilities (according to the different implementation phases presented in §1). They are currently being examined by ASN.

ASN comments

Before the Fukushima accident, ASN initiated a working group with EDF and the IRSN on the methodologies of assessing beyond-design-basis situations. This working group began its work in 2010 and is continuing its evaluation of paraseismic justification methods involving slight incursions into the plastic domain further to an exceptional event, with the aim of being able to take the facilities from a stabilised situation to a safe situation and maintain them there.

1.2 LOSS OF THE SAFETY SYSTEMS

On completion of the stress tests, ASN considered that continuation of operation of the examined facilities required increasing their robustness to extreme situations beyond the existing safety margins as quickly as possible. Consequently, ASN has been obliged to set the following requirement, whose scope satisfies several of the peer review's recommendations, and the following recommendation resulting from the second extraordinary meeting of the Convention on Nuclear Safety.

CNS: *Upgrading safety systems or installing additional equipment and instrumentation enhance the ability of each nuclear power plant to withstand an unexpected natural event without access to the electrical power grid for an extended period of time, including for an external event affecting multiple units.*

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

I. Before 30 June 2012, the licensee shall propose to ASN a hardened safety core of robust material and organisational measures designed, for the extreme situations studied in the stress tests, to:

- prevent an accident with fuel melt, or limit its progression,
- limit large-scale radioactive releases,
- enable the licensee to fulfil its emergency management duties.

II. Within this same time-frame, the licensee shall submit to ASN the requirements applicable to this hardened safety core. In order to define these requirements, the licensee shall adopt significant fixed margins in relation to the requirements applicable on 1 January 2012. The systems, structures and components (SSCs) which are included in these measures shall be maintained in a functional state, in particular for the extreme situations studied in the stress tests. These SSCs are protected against the on-site and external hazards induced by these extreme situations, such as: falling loads, impacts from other components and structures, fire, explosion.

III. For this hardened safety core, the licensee shall install SSCs that are independent and diversified in relation to the existing SSCs, in order to limit common mode risks. If applicable, the licensee shall justify the use of undiversified or existing SSCs.

IV. The licensee shall take all necessary steps to ensure that the emergency organisation and resources are operational in the event of an accident affecting all or some of the facilities on a given site.

The licensee shall therefore include these steps in the hardened safety core defined in I. of this requirement and, in accordance with II of this requirement, shall issue requirements concerning:

- the emergency situation management premises, so that they offer greater resistance to hazards and remain accessible and habitable at all times and during long-duration emergencies, including in the event of radioactive releases. These premises shall enable the emergency teams to diagnose the status of the facilities and control the resources of the hardened safety core;
- the availability and operability of the mobile means vital for emergency management;
- the means of communication essential to emergency management, in particular comprising the means of alerting and informing the emergency teams and the public authorities and, should this prove necessary, the arrangements for alerting the population if the off-site emergency plan is triggered in reflex phase by delegation from the Prefect;
- the availability of parameters used to diagnose the status of the facility, as well as meteorological and environmental measurements (radiological and chemical, inside and outside the emergency

- the active dosimetry resources, radiation protection measuring instruments and individual and collective protective means. These resources shall be available in sufficient quantity by 31 December 2012.

State of progress:

- A specific meeting of the Advisory Committee of Experts for nuclear reactors has been held on 13 December 2012 to decide on:
  - the objectives associated with the hardened safety core and its functional perimeter,
  - the types and levels of initiating events considered when defining the hardened safety core,
  - the choices adopted when considering the events that these initiating events induce on the facility and the hardened safety core,
  - the conditions of implementation of the hardened safety core, and notably the states of the facility that allow its use,
  - the requirements associated with the equipment of the hardened safety core,
  - the methods and criteria used to demonstrate satisfying of the requirements,
  - the integration of the organisational and human factors for the implementation of the hardened safety core provisions,
  - the emergency management provisions planned to meet the requirements of the hardened safety core.
- The GPR concluded on the need to supplement the functional perimeter of the hardened safety core and to detail the design hypotheses, particularly with regard to earthquakes. On this basis ASN has issued complementary prescriptions through a set of resolutions dated 21 January 2014.
- On 30 June 2014, EDF submitted the list of new and existing equipment items intended to form part of the hardened safety core, the general hypotheses for the design, construction, verification, qualification and testing of these new or existing equipment items, the seismic levels for each site in response to ASN's demand of 21 January 2014. These files will be examined by the GRP in the first half of 2015.

1.2.1 Cooling systems and alternate heat sink

Peer Review: *The provision of alternative means of cooling including alternate heat sinks. Examples include steam generator (SG) gravity alternative feeding, alternate tanks or wells on the site, air-cooled cooling towers or water sources in the vicinity (reservoir, lakes, etc.) as an additional way of enabling core cooling.*

None of the French reactors in operation has an alternate heat sink. The Flamanville 3 EPR reactor will have an alternate heat sink.

During the stress tests and at the request of ASN, the licensee analysed situations entailing loss of heat sink and loss of electrical power supplies to the reactors, going beyond the situations covered by the current baseline requirements, in particular considering scenarios which affect all the reactors on a site on a long-term basis and which could also be caused by an earthquake or off-site flooding, including of a level higher than that considered in the current baseline requirements. These additional studies have led ASN to set the following requirements and formulate demands.

ASN requirement

ECS - 16.I: Emergency water supply resources

I. Before 30 June 2013, the licensee shall present ASN with the intended modifications for installing technical backup devices for long-term removal of residual power from the reactor and the spent fuel pool in the event of loss of the heat sink. These devices must meet the requirements concerning the hardened safety core presented in requirement [ECS-1] above. Pending the commissioning of the ultimate backup electrical power supplies mentioned in paragraph II of requirement [ECS-18], these devices must be kept functional in the event of prolonged and complete loss of the electrical power supplies, using temporary electrical systems if necessary.

State of progress:

The modifications have been submitted for all the sites and are currently being examined.

ASN requirement

ECS – 16.II: Emergency water make-up in the reactor coolant system when it is open

II. Before 31 December 2012, the licensee shall present ASN with the modifications it intends to make for the installation, before 31 December 2013 unless specifically justified, of systems to ensure the injection of borated water into the reactor core in the event of total loss of site electrical power supplies when the reactor primary coolant system is open.

Before 30 June 2013, the licensee shall propose final requirements to ASN for these provisions and shall indicate whether or not they are part of the hardened safety core.

State of progress:

ASN has given its agreement for the installation, on all 900 MWe reactors, of a fixed mean including an electrical motor-pump connected to the containment spray system and the safety injection system. This motor-pump is supplied by the new generator set installed in compliance with requirement ECS-18.III (see § 1.2.9) and allow the injection of borated water. The implementation of these modifications is achieved. On other reactors, EDF justified that the existing equipment items allow the injection of borated water in the primary circuit in these situations.

As part of the implementation of the hardened safety core, a new pump will be installed in order to provide make-up water to the primary circuit in these situations. This pump will have a specific instrumentation and control. Furthermore, this new pump and its line connection to water sumps could also be used to prevent basemat melt-through according to the on-going studies by EDF. The all system should be available after an earthquake and in severe accident conditions with complete core meltdown.

ASN requirement

ECS – 17: Reinforcement of the facilities to manage lasting situations of total loss of heat sink or total loss of electrical power supplies.

No later than 31 December 2013, the licensee shall examine the requirements associated with the equipment needed to manage total loss of heat sink or total loss of electrical power situations, with regard to temperature resistance, resistance to earthquakes, flooding and the effects induced on the facility by these hazards.

Before 31 December 2013, the licensee shall submit a summary of this review to ASN, along with proposals for changes to the baseline safety requirements and the resulting facility reinforcements in order to deal with these situations, in particular for long-duration scenarios.

State of progress: Studies received.

Control of situations of total loss of heat sink or total loss of electrical power supplies is supported by the hardened safety core. The integration of the requirements with regard to temperature resistance,

earthquake resistance, flooding and the effects these hazards induce on the facility is described in EDF's reply concerning the general approach to the design of the hardened safety core, submitted in June 2014.

This file will be examined in the first half of 2015.

With regard to the needs for changes in the baseline requirements, they will be examined in the normal process of the periodic safety reviews. ASN will ensure that these changes are consistent with the new WENRA reference levels for external hazards.

1.2.2 Electrical power sources

Peer Review: *The enhancement of the on-site and off-site power supplies. Examples include adding layers of emergency power, adding independent and dedicated backup sources, the enhancement of the grid through agreements with the grid operator on rapid restoration of off-site power, additional and/or reinforced off-site power connections, arrangements for black start of co-located or nearby gas or hydro plants, replacing standard ceramic based items with plastic or other material that are more resistant to a seismic event. Another example is the possible utilization of generator load shedding and house load operation for increased robustness, however, before introducing such arrangements the risks need to be properly understood.*

During the stress tests, ASN analysed situations with loss of electrical power supplies to the reactors going beyond the situations covered by the current baseline requirements, in particular considering scenarios which affect all the reactors on a site on a long-term basis and which could also be caused by an earthquake or off-site flooding, including of a level higher than that considered in the current baseline requirements. This led ASN to set the following requirements and formulate demands in addition to the commitments taken by the licensee.

ASN requirement

ECS - 18.II: Additional electrical power supply means

As early as possible, given the constraints of fleet-wide deployment, and in any case before 31 December 2018, the licensee shall install - for each reactor on the site - an additional electrical power supply capable of supplying the systems and components of the hardened safety core per requirement [ECS-1] if the other off-site and on-site electrical power supplies are lost.

These systems must meet the requirements concerning the hardened safety core per requirement [ECS-1].

State of progress: Studies in progress. Deadline of 31/12/2018.

ECS – 18.III: Installation of provisional emergency electrical power supplies pending installation of the means required by requirement ECS – 18.II

In the meantime, and no later than 30 June 2013, the licensee shall install a temporary system on each reactor for supplying:

- the I&C (Instrumentation and Control system) necessary in the event of loss of the off-site and on-site electrical power supplies,
- the control room lighting.

State of progress:

As at 30 June 2013, the licensee has installed temporary ultimate backup diesel-generator sets on each reactor.

EDF commitment given in the stress test reports submitted on 15 September 2011

The robustness of the associated electrical equipment to the situations envisaged further to Fukushima experience feedback will be consolidated up to a seismic level of 1.5 times the safe shutdown earthquake (SSE). Modifications will be proposed if necessary.

State of progress: Information submitted on 31/12/2012.

For the equipment outside the hardened safety core, the seismic resistance complies with the baseline safety requirements reassessed for the periodic safety reviews on the basis of methods that include margins. The hardened safety core constituents will be verified on the basis of the increased safe shutdown earthquake level prescribed by ASN for the hardened safety core and on the basis of codified methods or realistic deterministic methods. If seismic margins are not available for any constituents, those constituents shall be replaced. This verification will be carried out as and when the hardened safety core is implemented in accordance with the different phases presented in §1.

Lastly, the mobile means that the FARN may bring in (see point 1.2.13) shall include emergency diesel generator sets and lighting systems.

1.2.3 Electric backup batteries

Peer Review: *The enhancement of the DC power supply. Examples include improving the battery discharge time by upgrading the existing battery, changing/diversifying battery type (increasing resistance to common-mode failures), providing spare/replacement batteries, implementing well-prepared load shedding/ staggering strategies, performing real load testing and on-line monitoring of the status of the batteries and preparing dedicated recharging options (e. g. using portable generators).*

Electric batteries provide and guarantee continuity of the electrical supply to certain key equipment items in the event of loss of the off-site electrical power supplies and when the emergency generator sets are not operating. The protection, capacity and autonomy of these batteries were specifically studied in the framework of the stress tests. ASN was induced to set the following requirements and demands, and the peer review led to a recommendation on this subject.

Recommendation specific to France from the 2012 Peer Review

The peer review team recommends that ASN should also consider the possibility of recharging the batteries before they are completely discharged in the event of total loss of electrical power supplies, and the already envisaged increase in their capacity.

ASN requirement

ECS - 18.I: Reinforcement of battery autonomy

I. Before 30 June 2012, the licensee shall present ASN with the modifications it intends to make before 31 December 2014 in order to significantly increase the operating time of the batteries used in the event of loss of the off-site and on-site electrical power supplies.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All – 24: ASN also asks you to study the advantages and drawbacks of installing a device making it possible to recharge the batteries used in the event of total loss of electrical power supplies.

State of progress and future time-lines:

The power autonomy of the batteries has been increased from 1 hour to 2 hours (completion of works at end of 2014), and at the end of June 2013 the licensee installed temporary ultimate backup diesel generator sets (ensuring minimum instrumentation & control and control room lighting) pending the installation by the end of 2018 of ultimate backup diesel generator sets capable of withstanding the design-basis conditions of the hardened safety core.

1.2.4 Operational and preparatory actions

Peer Review: *Implementation of operational or preparatory actions with respect to the availability of operational consumables. Examples include, ensuring the supply of consumables such as fuel, lubrication oil, and water and ensuring adequate equipment, procedures, surveillance, drills and arrangements for the resupply from off-site are in place.*

The actions to be implemented further to a large-scale event are of both material and organisational nature. Aspects studied with particular attention include the autonomy of the sites in all circumstances - especially further to events leading to site isolation, the bringing in of outside resources, and personnel training. These aspects were verified during targeted inspections carried out in 2011. In the course of these inspections ASN identified deviations that led to specific demands (the inspection follow-up letter can be consulted on the ASN website www.asn.fr). In addition, ASN has set the following requirements and demands.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See §1.2

Comment: The material and organisational provisions included in the hardened safety core must enable the licensee to fulfil its emergency management duties. Implementing these provisions implies training the personnel and integrating appropriate modifications on the sites to facilitate their deployment.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All – 19: ASN asks you to improve the reliability of the on-site stocks of fuel and oil, as well as their procurement in all circumstances, such as to ensure an autonomy of at least 15 days for all the reactors of a site. ASN asks you to submit a corresponding action plan to it within two months, along with the associated schedule.

State of progress:

This aspect is subject to verifications as part of ASN's normal inspection activities. The FARN has set up an organisational structure and means for supplying consumables to sites where access conditions have been impaired.

1.2.5 Instrumentation and measuring

Peer Review: *The enhancement of instrumentation and monitoring. Examples include separate instrumentation and/or power sources to enable monitoring of essential parameters under any circumstances for accident management and the ability to measure specific important parameters based on passive and simple principles.*

During the stress tests, complementary studies were conducted to examine the robustness of the instrumentation & control necessary for diagnosis and to orient the operating team during electrical power failure. The conclusions of this work led ASN to set the following requirements and demands, and in particular the inclusion of the technical instrumentation for emergency management in the "hardened safety core". The conclusions also raised observations from the peer review.

Observations resulting from the French peer review

The instrumentation must undergo qualification for the environmental characteristics prevailing during severe accidents and against external hazards, and its electrical power supply must be ensured (the spent fuel pool instrumentation shall be included in the hardened safety core). […]
The instrumentation that detects entry into a severe accident situation is not available from the control room. […]
For the reactors in service, operation of the instrumentation necessary in a severe accident situation cannot be guaranteed in the event of an earthquake because it is not qualified for earthquakes. This instrumentation should be added to the hardened safety core. […]
ASN has asked the licensees to include the equipment necessary for emergency situation management in the hardened safety core.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See §1.2

Comment: ASN has asked the licensees to include the equipment and instrumentation necessary for emergency situation management in the hardened safety core.

ASN requirement

ECS - 19: Redundancy of instrumentation for detecting reactor vessel melt-through and hydrogen in containment

I. As early as possible, given the constraints of cross-fleet deployment, and in any case before 31 December 2017, the licensee shall install redundant means in the reactor pit to detect vessel melt-through and redundant means in the containment to detect the presence of hydrogen.

Instrumentation in the control room shall indicate corium melt-through of the vessel.

State of progress:

- 31/12/2016: Deadline for implementation of redundant means for the Blayais, Bugey, Chinon, Cruas, Dampierre, Fessenheim, Gravelines, Saint-Laurent, Tricastin, Belleville, Flamanville, Paluel, and Saint-Alban sites
- 31/12/2017: Deadline for the implementation of redundant means for the Cattenom, Chooz, Civaux, Golfech, Nogent and Penly sites.

II. Before 31 December 2013, the licensee shall propose final requirements to ASN for these provisions and shall indicate whether or not they are part of the hardened safety core.

State of progress:

Studies submitted, the modification application deadlines are maintained.

ASN requirement

ECS – 18 I: Reinforcement of battery autonomy

ECS – 18 II: Ultimate backup diesel generator sets

Wording of the requirement and state of progress: See § 1.2.2 and § 1.2.3

Comment: For the reactor fleet in service, the batteries supply power for the instrumentation & control necessary for diagnosis and to orient the operating team during an electrical power failure. The ultimate backup diesel generator sets shall guarantee the supply of the minimum instrumentation and control necessary for the information required in core melt situations.

ASN requirement

ECS - 20: Reinforcement of pool condition instrumentation

I. Before 30 June 2012, the licensee shall present ASN with the modifications to be made, for measuring both the condition of the fuel storage pool (temperature and water level in the spent fuel pool) and the radiological atmosphere in the fuel building hall.

State of progress:

Information submitted on 30/06/2012. ASN has formulated additional requests relative to the instrumentation for managing hardened safety core situations, through a set of resolutions dated 21 January 2014.

II. Pending their implementation:

- By 31 December 2012 at the latest, the licensee shall provide its national organisation with charts indicating the times to reach boiling point in the event of total loss of cooling, according to the residual power of the fuel stored in the spent fuel pool.
- No later than 31 December 2013, the licensee shall ensure that level measurement in the event of total loss of electrical power supplies is available.

State of progress:

The charts are available and pool level measurement has been modified to benefit from an electrical power backup.

1.2.6 Improvement of safety at shutdown and in the different reactor states

Peer Review: *The enhancement of safety in shutdown states and mid-loop operation. Examples of improvements include, reducing or prohibiting mid-loop operation, adding dedicated hardware, procedures and drills, the use of other available water sources (e. g. from hydro-accumulators), requiring the availability of SGs during shutdown operations and the availability of feedwater in all modes.*

During the stress tests, ASN analysed situations with loss of heat sink and loss of electrical power supplies to the reactors, going beyond the situations considered in the current baseline requirements. It considered all the states of reactors and fuel storage pools, and scenarios which firstly affect all the reactors on a site on a long-term basis and secondly could be caused by an earthquake or external flooding, including of a level higher than that considered in the current baseline requirements. For each of these situations, the times before the fuel becomes exposed in the event of loss of the cooling systems and the electrical supplies have been evaluated. ASN has set the requirements detailed in paragraphs 1.2.1 to 1.2.5 and expressed the following demands in addition to the commitments taken by the licensee.

ASN requirement

ECS – 16 II: Emergency water make-up in the reactor coolant system

Wording of the requirement and state of progress: See § 1.2.1

Comment: This system ensures the injection of borated water into the reactor core in the event of total loss of on-site electrical power when the reactor coolant system is open.

EDF is initially making provisions on each reactor to allow the injection of borated water by connecting mobile means to tappings installed for that purpose (completion due at end of 2015), a function that will be ensured in a second phase by fixed equipment of the hardened safety core.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All – 30: ASN asks you to integrate into the accident operations procedures and the severe accident management documents - including the severe accident management guidelines in particular - the new provisions for handling the extreme situations studied in the stress tests and affecting several reactors on the same site, for all operating states, as well as the fuel storage buildings.

State of progress:

EDF has partially responded to the demand and will submit the remainder of the response before 31 December 2015. The elements relating to the operational management of these equipment items were examined by ASN prior to the implementation of the modifications to permit the injection of borated water and in the context of the incident and accident operational management change requests also submitted to ASN.

EDF commitment given in the stress test reports submitted on 15 September 2011

Several changes in accident operating management shall be made according to the different reactor states.

State of progress:

ASN has already agreed to the implementation of a change in accident management in situations of total loss of electrical power supplies with a break at the reactor coolant pump seals, in order to guarantee a sufficient steam supply to drive the turbine-driven pump of the steam generator (SG) emergency feedwater system and the emergency turbine generator set (LLS) by preventing the risk of excessive depressurization of the SGs for all the reactors.

The licensee can also call upon the additional resources of the FARN which, by the end of 2014, will be liable to intervene simultaneously on all the installations of a 4 plant-unit site.

1.2.7 Reactor primary coolant pump seals

Peer Review: *The use of temperature-resistant (leak-proof) primary pump seals.*

Correct functioning of the reactor coolant pump (RCP) seals, when the reactor is in operation or in hot shutdown state, requires cooling by continuous injection of pressurised water. For the 900 MWe plant series reactors, if the off-site electrical power supplies and the on-site emergency generator sets are lost while in either of these states, pressurised water injection is ensured by a pump common to a pair of reactors. The analysis of the different cases of loss of electrical power supplies has led ASN to make the following demands.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

900 MWe – 22: ASN asks you to present it within six months with a safety demonstration, as well as any necessary modifications, to ensure simultaneous injection at the RCP seals on two neighbouring reactors of the 900 MWe plant series, in the event of loss of off-site electrical power supplies and of the on-site emergency generator sets.

All – 23: ASN asks you to submit to it within six months the safety demonstration for avoidance of the onset of a severe accident following deterioration of the RCP seals, in a situation involving loss of off-site electrical power supplies and all on-site electrical sources (including the LLS) on a site.

State of progress:

The licensee has finalised the installation of high-temperature seals capable of withstanding loss of cooling for an extended period.

EDF has also studied the installation of a passive device for protecting seal No.1 of the reactor coolant pumps in the event of loss of the electrical power supplies. This device is undergoing qualification before being installed on all the coolant pumps of the reactor fleet on the basis of a schedule that is currently being defined.

1.2.8 Ventilation

Peer Review: *The enhancement of ventilation capacity during SBO to ensure equipment operability.*

Many items of equipment cannot function in the medium and long term if they, or the premises in which they are situated, are not ventilated or cooled. As improving the robustness of certain items of equipment required for cooling the reactor or the spent fuel pool is part of the hardened safety core, this also implies that the robustness of their means of ventilation must also be considered. These aspects formed the subject of an investigation presented to the Advisory Committee of Experts for nuclear reactors on 13 December 2012. ASN will adopt a position on the conclusions of this investigation at the beginning of 2013.

Furthermore, at the end of the stress tests ASN set the following requirements and demands.

ASN requirement

ECS – 17: Reinforcement of the facilities to manage lasting situations of total loss of heat sink or total loss of electrical power supplies.

Wording of the requirement and state of progress: See § 1.2.1

Comment: the problems associated with ventilation will be examined as part of the examination by ASN of EDF proposals for the hardened safety core and in response to this requirement.

At the request of ASN, EDF has identified the hardened safety core equipment and its supporting equipment(i.e. equipment whose failure compromises operation of the hardened safety core) and the requirements applicable to these items of equipment. Operation of the hardened safety core support functions shall be ensured under the design-basis conditions of the hardened safety core, as and when it is put in place.

ASN letter to EDF further to the meeting of the Advisory Committee of Experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All – 28: With regard to total loss of heat sink situations, ASN asks you to examine the means of ultimately restoring sustainable cooling of the reactors and pools, calling on the experience feedback from the Fukushima accident.

State of progress:

This safety function shall be ensured by the hardened safety core on the basis of an alternate heat sink and ultimate backup diesel generator sets.

1.2.9 Main and emergency control rooms

Peer Review: *The enhancement of the main control room (MCR), the emergency control room (ECR) and emergency control centre (ECC) to ensure continued operability and adequate habitability conditions in the event of a station black-out (SBO) and in the event of the loss of DC (this also applies to Topic 3 recommendations).*

Total loss of electrical power supplies (loss of the off-site sources and the on-site diesel generators), also called station black-out (SBO), is a situation taken into account in the severe accident management guidelines (SAMG). This situation leads to the loss of the dynamic containment ensured by the ventilation systems, and particularly the main control room ventilation function and ventilation filtration via the iodine trap. Permanent habitability of the control room is guaranteed, unless the reactor containment U5 venting system filter is opened. Habitability can be temporarily compromised if the U5 system is used, or if there are large releases of toxic substances from outside the site. In this respect, the licensee has planned to reinforce the electrical back-up of control room ventilation and filtration by an ultimate backup diesel generator (GUS). Pending implementation of this modification, the Nuclear Rapid Response Force (FARN, see paragraph 1.2.13) will deploy means to ensure the electrical back-up of these equipment items for the damaged reactor.

The emergency rooms (security block – BDS, emergency equipment stores) were designed without applicable specific regulatory requirements relative to flooding and earthquakes. The BDS is temporarily uninhabitable after opening the U5 system filter.

ASN has therefore set the following requirements, which more particularly require the emergency management rooms to be included in the "hardened safety core" and operating control of the facilities to be guaranteed after hazardous substance releases.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: The emergency management rooms, the availability of parameters used to diagnose the status of the facility, the communication means necessary for emergency management, and some meteorological and environmental measurements shall be included in the hardened safety core.

As part of phase 2 of hardened safety core implementation, EDF shall build on each site a local emergency management centre that withstands the hardened safety core situations (the first local emergency management centre shall be built for the commissioning of the EPR in 2016). In the interim, the existing emergency management premises have undergone seismic reinforcement.

ASN requirement

ECS - 18.II: Additional electrical power supply means

Wording of the requirement and state of progress: See § 1.2.2. The definitive ultimate backup diesel generator sets shall be built by the end of 2018.

Comment: The ultimate emergency diesel generator sets provided by the licensee as part of the hardened safety core shall ensure power supply for the minimum necessary reactor instrumentation and control in the control room, for control room lighting, and for the ventilation-filtration system.

ASN requirement

ECS – 18.III: Installation of provisional emergency electrical power supplies pending installation of the means required by requirement ECS – 18.II

Wording of the requirement and state of progress: See § 1.2.2. These equipment items have been in place on each of the reactors since 30 June 2013.

Comment: The diesel generator sets provided by the licensee shall ensure power for the minimum necessary reactor instrumentation and control in the event of total loss of the electrical power supplies and of control room lighting.

Other ASN requirements relative to severe accident management

ECS - 29: Reinforcement of the U5 venting-filtration system ("sand-bed filter")

Before 31 December 2013, the licensee shall submit to ASN a detailed study of the possible improvements to the U5 venting-filtration system, taking account of the following points:

- resistance to hazards,
- limitation of hydrogen combustion risks,
- efficiency of filtration in the case of simultaneous use on two reactors,
- improved filtration of fission products, in particular iodines,
- radiological consequences of opening the device, in particular for accessibility of the site, and the radiological atmosphere of the emergency premises and control room.

State of progress:

Studies submitted. As part of the response to requirement ECS 1, EDF shall also submit by end 2014 the study of a solution enabling the U5 filter (container venting-filtration system) not to be used in a severe accident situation. ASN will give a ruling after analysing these two studies.

ASN requirement

ECS - 31: Modifications to ensure facility management further to releases

Wording of the requirement: See §1.3.12

Comment: This requirement provides for the constitution of a file presenting the planned modifications on the site to ensure that in the event of a release of dangerous substances or opening of the U5 venting-filtration system, the operation and monitoring of all the facilities on the site is guaranteed until a sustainable safe state is reached.

State of progress:

The implementation of the hardened safety core provides for the construction on each site of a building allowing emergency management in an accident situation. The first emergency management centre construction is planned on the Flamanville site. The examination relative to this emergency management centre shall be carried out as part of the commissioning authorisation of the Flamanville 3 EPR reactor. This centre shall include means of protection and communication for the emergency teams. A number of operations shall still have to be carried out in the control room. The ultimate backup diesel generator set shall enable the ventilation-filtration function to be maintained in the control room and in the space between the two containment walls of the 1300 MWe and N4 reactors.

1.2.10 Spent fuel pool

Peer Review: *The improvement of the robustness of the spent fuel pool (SFP). Examples include reassessment/upgrading SFP structural integrity, installation of qualified and power-independent monitoring, provisions for redundant and diverse sources of additional coolant resistant to external hazards (with procedures and drills), design of pools that prevents drainage, the use of racks made of borated steel to enable cooling with fresh (unborated) water without having to worry about possible recriticality, redundant and independent SFP cooling systems, provision for additional heat exchangers (e. g. submerged in the SFP), an external connection for refilling of the SFP (to reduce the need for an approach linked to high doses in the event of the water falling to a very low level) and the possibility of venting steam in a case of boiling in the SFP.*

CNS: *Installing additional equipment and instrumentation in spent fuel pools to ensure cooling can be maintained or restored in all circumstances, or performing additional technical evaluations to determine if additional equipment and instrumentation are needed.*

The stress tests included an in-depth examination of the consequences of a major natural hazard on the systems that can evacuate the residual power of the fuel stored in pools, on the integrity of the pools in

the fuel building and the reactor building and the systems connected to them, and the risks of storage rack deformation and falling loads.

The conclusions of the analyses have led ASN to set the following requirements.

ASN requirement

ECS - 18.II: Additional electrical power supply means

Wording of the requirement and state of progress: See § 1.2.2

Comment: The diesel generator sets provided by the licensee shall power a pump that can draw water from the water table or large-capacity ponds, with the complete set-up constituting an ultimate back-up power source specific to each reactor.

ASN requirement

ECS - 16.I: Emergency water make-up resources

Wording of the requirement and state of progress: See § 1.2.1

Comment: These emergency water make-up resources must ensure lasting removal of residual power from the reactor and the spent fuel pool in the event of loss of the heat sink.

ASN requirement

ECS - 20: Reinforcement of spent fuel pool condition instrumentation

Wording of the requirement and state of progress: See § 1.2.5

ASN requirement

ECS - 21: Additional measures to prevent or mitigate the consequences of a fuel transport package falling in the fuel building.

(Bugey and Fessenheim sites)

Before 31 December 2012, the licensee shall send ASN a study of the consequences of an accident involving a fall by a spent fuel transport package, including in the extreme situations studied by the stress tests. A study of possible additional measures to prevent or mitigate the consequences of this fall shall be presented before 31 December 2013.

State of progress:

- End of 2012: submission of study of consequences of accidental falling of a fuel transport package, in compliance with the requirements.
- June 2013: submission of study of additional measures envisaged for the Bugey site, in compliance with the requirements.
- End of 2013: submission of study of additional measures envisaged for the Fessenheim site, in compliance with the requirements.

ASN will adopt a position on these studies in the first half of 2015.

ASN requirement

ECS - 22: Reinforcement of the measures to prevent accidental rapid draining of the fuel storage pools

Before 30 June 2012, the licensee shall present ASN with the modifications to be made to its facilities in order to reinforce prevention of the risk of accidental emptying of the fuel building pool:

- measures to prevent complete and rapid siphon emptying of the pool in the event of a break of a connected pipe
- automation of isolation of the cooling system intake line.

The measures to prevent complete and rapid siphon emptying of the pool in the event of a break of a connected pipe shall be performed before the end of March 2014.

Automation of cooling system intake line isolation shall be performed by 31 December 2016.

State of progress:

- Presentation of modifications on 30/06/2012.
- Measures have been implemented to prevent complete and rapid siphon emptying of the pool in the event of a break of a connected pipe, in compliance with the requirement.
- 31/12/2016: Deadline for implementation of automation of isolation of the cooling system intake line for the 900 and 1300 MWe plant series.
- 31/12/2017: Deadline for implementation of automation of isolation of the cooling system intake line for the N4 plant series.

ASN requirement

ECS - 23: Placing a fuel assembly in safe position during handling;

Before 30 June 2012, the licensee shall submit to ASN a study of the possible measures, in the event of total loss of electrical power supplies and accidental emptying, to ensure the safe positioning of a fuel assembly being handled in the fuel building, before the ambient conditions no longer allow access to the premises.

State of progress:

Studies submitted by EDF. They will be examined at a meeting of the Advisory Group of Experts for Reactor in the first half of 2015.

EDF has moreover verified the reliability of operation of the fuel storage building steam outlet by the operators in the event of loss of the electrical power supplies.

ASN requirement

ECS - 25: Reinforcement of the provisions for managing a transfer tube leak

Before 31 December 2012, the licensee shall submit to ASN a study of the possible changes to equipment or operating conditions in order to prevent uncovering of the assemblies during handling, as the result of a break in the transfer tube between the pools in the reactor and fuel buildings or in the compartment drainage pipes.

State of progress:

EDF has identified two modifications to prevent exposure of the fuel assembly during handling in the event of a break in the transfer tube. These modifications will contain the leaks from the transfer tube and thereby stop potential emptying of the various compartments of the pools. These modifications are currently being examined and necessitate discussions with the licensee.

Before 31 December 2012, the licensee shall present ASN with the possible changes to equipment or operating conditions to be made before 30 June 2013, in order to prevent the rapid loss of water inventory above the stored fuel assemblies, for example as the result of a break in the transfer tube between the pools in the reactor and fuel buildings or in the compartment drainage pipes.

State of progress:

As at 30 June 2013, EDF has put in place organisational measures (by changing the conditions of administrative lockout of valves to guarantee their position) to prevent exposure of the fuel assembly during handling in the event of a break in the transfer tube.

1.2.11 Separation and independence of the safety systems

Peer Review: *The enhancement of the functional separation and independence of safety systems. Examples include the elimination of full dependence of important safety functions on auxiliary systems such as service water and the introduction of an alternate source of cooling.*

Pursuant to the international recommendations, the French regulations applicable in the field of nuclear safety, particularly article 3.1 of the BNI order of 7 February 2012, provide for the implementation of successive and sufficiently independent defence levels, and a cautious design approach integrating sizing margins and whenever necessary ensuring redundancy, diversification and appropriate physical separation of protection-related equipment items that fulfil functions necessary for demonstrating nuclear safety. Prior to the publication of this order, these requirements were frequently integrated in the analyses performed by ASN and the IRSN.

In addition to the already applicable requirements, the principles of separation and independence are part of the requirements associated with the equipment constituting the hardened safety core. Furthermore, the licensee must take account of the risks of common mode failure between the existing equipment and the new equipment installed as part of the hardened safety core, while seeking their diversification and independence.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: The licensee proposed ASN a hardened safety core of material and organisational provisions, including systems that are independent and diversified with respect to the existing systems in order to limit common mode risks.

On 21 January 2014 ASN issued a series of resolutions specifying design provisions for the hardened safety core and reaffirmed the principle of electrical independence between the existing systems and the material provisions of the hardened safety core.

ASN requirement

ECS - 16.I: Emergency water supply resources

Wording of the requirement and state of progress: See § 1.2.1

1.2.12 Accessibility

Peer Review: *The verification of assured flow paths and access under SBO conditions. Ensure that the state in which isolation valves fail and remain, when motive and control power is lost, is carefully considered to maximise safety. Enhance and extend the availability of DC power and instrument air (e. g. by installing additional or larger accumulators on the valves). Ensure access to critical equipment in all circumstances, specifically when electrically operated turnstiles are interlocked.*

Numerous provisions are made to guarantee access to the premises and facilitate interventions in the event of total loss of the electrical power supplies. Their robustness must however be increased in the event of loss of heat sink or this combined with loss of electrical power supplies. These conclusions have led ASN to set the following requirements that more particularly require an increase in the robustness of the electrical power supplies and a verification of the feasibility of accident management measures for the situations studied in the stress tests.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: Setting up a hardened safety core of material and organisational provisions combined with enhanced requirements has led the licensee to perform an additional verification of the robustness and accessibility of these material provisions considering the hazards and effects induced by an earthquake or flood beyond the current baseline safety standard.

ASN requirement

ECS - 18.II: Additional electrical power supply means

Wording of the requirement and state of progress: See §1.2.2

Comment: The diesel generator sets provided by the licensee shall ensure power for the ventilation-filtration of the control room and ventilation-filtration of the inter-containment space (1300/N4 plant series).

Other ASN requirements relative to severe accident management

ECS - 35.I and II: Feasibility of emergency management actions in extreme situations

I. No later than 31 December 2012, the licensee shall define the human actions required for management of the extreme situations studied in the stress tests. It shall check that these actions can effectively be carried out given the intervention conditions likely to be encountered in such scenarios. It shall for instance take account of the relief of the emergency teams and the logistics necessary for the interventions. It shall specify any material or organisational adaptations envisaged. On the deadline date, the licensee shall transmit the appraisal of this work and the envisaged measures. On 30 June 2012, the licensee shall send ASN an interim report.

II. Before 31 December 2012, the licensee shall send ASN a list of the necessary emergency management skills, specifying whether these skills could be held by outside contractors. The licensee shall provide proof that its organisation ensures the availability of the necessary skills in an emergency situation, including if outside contractors are used.

State of progress:

The final report on the human actions required for extreme situation management has been submitted, as the list of skills necessary for emergency management.

This subject will be examined by the GPR in 2017 when the hardened safety core management procedures become available.

1.2.13 Mobile equipment

Peer Review: *The provision of mobile pumps, power supplies and air compressors with prepared quick connections, procedures, and staff training with drills. Mobile devices are intended to enable the use of existing safety equipment, enable direct feeding of the primary or secondary side, allow extended use of instrumentation and operation of controls, allow effective fire-fighting, and ensure continued emergency lighting. The equipment should be stored in locations that are safe and secure even in the event of general devastation caused by events significantly beyond the design basis (this also applies to Topic 3 recommendations).*

The emergency procedures, which will incorporate the new measures identified in the stress tests, provide for the use of mobile equipment situated either on or off the site, and whose availability and operability must be guaranteed. ASN has set the following requirements with respect to these mobile material provisions.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components.

Wording of the requirement and state of progress: See § 1.2

Comment: The licensee must ensure the availability and operability of the mobile equipment vital for emergency management.

ASN requirement

ECS – 30: Storage of mobile means

[…]

III. No later than 30 June 2013, the licensee shall store its mobile resources necessary for emergency management in appropriate premises or zones able to withstand the SSE and flooding in the event of the flood safety margin level being reached.

State of progress:

This measure, implemented by EDF, is checked as part of the ASN inspections.

ASN requirement

ECS – 36: The Nuclear Rapid Response Force (FARN)

I. Before 30 June 2012, the licensee shall present ASN with the measures it intends to take in order to provide specialised teams capable of relieving the shift teams and deploying emergency response resources in less than 24 hours, with operations starting on the site within 12 hours following their mobilisation. This system may be common to several of the licensee's nuclear sites.

These teams shall be sized so that they can respond on all the reactors of the site and have measuring instruments that can be deployed as of their arrival. The licensee shall specify the organisation and sizing of these teams, in particular:

- the activation criteria,
- the tasks incumbent upon the teams,
- the material and human resources at their disposal,
- the personal protective equipment,
- the system put into place to ensure the maintenance of these material resources and their permanent operability and availability;
- the training of their staff and the skills currency process.

II. On 31 December 2012, this organisation will be deployable for intervention on a reactor on the site. It shall be able to intervene simultaneously on all the reactors of the site by the end of 2014.

III. Before 30 June 2012, the licensee shall also present the measures for adapting the organisation to simultaneous intervention on several of its nuclear sites.

State of progress:

- The FARN and the provisions for adapting the organisation to simultaneous interventions on several of its nuclear sites were presented on 18/05/2012.
- The facility modifications envisaged by EDF to connect the emergency mobile resources brought in by the FARN have been specifically examined by ASN and the IRSN. In 2012, ASN gave its agreement on the creation of pitting on certain systems. All the tappings for connecting the FARN's resources will be in place by the end of 2015.
- 31/12/2012: The FARN organisation is deployable to intervene on one reactor of a site for all the sites.
- 31/12/2014: Deadline for deployment of the organisation capable of intervening simultaneously on all the reactors of a given site (all reactors of all sites except for Gravelines).
- 31/12/2015: Deadline for deployment of the organisation capable of intervening simultaneously on the six plant units of the Gravelines site.

Comment: The FARN is responsible for implementing the emergency response means in less than 24 hours and has its own mobile resources. The build-up of this organisation is monitored and checked during inspections. Deployment of the FARN and personnel recruitment are running in accordance with the regulatory schedule.

1.2.14 Protection of the systems

Peer Review: *The provision for a bunkered or "hardened" system to provide an additional level of protection with trained staff and procedures designed to cope with a wide variety of extreme events including those beyond the design basis (this also applies to Topic 3 recommendations).*

The aim of defining a hardened safety core of material and organisational measures is to implement an additional level of protection. ASN has set the following requirement from this viewpoint.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

1.2.15 Multiple accidents

Peer Review: *The enhancement of the capability for addressing accidents occurring simultaneously on all plants of the site. Examples include assuring preparedness and sufficient supplies, adding mobile devices and fire trucks and increasing the number of trained and qualified staff (this also applies to Topic 3 recommendations).*

Analysis of the management of multiple accidents affecting all or part of the reactors of a given site simultaneously has called into question the previously implemented material and organisational provisions. In this context ASN has set the following requirements.

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: The licensee shall take all necessary measures to ensure that the emergency organisation and resources are operational in the event of an accident affecting all or some of the facilities on a given site.

The emergency centres forming part of the hardened safety core shall be built on each site; the material resources of the hardened safety core are installed on each reactor.

ASN requirement

ECS – 32: Multiple plant unit emergency organisation

Before 31 December 2012, the licensee shall reinforce its material and organisational measures to take account of accident situations simultaneously affecting all or some of the facilities on the site.

State of progress:

Action completed. A revised on-site emergency plan (PUI) baseline has been deployed on all EDF sites since 15 November 2012. It takes into account accident situations simultaneously affecting several facilities on a given site.

The revised on-site emergency plan baseline is applied on all NPP sites from 13 November 2014. It takes into account the setting up of the FARN with the necessary human and material resources to intervene on a site with 4 plant units and the local emergency resources in accordance with the respective regulatory deadlines (§ 1.2.13).

ASN requirement

ECS – 36: The Nuclear Rapid Response Force (FARN)

Wording of the requirement and state of progress: See § 1.2.13

Comment: This organisation must be suitably sized to be able to intervene simultaneously on all the reactors.

ASN letter to EDF further to the meeting of the Advisory Committee of Experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All – 30: ASN asks you to integrate into the accident operations procedures and the severe accident management documents, including the severe accident management guidelines in particular, the new provisions for handling the extreme situations studied in the stress tests and affecting several reactors on the same site, for all operating states, as well as the fuel storage buildings.

State of progress: See § 1.2.6

1.2.16 Inspection of equipment and training programmes

Peer Review: *The establishment of regular programmes for inspections to ensure that a variety of additional equipment and mobile devices are properly installed and maintained, particularly for temporary and mobile equipment and tools used for mitigation of BDB external events. Development of relevant staff training programmes for deployment of such devices.*

The inspections carried out by the licensee to verify the presence, operability and maintenance of the equipment and other material provisions are required by the regulations applicable to nuclear facilities, and are themselves subject to regular inspections by ASN.

ASN's targeted inspections carried out in 2011 examined the implementation of the monitoring and maintenance programmes, and the training of the teams. During these inspections, ASN identified deviations that resulted in specific demands (the inspection follow-up letters can be consulted on the ASN website www.asn.fr); in 2012 ASN conducted dedicated inspections to check integration of the demands made further to the 2011 inspections. The findings led ASN to set a requirement obliging conformity of the protection volume to be sustainably ensured.

Lastly, with respect to deployment of the FARN, ASN performed several inspections to check the provisions guaranteeing availability of its mobile resources.

ASN requirements

ECS – 36: The Nuclear Rapid Response Force (FARN)

Wording of the requirement and state of progress: See § 1.2.13

Comment: The FARN is responsible for implementing the emergency response means in less than 24 hours and has its own mobile resources, of which the nature, the maintenance and the provisions for guarantee their operability and availability.

ASN requirements

ECS – 5: Conformity of the protection volume

Wording of the requirement: See § 1.1.3

State of progress:

On certain sites, protection of the facilities against flooding is dependent on the installation of mobile equipment. Compliance with this requirement more particularly requires the implementation of a specific monitoring programme and increased training of the personnel concerned.

These aspects are checked in the course of the normal inspection programme for the facilities.

1.2.17 Additional studies in areas where uncertainties remain

Peer Review: *The performance of further studies in areas where there are uncertainties. Uncertainties may exist in the following areas:*

- *The integrity of the SFP and its liner in the event of boiling or external impact.*
- *The functionality of control equipment (feedwater control valves and SG relief valves, main steam safety valves, isolation condenser flow path, containment isolation valves as well as depressurisation valves) during the SBO to ensure that cooling using natural circulation would not be interrupted in a SBO (this is partially addressed in recommendation 3.2.10).*
- *The performance of additional studies to assess operation in the event of widespread damage, for example, the need different equipment (e.g. bulldozers) to clear the route to the most critical locations or equipment. This includes the logistics of the external support and related arrangements (storage of equipment, use of national defence resources, etc.).*

The stress test analysis of robustness of the facilities in the event of loss of the electrical power supplies or the heat sink revealed, in addition to the safety enhancement measures mentioned earlier, the need to analyse certain phenomena in more detail. This particularly concerns the long-term operating reliability of

certain equipment items, the examination of coolant pump seal robustness, the study of how the behaviour of the fuel and the water in the spent fuel pools evolves over time in situations of loss of cooling, and the review of the changes proposed by EDF for incident operating management. More particularly, ASN formulated the requirement mentioned below concerning the evolution over time of the behaviour of the fuel and the water present in the spent fuel pool.

These studies will be examined by ASN as and when they are submitted, with ASN and its technical support organisation focusing at present in priority on reviewing EDF's proposals for the modifications of the facilities, and the setting up of the "hardened safety core" in particular.

ASN requirement

ECS - 24: Thermohydraulic development of a pool accident

Before 31 December 2012, the licensee shall submit to ASN a study of the evolution over time of the behaviour of the fuel and the water present in the spent fuel pool, in emptying and loss of cooling situations. The licensee shall in particular evaluate the radiological ambient atmosphere in a pool boiling situation, along with the hydrogen concentrations, as a result of radiolysis, that could be reached in situations involving a loss of ventilation in the fuel building. At that time, the licensee shall propose and justify the measures that could be taken.

State of progress:

The studies submitted describe the kinetics and consequences of the boiling crisis phenomenon in the pool. The proposed mitigation measures consist in restoring the water inventory in the pools through water makeup which forms part of the hardened safety core. These measures shall be examined at the GPR meeting planned for June 2015.

1.3 SEVERE ACCIDENT MANAGEMENT

Recommendation specific to France from the 2012 Peer Review

The main improvements to be made in order to cope with severe accidents, possibly affecting multiple units and caused by natural hazards, have been pointed out by ASN. One recommendation resulting from the peer review process is to guarantee their implementation.

ASN position

ASN is particularly vigilant in monitoring the implementation of all the requirements it has issued, and the reinforcing of the baseline safety requirements, especially with regard to earthquakes, flooding and risks associated with other industrial activities. All the requirements imposed by ASN further to the stress tests have application deadlines and are legally binding.

Since summer 2012 ASN has periodically presented the progress of all these actions. For further information go to www.asn.fr

1.3.1 WENRA reference levels

Peer Review: *The incorporation of the WENRA reference levels related to severe accident management (SAM) into their national legal frameworks, and ensure their implementation in the installations as soon as possible. This would include:*

- *Hydrogen mitigation in the containment - Demonstration of the feasibility and implementation of mitigation measures to prevent massive explosions in case of severe accidents.*
- *Hydrogen monitoring system - Installation of qualified monitoring of the hydrogen concentration in order to avoid dangerous actions when concentrations that allow an explosion exist.*
- *Reliable depressurization of the reactor coolant system – Hardware provisions with sufficient capacity and reliability to allow reactor coolant system depressurization to prevent high-pressure melt ejection and early containment failure, as well as to allow injection of coolant from low pressure sources.*
- *Containment overpressure protection - Containment venting via the filters designed for severe accident conditions.*
- *Molten corium stabilization - Analysis and selection of feasible strategies and implementation of provisions against containment degradation by molten corium.*

Following publication of the TSN Act in 2006 and its application decrees, ASN wished to completely revise the general technical regulations applicable to BNIs. This approach moreover corresponds to a will for European harmonisation of nuclear safety, by incorporating in the new regulations the principles or "reference levels" developed by the Western European Nuclear Regulators' Association (WENRA).

The order 7 February 2012 setting the general rules for basic nuclear installations takes up the WENRA reference levels that come under this level of regulatory text. The majority of the provisions of this order, published on 8 February 2012, comes into force on 1 July 2013. This order also provides a foundation for several of the requirements expressed by ASN further to the stress tests. This order will be supplemented by several regulatory resolutions or guidelines from ASN which will be published in 2013 and 2014 in order to finalise implementation of the WENRA reference levels.

Alongside the updating of the regulations, ASN asked EDF to evaluate the effective integration of these reference levels in its facilities. It emerges that 285 reference levels are fully implemented and the 11 remaining reference levels are partially implemented.

More particularly:

- Since the end of 2007, all the reactors in service are equipped with hydrogen passive autocatalytic recombiners (PAR) intended to prevent global hydrogen detonation in the reactor containment.
- the installation of redundant instrumentation dedicated to severe accident management, able to detect reactor vessel melt-through and the presence of hydrogen in the containment was initially planned for the third ten-year outages of the 900 MWe and 1300 MWe reactors, and the first ten-year outage of the 1450 MWe reactors. In accordance with the ASN requirement, deployment of these modifications has been speeded up to ensure that the reactors are equipped with redundant measurement instrumentation before 31/12/2017;

- the prevention of pressurized meltdown sequences is based on voluntary opening of the pressuriser safety relief valve tandems. A hardware modification to improve pressuriser safety relief valve opening reliability, decided before the Fukushima accident and already applied on certain reactors, is planned for the next 10-year outage of each reactor. For those reactors on which the modification is not applied by the end of 2013, a provisional mobile safety means for ensuring the reliability of pressuriser safety relief valve opening is provided;
- for the reactors in service, the U5 system management rules limit the pressure in the reactor containment in the event of an accident to a value slightly below its design-basis pressure by means of an associated decompression and filtration device;
- On the Flamanville 3 EPR, the CHRS (Containment Heat Removal System) evacuates heat from the containment and controls its pressure. In the framework of the stress tests, EDF proposed adding a mobile and independent water make-up system in the reactor building, via the CHRS spray nozzles, to avoid loss of containment integrity in the event of sustained loss of the off-site electrical power supplies. In addition to the measures planned to maintain containment integrity, ASN asked EDF to identify the existing or additional systems to be included in the hardened safety core to control pressure in the containment in the event of a severe accident and to analyse the advantages and drawbacks of the various possible systems.
- prevention of containment damage by corium is ensured by injecting primary coolant into the reactor vessel and then into the reactor pit via the opening in the vessel bottom if applicable. In addition to the provisions in effect, ASN has instructed EDF to study the feasibility of installing technical devices, such as a geotechnical containment or a system with an equivalent effect to prevent the transfer of radioactive contamination to groundwater in the event of a severe accident leading to corium melt-through of the reactor vessel.

ASN requirement

ECS - 27.I: Study of the feasibility of installing a geotechnical containment or a system with the same effect

I. Before 31 December 2012, the licensee shall send ASN a feasibility study for the installation or renovation of a geotechnical containment or equivalent technical measure to prevent the transfer of radioactive contamination to groundwater and, by means of underground flow, to the surface waters, in the event of a severe accident leading to corium melt-through of the vessel.

II. Before 30 June 2013, the licensee shall submit to ASN an updated hydrogeological data sheet for the site, containing the current geological and hydrogeological data.

State of progress:

- 30/06/2012: The hyrogeological data sheets for the Fessenheim, Bugey and Civaux sites have been submitted.
- 31/12/2012: The study concerning the installation of technical systems to prevent the transfer of radioactive contamination to the groundwater in the event of a severe accident which led to reactor vessel melt-through by the corium.
- 30/06/2013: Deadline for submitting the hydrogeological data sheets for the Dampierre, Gravelines, Saint-Laurent, Chooz, Nogent, Belleville, Paluel, Cattenom, Penly, Saint-Alban, Blayais, Flamanville, Tricastin, Chinon, Golfech and Cruas sites have been transmitted.

EDF concluded that a geotechnical containment at an economically acceptable cost is not feasible. This file is currently being examined by ASN and will be analysed jointly with other measures currently being studied, particularly those aiming at preventing basemat melt-through (for which EDF's studies are due on 31 December 2014).

ASN requirement

ECS - 28: EPR - Reinforcement of the provisions for managing the pressure in the containment

Before 30 June 2012, the licensee shall present ASN with the systems specified in the preliminary safety analysis report, or any systems to be added and constituting a part of the hardened safety core in order to ensure control of pressure in the containment in the event of a severe accident. Within the same time-frame, the licensee shall send ASN a study of the advantages and drawbacks of the various possible systems.

State of progress:

The elements submitted by EDF will be examined within the framework of the examination of the EPR commissioning authorisation application file.

1.3.2 Provisions for ensuring equipment resistance to severe accidents

Peer Review: *Adequate hardware provisions that will survive external hazards (e.g. by means of qualification against extreme external hazards, storage in a safe location) and the severe accident environment (e.g. engineering substantiation and/or qualification against high pressures, temperatures, radiation levels, etc.), in place, to perform the selected strategies.*

Recommendation specific to France from the 2012 Peer Review

Several equipment items required for severe accident management are not qualified for earthquakes […].
The passive autocatalytic recombiners designed for withstanding design-basis accidents are qualified to seismic standards whereas those designed to withstand severe accidents are not […].
The hydrogen recombiners and venting filters currently used on the reactor fleet will have to be qualified for external hazards.

On the reactors currently in operation, the current baseline safety requirements do not require the equipment for mitigating the consequences of a severe accident and radioactive releases to take external hazards into account. The licensee must, in response to a requirement formulated by ASN concerning the hardened safety core, specify the hardened core equipment (existing equipment and additional countermeasures) for preventing and mitigating the consequences of a severe accident. These equipment items shall be robust to hazards beyond the current hazard level considered. This applies in particular to the hydrogen recombiners and the system for limiting the pressure in the reactor containment in use on the reactors currently in operation.

ASN and its technical support organisation are currently examining the licensee's proposal.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: See above.

ASN requirement

ECS - 20: Reinforcement of spent fuel pool condition instrumentation

Wording of the requirement: See § 1.2.5.

Comment: The spent fuel pool instrumentation must be modified to allow measurement of its status (temperature and water level) and of the radiological atmosphere in the fuel building hall.

State of progress:

Water level measurement in the spent fuel pool is implemented and electrically backed-up by new generator sets, until their connection to the ultimate backup diesel-generator set.

ASN requirement

ECS - 29: Reinforcement of the U5 venting-filtration system ("sand-bed filter")

Wording of the requirement and state of progress: See § 1.2.9

Comment: The licensee submitted a detailed study of the possible improvements to the U5 venting-filtration system, considering in particular its resistance to hazards.

EDF is going to proceed with the seismic reinforcement of the U5 venting-filtration system. EDF nevertheless plans controlling the pressure in the reactor containment through an ultimate spraying system. This point is the subject of studies which will be presented at the end of 2014 and examined at a meeting of the GRP in early 2016.

1.3.3 Analysis of the provisions for severe accident management further to an extreme external hazard

Peer review: *The systematic review of SAM provisions focusing on the availability and appropriate operation of plant equipment in the relevant circumstances, taking account of accident initiating events, in particular extreme external hazards and the potential harsh working environment.*

In addition to the elements mentioned in § 1.3.2, ASN has instructed EDF to check that the emergency management actions planned for in extreme situations studied for the stress tests are effectively achievable. It also instructed EDF to take into consideration the industrial risks induced in extreme situations by nearby risk-prone facilities

---

ASN requirement

ECS - 29: Reinforcement of the U5 venting-filtration system ("sand-bed filter")

Wording of the requirement and state of progress: See § 1.2.9

Comment: This requirement provides for the performance of a detailed study into ways of improving the U5 venting-filtration system, taking into account the radiological consequences of opening the system, notably on site accessibility.

ASN requirement

ECS – 14.I: Integration of industrial risks in extreme situations

I. No later than 31 December 2013, the licensee shall supplement its ongoing studies with the inclusion of the risk arising from activities taking place near its facilities, in the extreme situations studied by the stress tests and in conjunction with neighbouring licensees responsible for these activities (nuclear facilities, installations classified on environmental protection grounds or other facilities liable to constitute a hazard). By that deadline, the licensee shall propose any modifications to be made to its facilities or their operating procedures as a result of this analysis.

State of progress:

- 30/09/2012: Studies and modification proposals submitted for the Tricastin site.
- 31/12/2012: Studies and modification proposals submitted for the Gravelines and Saint-Alban sites.

- 31/12/2013: The studies and modification proposals for the Bugey, Fessenheim, Chinon, Dampierre, Saint-Laurent, Golfech, Chooz, Nogent, Belleville, Paluel, Cattenom, Penly, Cruas, Blayais, Civaux and Flamanville sites have been transmitted.

These studies are scheduled for examination in the first half of 2015.

ASN requirement

ECS - 35.I and II: Feasibility of emergency management actions in extreme situations

Wording of the requirement and state of progress: See § 1.2.12

1.3.4 Enhancing the severe accident management guides (SAMG)

Peer review: *In conjunction with the recommendation 2.4, the enhancement of SAMGs taking into account additional scenarios, including, a significantly damaged infrastructure, including the disruption of plant level, corporate-level and national-level communication, long-duration accidents (several days) and accidents affecting multiple units and nearby industrial facilities at the same time.*

CNS*: Performing or planning an evaluation of the guidance that is to be used by the operator to manage emergency situations resulting from severe accidents caused by extreme natural phenomena at nuclear power plants, including for low power and shutdown states. These documents include emergency operating procedures to prevent core damage, severe accident management guidelines to prevent containment failure, and extensive damage mitigation guidelines to address accidents that result in fires or explosions that affect a large portion of a nuclear power plant.*

Recommendation specific to France from the 2012 Peer Review

The French severe accident management guides do not cover accidents in the spent fuel pools, nor do they include events that could affect several plant units simultaneously. The shutdown states are only included and implemented for the 900 MWe reactors; their implementation on the other plant series is planned.

The various works carried out in the framework of the stress tests took into account scenarios that had not been considered in the past. Consequently, integration of the conclusions of the stress tests and the associated requirements will lead to significant modifications in the various documents relating to severe accident management. This context has led ASN to set the following requirements and formulate the following demands.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: Implementation of the "hardened safety core" shall be accompanied by measures to ensure that the emergency organisation and resources are operational in the event of an accident affecting all or some of the facilities on a given site, which will require the preparation of specific guides relative to the various scenarios considered.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All – 30: ASN asks you to integrate into the accident operational management procedures and the severe accident management documents, including the severe accident management guidelines in particular, the new provisions for handling the extreme situations studied in the stress tests and affecting several reactors on the same site, for all operating states, as well as the fuel storage buildings.

State of progress: See § 1.2.6.

ASN requirement

ECS – 14.I: Integration of industrial risks in extreme situations

Wording of the requirement and state of progress: See § 1.3.3.

ASN requirement

ECS – 14.II: Coordination with neighbouring industrial operators in the event of an emergency

II. No later than 30 September 2012, the licensee shall take all steps, for example by means of agreements or detection and alert systems, to ensure that it is rapidly informed of any event liable to constitute an external hazard for its facilities, in order to protect its staff against these hazards and to ensure that emergency management is coordinated with the neighbouring operators.

State of progress:

- 30/09/2012: Tricastin site alert system implemented.
- 31/12/2012: Alert system on the Gravelines and Saint-Alban sites implemented.
- 31/12/2013: Alert system on the Bugey, Fessenheim, Chinon, Dampierre, Saint-Laurent, Golfech, Chooz, Nogent, Belleville, Paluel, Cattenom, Penly, Cruas, Blayais, Civaux and Flamanville sites implemented.

The studies of the Tricastin, Saint Alban and Gravelines sites are in the course of examination for the first half of 2015. The Tricastin site represents a specific case insofar as the notable industrial facilities nearby are also nuclear facilities. With regard to the other sites, the industrial facilities have no impact on the nuclear facility, therefore there is no need to coordinate the management of an accident situation other than by the measures already provided for in the off-site emergency plans implemented by the prefectures.

1.3.5 Validation of the severe accident management guides (SAMG)

Peer Review: *The validation of the enhanced SAMGs.*

The various documents relative to severe accident management will be validated following the usual processes established by ASN and the licensees. These processes include an independent technical analysis by the IRSN, ASN's technical support organisation. ASN will adopt a position regarding these documents on the basis of this analysis.

1.3.6 Severe accident simulation exercises

Peer Review: *Exercises aimed at checking the adequacy of SAM procedures and organizational measures, including extended aspects such as the need for corporate and nation level coordinated arrangements and long-duration events.*

The French regulations provide for the conducting of severe accident simulation exercises at regular intervals. Each nuclear power plant must thus carry out several exercises each year, including one in which the on-site emergency plan is deployed. Each nuclear power plant must carry out a national-scale exercise at intervals not to exceed 5 years.

The various works carried out for the stress tests considered hypotheses and new configurations that will be introduced into the severe accident simulation scenarios as and when appropriate. This context has led ASN to set the following requirement.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: The organisational means and equipment necessary for emergency management and included in the hardened safety core must be identified in the on-site emergency plans (PUI) of the sites, along with their storage locations and deployment procedures. They must be tested regularly and training in their use must be provided during exercises. These different points will be checked during ASN inspections.

1.3.7 Severe accident management training

Peer Review: *Regular and realistic SAM training exercises aimed at training staff. Training exercises should include the use of equipment and the consideration of multi-unit accidents and long-duration events. The use of the existing NPP simulators is considered as being a useful tool but needs to be enhanced to cover all possible accident scenarios.*

French regulations and the EDF on-site emergency plans (PUI) provide for regular and appropriate training of the personnel intervening on site, and the performance of several exercises on each nuclear power plant each year. Thus, each section of the site's PUI (radiological and toxic safety, climatic and similar hazards safety, etc.) must undergo an overall exercise every 3 years. The number of exercises per year and per site is determined according to the number of emergency team members, as each team member must attend one PUI exercise per year. Implementation of the new material and organisational provisions will be accompanied by specific training actions to ensure their effectiveness. This context has led ASN to set the following requirements.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2

Comment: The organisational means and equipment necessary for emergency management and included in the hardened safety core must be identified in the on-site emergency plans (PUI) of the sites, along with their storage locations and deployment procedures. They must be tested regularly and training in their use must be provided during exercises.

ASN requirement

ECS – 10: Reinforcement of team preparation in the event of an earthquake

Before 30 June 2012, the licensee shall send ASN a personnel training programme to enhance their level of preparedness for an earthquake. This programme shall in particular include regular in-situation training exercises. This programme shall have been followed by the reactor operating personnel in charge of the seismic instrumentation and of the associated operating measures no later than 31 December 2012. The other site operating teams shall receive information by 31 December 2012 and shall have followed the entire programme no later than 31 December 2013.

State of progress:

- 30/06/2012: Training programme submitted to ASN
- 31/12/2012: Deadline for training of all the personnel in charge of the seismic rack and the operating measurements
- 31/12/2012: Deadline for transmitting the information to the other operating teams.
- 31/12/2013: Deadline for dispensing training to all the operating teams.

Actions completed.

ASN requirement

ECS – 32: Multiple plant unit emergency organisation

Wording of the requirement and state of progress: See § 1.2.15

Comment: The implementation of this organisation is accompanied by specific personnel training.

ASN requirement

ECS – 35.III: Severe accident management training

III. Before 30 September 2013, the licensee shall provide the personnel concerned with the training and preparation needed to enable them to respond to particularly stressful accident situations. It shall ensure that the outside contractors liable to intervene in management of the emergency adopt similar requirements concerning the preparedness and training of their own staff.

State of progress: Actions completed.

EDF has supplemented its training courses for the parties involved in the on-site emergency plan (PUI). Moreover, a feedback of the training of the parties involved in the FARN will be performed.

EDF undertakes research and development actions on the preparation of the operators and the teams involved in the emergency situations in order to, where necessary, update the internal training course.

EDF sub-contractors are not involved in emergency situations.

1.3.8 Extension of the scope of the severe accident management guides (SAMG) to all reactor states

Peer Review: *The extension of existing SAMGs to all plant states (full and low-power, shutdown), including accidents initiated in SFPs.*

The various works carried out in the framework of the stress tests took into account scenarios that had not been considered in the past. Consequently, integration of the conclusions of the stress tests and the associated requirements will, among other things, extend the scope of the various documents relating to severe accident management to all the reactor states. In this context ASN has asked the licensee to supplement its severe accident management procedures so that they cover all the reactor states and the spent fuel pool accident situations. The licensee has also given a commitment in this respect.

ASN letter to EDF further to the meeting of the Advisory Committee of Experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

All – 30: Modification of the accident operating management procedures and of the severe accident management documents.

Wording of the demand and state of progress: See § 1.2.6.

EDF commitment given in the stress test reports submitted on 15th September 2011

Several changes in the accident operating management will be performed according to the different reactor states.

Wording of the demand and state of progress: See § 1.2.6.

1.3.9 Improvement in communication

Peer Review: *The improvement of communication systems, both internal and external, including transfer of severe accident related plant parameters and radiological data to all emergency and technical support centre and regulatory premises.*

CNS: *Improving their radiation monitoring and communications capabilities and enhancing public communications, such as via dedicated public websites.*

The improvement in means of communication has been demanded by ASN in the short term and is the subject of the following requirements.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components

Wording of the requirement and state of progress: See § 1.2. The additional means of communication have been procured.

Comment: The communication means vital for emergency management shall be included in the "hardened safety core". They comprise in particular the means of alerting and informing the emergency teams and the public authorities. If this should prove necessary, the licensee can activate the arrangements for alerting the population if the off-site emergency plan is triggered in reflex phase by delegation from the Préfet.

ASN requirement

ECS – 30: Strengthening of communication means

[…]

II. No later than 30 June 2012, the licensee sets up independent means of communication allowing direct contact between the site and the national emergency organisation defined in the interministerial directive of 7 April 2005.

State of progress: Means of communication implemented on 30/06/2012.

1.3.10 Presence of hydrogen in places where it is not planned for in the design

Peer Review: *The preparation for the potential for migration of hydrogen, with adequate countermeasures, into spaces beyond where it is produced in the primary containment, as well as hydrogen production in SFPs.*

In an accident situation, hydrogen can be produced inside the reactor vessel during the core degradation phase due to the oxidation of fuel element cladding and other materials present in the reactor vessel, or outside the vessel during the corium-concrete interaction, and by radiolysis of the water in the spent fuel pool. The hydrogen can also come from damaged hydrogen transport lines. On completion of the analyses, ASN set the following requirement and made the following demands.

Furthermore, on completion of the stress tests, EDF undertook to study the hydrogen risk in the other peripheral buildings of the reactor containment. The study of the hydrogen risk in the annulus on the

1300 MWe reactors has been examined as part of the periodic safety review associated with their third 10-year outage.

ASN requirement

ECS - 19: Redundancy of instrumentation for detecting reactor vessel melt-through and hydrogen in containment

Wording of the requirement and state of progress: See § 1.2.5.

ASN letter to EDF further to the meeting of the advisory committee of experts on reactors in November 2011: CODEP-DCN-2012-020754 of 26 June 2012.

Fleet-04: ASN asks you to speed up application of the SSE design-basis requirement to hydrogen systems and the integration of the "seismic interaction" approach for lines carrying hydrogen. Before the end of 2012, you will send me a revised implementation schedule.

Fleet – 05: ASN asks you to guarantee the SSE resistance of the hydrogen presence detectors and their shut-off valves which are located outside the reactor building, and to supplement the future safety baseline requirements to take this into account.

State of progress:

Implementation schedule submitted, the upgrading deadlines have on average been met 3 years earlier than specified in the initial programme (the work is finished on the CP0 & N4 plant series and will be completed in 2017 on the CPY series, 2018 on the P4 series and 2020 on the P'4 series).

1.3.11 Management of large volumes of contaminated water

Peer Review: *The conceptual preparations of solutions for post-accident contamination and the treatment of potentially large volumes of contaminated water.*

ASN has checked that the industrial development work in this area is in progress. Research projects in this area have been presented under a call for research project proposals dedicated to nuclear safety and radiation protection, launched after the Fukushima Daiichi accident. The result of this call for project proposals will be known in 2013.

State of progress:

EDF has carried out detailed studies on this subject as part of the prescription relative to the evaluation of geotechnical containment on the sites. ASN will adopt a position on these studies in the first half of 2015.

1.3.12 Radiation protection

Peer Review: *The provision for radiation protection of operators and all other staff involved in the SAM and emergency arrangements.*

CNS: *Improving their radiation monitoring and communications capabilities and enhancing public communications, such as via dedicated public websites.*

Among the technical and organisational provisions of the hardened safety core, and pursuant to the ASN requirement, the licensee must integrate the provisions necessary to ensure the availability of the active dosimetry equipment, the measuring instruments for radiation protection and the personal and collective protective equipment. Furthermore, the verification of the feasibility of the human actions prescribed by ASN must take into account the radiation protection of the persons involved. Lastly, ASN has instructed the licensee to check that it is possible to monitor and manage the facilitates after radioactive releases while taking into account the radiation protection of the persons involved.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components.

Wording of the requirement: See § 1.2

Comment: The licensee shall take all the measures necessary to ensure the availability of the active dosimetry equipment, the measuring instruments for radiation protection and the personal and collective protective equipment.

State of progress:

These items of equipment have been procured by the sites. It will be checked during the ASN inspections.

ASN requirement

ECS - 31: Modifications to ensure facility management further to releases

Before 31 December 2012, the licensee shall send ASN a file presenting the planned modifications on its site to ensure that, in the event of release of dangerous substances or opening of the U5 venting-filtration system, operation and monitoring of all the facilities on the site are guaranteed until a long-term safe state is reached; the corresponding deployment schedule shall also be provided.

State of progress:

The licensee has submitted the dose estimates for different scenarios and different parties involved in emergency management. The instrumentation specific to the hardened safety core shall be put in place along with the hardened safety core.

ASN requirement

ECS - 35.I and II: Feasibility of emergency management actions in extreme situations

Wording of the requirement and state of progress: See § 1.2.12

Comment: The planned emergency management actions in extreme situations must be effectively achievable by the personnel under the conditions of intervention. The licensee has identified the personnel and resources necessary for emergency situation management. EDF conclusions will be examined by ASN.

1.3.13 On-site emergency management premises

Peer Review: *The provision of an on-site emergency centre protected against severe natural hazards and radioactive releases, allowing operators to stay onsite to manage a severe accident.*

CNS: *Upgrading regional, off-site and on-site emergency response centres.*

The emergency premises (security block – BDS, emergency equipment stores) were designed without applicable regulatory requirements relative to flooding and earthquakes. The BDS is temporarily uninhabitable after opening the U5 system filter.

ASN has therefore set the following requirements which make it mandatory to include the emergency situation management premises in the "hardened safety core", and for them to be highly resistant to hazards and to remain accessible and habitable at all times and during long-duration emergencies, including in the event of radioactive releases. Pending the installation of new emergency premises that meet these requirements, ASN has instructed the licensee to guarantee the design of the existing emergency premises against the seismic and flooding levels of the current baseline safety requirements.

ASN requirement

ECS - 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core.

Hardened safety core based on diversified structures and components.

Wording of the requirement and state of progress: See § 1.2

Comment: The elements essential for management of the emergency, that is to say the emergency management premises, the material resources required for emergency management, the means of communication and the essential technical and environmental instrumentation, shall be included in the hardened safety core. The emergency management premises must be designed and dimensioned for hazards beyond the current design safety baseline. They shall be accessible and habitable during long-duration emergencies and designed to accommodate the teams necessary for long-term site management.

On each site the licensee is going to build a local emergency management centre to meet the design-basis conditions of the hardened safety core.

ASN requirement

ECS – 30: Designing the emergency premises to withstand earthquakes and flooding

I. The licensee shall ensure that the emergency situation management premises can withstand flooding in the event of the flood safety margin level being reached. Before 30 June 2012, it presents ASN with the conclusions of this verification and any modifications considered necessary. Before 30 June 2013, it shall perform any necessary reinforcement work.

State of progress:

- 30/06/2012: The situation assessment to verify the resistance of the premises to flooding and the planned modifications were presented to ASN. After verification, the emergency premises did not require additional protection against flooding

The licensee checks that the emergency management premises can withstand the safe shutdown earthquake (SSE). Before 30 June 2012, it presents ASN with the conclusions of this verification and any modifications considered necessary. Before *[Date variable according to the sites, see below]*, it shall perform any necessary works.

State of progress:

- 31/06/2012: The situation assessment to verify the resistance of the premises to flooding and the envisaged modifications has been carried out.
- 31/06/2012: The compensatory measures to ensure the SSE resistance of the Civaux, Cruas and Flamanville sites have been defined.
- 30/06/2013:
    - The studies performed enabled to ensure the SSE resistance of the emergency premises of Bugey, Chinon, Chooz, Dampierre, Fessenheim, Gravelines, Paluel, Penly, Saint-Alban and Saint-Laurent sites.
    - Completion of the modifications necessary to ensure the SSE resistance of the emergency premises of the Belleville, Cattenom, Golfech and Nogent sites.
- 31/12/2013:
    - Completion of the modifications necessary on the Cruas and Tricastin sites in order to ensure the SSE resistance of emergency premises.
    - Implementation of the arrangements to manage emergency situations, due to an earthquake, from SSE resistant premises on the Civaux and Flamanville sites.

II. No later than 30 June 2012, the licensee sets up independent communication resources allowing direct contact between the site and the national emergency organisation defined in the interministerial directive of 7 April 2005.

State of progress: See § 1.3.9. Action completed.

III. No later than 30 June 2013, the licensee shall store its mobile resources necessary for emergency management in appropriate premises or zones able to withstand the SSE and flooding in the event of the flood safety margin level being reached.

State of progress: See § 1.2.13. Action completed.

ASN requirement

ECS – 32: Multiple plant unit emergency organisation

Wording of the requirement and state of progress: See § 1.2.15

Comment: The material and organisational provisions to take account of accident situations simultaneously affecting all or some of the facilities on the site also concern the on-site emergency management centre.

1.3.14 Support to the personnel on site

Peer Review: *Rescue teams and adequate equipment to be quickly brought on site in order to provide support to local operators in case of a severe situation.*

CNS: *Upgrading regional, off-site and on-site emergency response centres.*

The licensee has planned to reinforce the current emergency organisation, particularly by setting up a Nuclear Rapid Response Force ("FARN" in its French acronym) with material and human resources. The FARN is a national organisation specific to the licensee, which will be capable of rapidly providing material and human aid to one or more sites in difficulty simultaneously. This organisation must notably allow the relief of the teams present on the site if it is impossible for the normally planned relief teams to fulfil this function or to get to the accident-stricken site. ASN has set the following requirement.

ASN requirement

ECS – 36: The Nuclear Rapid Response Force (FARN)

Wording of the requirement and state of progress: See § 1.2.13

Comment: The FARN has specialist teams capable of intervening in the areas of operational control, maintenance and logistics on a site in an accident situation. The FARN's activities can be broken down into short-term (less than 3 days) or long-term (more than 3 days) activities.

The short-term activities have the following aims:

- bring operational control skills onto the site to back up or relieve the shift team;
- bring in additional material resources, connect them up and put them into service within 24 hours ;
- ensure radiological monitoring of the environment;
- bring to the site, in situations lasting more than 24 hours, the necessary logistics for correct operation of the resupplied functions.

The long-term activities have the following aims:

- deploy major equipment resources (protection of the environment, water production, radiation protection means, etc.);
- prepare for continuation of these actions beyond the first days of autonomy in the event of a long-duration emergency (including logistic resupply);
- mitigate the environmental impact of discharges, particularly by seeking to restore containment and treat the radioactive effluents;

- set up a rear base allowing long-term management of the accident.

Activation of the FARN is decided at national level on the basis of a situation analysis. The FARN comprises a national headquarters and four regional centres situated on the Bugey, Civaux, Dampierre and Paluel NPP sites.

The FARN national HQ is attached to EDF central management situated in the Paris region and its main duties are to supervise and manage the FARN and interface with EDF top management. The regional centres report to the FARN national HQ.

The regional centres have on-call intervention columns of 14 people with the varoius professional skills required (process, intervention, logistics). The equipment is stored in premises specific to each centre. Each column is capable of dealing with 2 reactors and can bring in the equipment necessary for this. Potential rear base locations are identified near the nuclear power plants.

The FARN has transport and handling equipment, redundant telecommunication means and equipment for ensuring the resupply of water and electricity (pumps, compressors, diesel generator sets, etc.).

1.3.15 Probabilistic Safety Assessment of level 2 (Level-2 PSA)

Peer Review: *A comprehensive Level 2 PSA as a tool for the identification of plant vulnerabilities, quantification of potential releases, determination of candidate high-level actions and their effects and prioritizing the order of proposed safety improvements. Although PSA is an essential tool for screening and prioritizing improvements and for assessing the completeness of SAM implementation, low numerical risk estimates should not be used as the basis for excluding scenarios from consideration of SAM especially if the consequences are very high.*

The contribution of the post-Fukushima approach, and particularly the setting up of the hardened safety core, is to make provisions for dealing with initiating accidents that go beyond the design basis, possibly combined accidents, irrespective of their probability of occurrence.

The aim of this approach is to cover the highly improbable situations.

The widening of the coverage of the level-1 PSAs, and the development of new level-1 and 2 PSAs, are subjects that are systematically included in the reactor periodic safety reviews.

The following table defines the PSAs currently available and the main categories of initiating events considered for each French reactor plant series.

Plant series	Initiating events considered for the level 1 and 2 PSAs
900 MWe reactors (CP0-CPY)	Failures within the reactor (PSA 1 and 2) Fire (PSA 1 for the CPY)
1300 MWe reactors (P4-P'4)	Failures within the reactor (PSA 1 and 2) For safety review associated with the 3rd 10-year outage, the following shall also be considered: • the events associated with the SFP (PSA 1 and as part of next reviews for PSA2); • on-site fire and flooding (PSA 1); • earthquake, climatic hazards and off-site flooding (PSA 1) in relation to VD4 900.
1400 MWe reactors (N4)	Failures within the reactor, integration of operating feedback (PSA 1) A level-2 PSA will be carried out for the next periodic safety review.
1650 MWe reactors (EPR) under construction	With a view to the commissioning licensing application, the level-1 PSA will be revised and the level-2 PSA will be established. They shall take into account: • the events within the reactor; • the events associated with the SFP; • earthquakes; • on-site fire and explosion; • on-site flooding

1.3.16 Studies relative to severe accidents

Peer Review: *The performance of further studies to improve SAMGs. Examples of areas that could be improved with further studies include:*

- *The availability of safety functions required for SAM under different circumstances.*
- *Accident timing, including core melt, reactor pressure vessel (RPV) failure, basemat melt-through, SFP fuel uncovering, etc.*
- *PSA analysis, including all plant states and external events for PSA levels 1 and 2.*
- *Radiological conditions on the site and associated provisions necessary to ensure MCR and ECR habitability as well as the feasibility of AM measures in severe accident conditions, multi-unit accidents, containment venting, etc.*
- *Core cooling modes prior to RPV failure and of re-criticality issues for partly damaged cores, with un-borated water supply.*
- *Phenomena associated with cavity flooding and related steam explosion risks.*
- *Engineered solutions regarding molten corium cooling and prevention of basemat melt-through.*
- *Severe accident simulators appropriate for NPP staff training.*

CNS: *Developing probabilistic safety assessments to identify additional accident management measures or changes in radiation protection measures for workers on the site that might be needed to perform necessary activities in the event of a severe accident.*

The subjects proposed by the peer review are questions that are addressed systematically at the meetings of the Advisory Committee of Experts dedicated to the studies carried out for the 10-yearly periodic safety reviews. Furthermore, some questions can form the subject of comparisons with international practices at the meetings of the Advisory Committee of Experts on reactors dedicated to the analysis of operating experience feedback from the French and foreign reactors (organised every two to three years).

On the subjects mentioned by the peer review, progress has been made in the following areas:

- on the habitability of the control and emergency management rooms, see § 1.2.9;
- on the level-2 probabilistic safety assessments, see § 1.3.15;
- the requirements associated with the behaviour of the equipment in severe accident situations are being examined as part of the third 10-year outages of the 1300 MWe reactors; a meeting of the Advisory Committee of Experts has been held in the 1st quarter of 2013 to present the progress in this area (examination of the conditions for maintaining the qualification over time);
- management of the water in the reactor pit, with regard to the benefit brought by a possible retention of corium in the reactor vessel or pit and the risk of vapour explosion (which today is still the subject of R&D work and debate between experts), has been examined as part of the meeting of the Advisory Group of Experts held in the 1st quarter of 2013 and is also examined as part of the fourth 10-year outages of the 900 MWe reactors.

ASN has moreover set the following requirement.

ASN requirement

ECS - 27.I: Study of the feasibility of installing a geotechnical containment or a system with the same effect

Wording of the requirement and state of progress: See §1.3.1

Comment: ASN has asked EDF to update the site hydrogeological data sheets, grouping the geological and hydrogeological data for each site. An evaluation of the transfer time of potential pollution between the reactor buildings and the area immediately downstream of the site is presented. Along with the feasibility study, this information will help assess the appropriateness of implementing measures to prevent any ingress of water into the soil or subsoil.

2 IMPLEMENTATION OF THE OTHER SUBJECTS ADDRESSED IN THE FRAMEWORK OF THE CONVENTION ON NUCLEAR SAFETY

Summary of the main changes since 2013:

- France has put in place a new national response plan for a major nuclear or radiological accident;
- In March 2013 ASN set up a new emergency centre in its head office in Montrouge, designed on the basis of the best international standards;
- A baseline emergency requirements, including the lessons learned from the accident of Fukushima Daiichi, has been deployed on all the French NPPs;
- ASN maintains its high level of international involvement, at both European level and beyond. ASN actively participates, for example, in the reflections conducted by the European radiation protection authorities in order to harmonise population protection measures on either side of national frontiers.

2.1 NATIONAL ORGANISATIONS

The Fukushima Daiichi nuclear power plant (NPP) disaster confirms that in spite of the precautions taken in the design, construction and operation of nuclear facilities, the possibility of an accident can never be ruled out, therefore it is necessary to plan for and regularly test the material and organisational provisions for coping with such a situation. France thus wished to draw all the lessons from this disaster and has undertaken work on nuclear emergency management which has resulted in a new national response plan for a major nuclear or radiological accident, reflecting the government's determination to enforce tightened requirements in terms of safety of nuclear facilities and transport operations .

This plan is based on the existing measures, such as the alert system specific to nuclear events, the system for disseminating information around the nuclear sites, the off-site emergency plans, the on-site emergency plans and the nuclear licensees' emergency response organisation. The plan supplements the above measures to integrate hypotheses that would require a State response to reinforce the safety of the population in the event of a severe accident occurring beyond the French borders, and to cope with the possibility of radioactive material transport accidents, including at sea.

The adequacy of this plan was tested and confirmed in June 2013 during an exercise carried out around a nuclear power plant.

2.1.1 The main actors involved in a radiological emergency situation in France

In the context of a radiological emergency situation, the ministries concerned on account of their remit, and ASN, gear themselves to advise the government and the Prefect - the government's representative who is responsible for managing the situation at local level - on the protective measures to take. They provide the information and advice to enable them to assess the state of the facility, the seriousness of the incident or accident, its possible developments, and the measures required to protect the general public and the environment.

The main state entities involved at national level are:

The SGDSN (General Secretariat for Defence and National Security):

The SGDSN, which is placed under the authority of the Prime Minister, is responsible for ensuring the interministerial consistency of the planned measures in the event of an accident, and for the planning and assessment of exercises. It ensures the secretaryship of the CICNR (French Interministerial Committee for Nuclear or Radiological Emergencies). Meetings of the CICNR are convened by the Prime Minister. Its role is to coordinate the governmental action in radiological or nuclear emergency situations and is

therefore responsible for developing the interministerial policy relating to national defence and security and for monitoring its implementation.

Ministry of the Interior:

The DGSCGC (General Directorate for civil security and crisis management) has the COGIC (French Government Emergency Management Operations Centre) and the MARN (Nuclear Risk Management Aid Committee) at its disposal. It provides the Prefect, who is responsible for the rescue operations, with material and human resources to protect persons and property.

Ministry of Health:

It ensures human health protection against the effects of ionising radiation.

Ministry of Ecology, Sustainable Development and Energy (MEDDE):

The MSNR (Nuclear Safety and Radiation Protection Mission) participates in the State's nuclear safety and radiation protection missions in collaboration with the other competent departments. It contributes, in cooperation with the ministry in charge of civil protection services, to the setting up of the national emergency organisation to cope with a nuclear accident (or during radioactive material transportation) or any accident which may affect health by radiation, happening in France or with potential impact on French territory.

Ministry of Defence:

The ASND (Defence Nuclear Safety Authority) is the competent authority for inspecting the safety of secret basic nuclear installations (SBNIs), of military nuclear systems (SNM) and defence-related transport operations. ASN and the ASND signed an agreement on 26 October 2009 to coordinate their efforts in the event of an accident affecting an activity controlled by the ASND in order to facilitate the transition from the emergency phase managed by ASND to the post-accident phase for which ASN is the competent authority.

Ministry of Foreign Affairs and International Development (MAEDI):

Under the "Early Notification and "Assistance" conventions and the 1987 decision of the European Council, the MAEDI is the "national alert point" responsible for immediately passing on the information received. It is also responsible for responding to requests for assistance received from third countries, if they are covered by an interministerial instruction. The MAEDI is also responsible for managing French nationals abroad (holding plans and providing safety equipment, issuing via the embassies the relevant information and measures advocated by the French authorities, planning for a possible evacuation, etc.). Lastly, it is responsible for communications of a political nature with the IAEA, in liaison with France's member of the IAEA Board of Governors and through the French permanent representation. The information stipulated by the international conventions are provided by ASN, as competent authority, to international organisations (IAEA and European Union).

Nuclear Safety Authority (ASN):

ASN is involved in the management of radiological emergency situations. With the technical assistance of the IRSN, it checks the measures taken by the licensee, assists the government in all questions for which it is competent, and informs the public on the state of safety of the facility causing the emergency situation. ASN moreover acts as competent authority within the framework of the international agreements on early notification. The duties of ASN are described in more detail in the next chapters.

Institute of Radiation Protection and Nuclear Safety (IRSN):

IRSN is the technical support of ASN. In case of radiological emergency situation, IRSN analyses, in close cooperation with technical teams of the licensees, the collected data and measurements, in order to establish a diagnostic of the situation and the prospects concerning the evolution of the accident, the

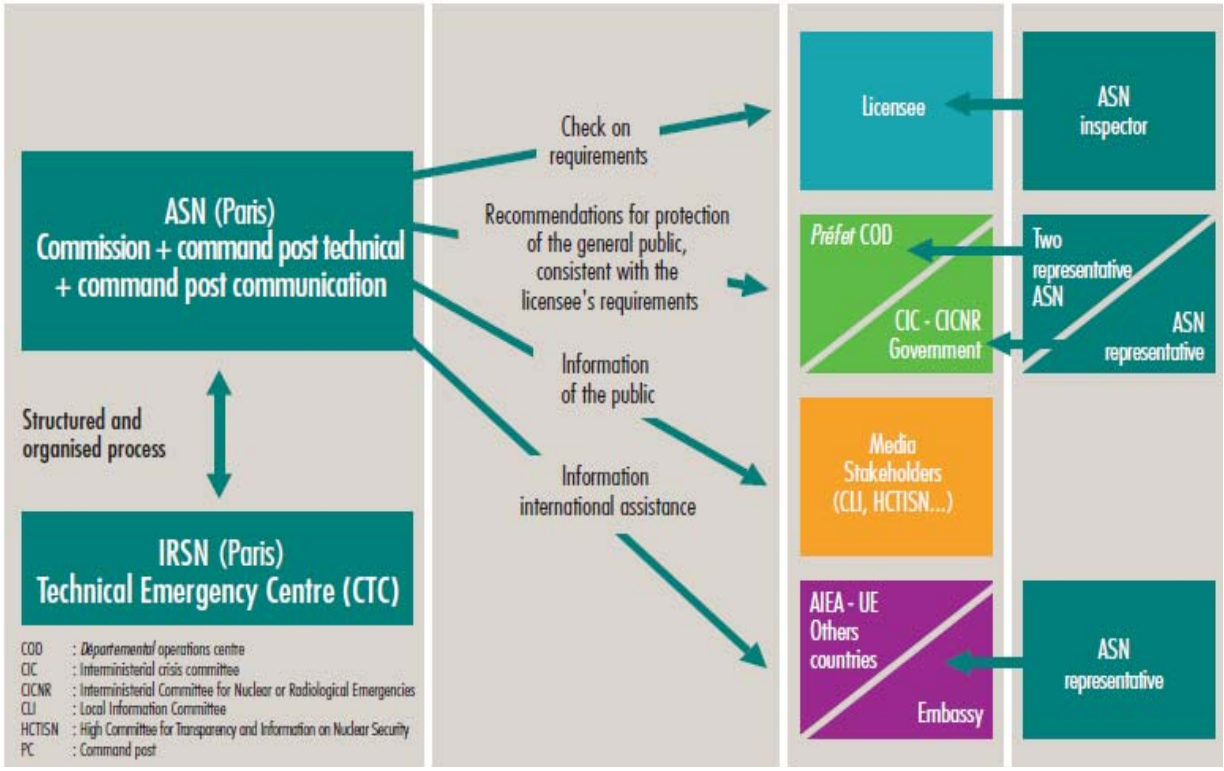
releases and their consequences on the population and the environment. In particular, IRSN establishes, in cooperation with Météo France, patterns of radioactive releases dispersal, even on a world scale.

2.1.2 ASN duties in a radiological emergency situation

Pursuant to the provisions of the "TSN Act" on Transparency and Security in the Nuclear Field of 13 June 2006, now codified in the Environment Code, ASN is an independent administrative authority and participates in the management of radiological emergency situations for questions relating to nuclear safety and radiation protection. Aided by the IRSN expertise, it fulfils four main duties, namely:

- ensuring the validity of the measures taken by the licensee, and checking the licensee if necessary,
- advising the Government and its local representatives with regard to measures for protecting the general public and the environment,
- participating in the dissemination of information to the various audiences,
- acting as competent Authority in the framework of the international agreements.

These four duties are taken up in the diagram below:



To carry out its duties ASN has its own emergency centre, whose activation is not necessarily an indication of the gravity of the situation, and has its alert system which allows rapid mobilisation to staff the emergency centre and of IRSN which rigs its own technical emergency centre, the DGSCGC, the SGDSN and Météo France. The alert system, the emergency centre and its equipment are regularly tested during emergency exercises. In particular, during these exercises, ASN exchanges information with the European Commission, the IAEA and the member countries (ECURIE and USIE).

2.1.3 Experience feedback to ASN from the Fukushima Daiichi accident

The Fukushima Daiichi NPP accident has not only confirmed the ability of ASN and the IRSN - its technical support organisation - to mobilise their resources in a large-scale accident situation but also revealed the points that need to be improved in an emergency situation.

2.1.3.1 Large-scale mobilisation

The follow-up of the Fukushima Daiichi NPP accident mobilised about 200 staff members of all levels, from all the departments and several regional divisions, who manned the emergency centre on a rota basis. Altogether this operation mobilised 1,000 man-days in one month.

The very high level of mobilisation of the ASN staff made it possible to man the emergency centre. Although ASN was able to answer the questions of the various audiences thanks to this mobilisation, the Fukushima Daiichi accident did disrupt significantly its daily functioning. The IRSN, which also activated its technical emergency centre to produce diagnoses and predictions concerning the accident and releases, and to assess its consequences on health and the environment, likewise found that its capacities reached the point of "saturation",.

ASN and the IRSN thus concluded that a nuclear accident occurring closer to hand, in Europe, would lead to the mobilisation of all their resources to respond to the needs of the French authorities, and that an accident in France would raise real difficulties in terms of human and material resources.

2.1.3.2 The importance of international coordination

During the accident, ASN participated in regular audio conferences, organized by the United States (USNRC), with the United Kingdom (HSE/ONR) and Canada (CNSC). These audio conferences enabled the four nuclear safety authorities to share information quickly and efficiently and thereby improve their understanding of the accident and the source term.

Conversely, the lack of coordination between the European countries and the differences in approaches concerning the control of foodstuffs and products at country borders raised questions from the public. At a more general level, the lack of harmonisation in public protection measures could lead to important difficulties to manage emergency situations, in particular in case of a border nuclear power plant.

Consequently, the nuclear safety and radiation protection authority associations WENRA and HERCA have initiated work to streamline and harmonise the actions undertaken by the safety organisations. France is actively participating in this work.

2.1.3.3 The predominant position of communication

The prime objective of the handling of the accident and deployment of the emergency centres in France was to inform the various audiences about the accident and its development, and of the risks run by the French population (in France and in Japan). ASN was thus in permanent contact with the ministries and the French embassy in Japan, the media, its foreign counterparts and the international organisations (ASN communications involved 17 press conferences, 28 press releases, and 1,200 media queries).

ASN adapted its modes of communication so that it could cope with the streams of questions from the public. ASN organised regular press conferences, and trained external service providers to respond to the large number of telephone queries.

2.1.3.4 Environmental monitoring

France has set up a national environmental radioactivity monitoring network (RNMRE) which collects and makes available to the public environmental radioactivity measurement results and documents synthesising the radiological situation in the country and evaluating the ionising radiation doses to which the general public is exposed.

This network has a website http://www.mesure-radioactivite.fr/public/ which posts on line the measurements made by ASN-approved laboratories, including associative laboratories.

Giving the public access to data provided not only by the public authorities and the licensees but also by associations, contributes to transparency and reinforces the public protection measures implemented. Following the Fukushima accident, ASN and the IRSN are undertaking reflections to facilitate data exchange between the RNMRE and the CRITER data base of IRSN application if events arise.

2.1.3.5 The action plan relative to ASN's internal organisation in a radiological emergency situation

In order to gain maximum benefit from the lessons it learned in its management of the Fukushima accident, ASN organised a general assessment involving all its personnel. This assessment highlighted the lines of improvement concerning the material and logistic resources, the ASN emergency centre's missions and internal functioning, its deployment and the ASN's external relations (with the media and public, the IRSN, the other public and institutional players and the international authorities).

More specifically, ASN realised the relevance of renovating its emergency centre and training its staff in post-accident management. When ASN moved to its new premises in Montrouge, it set up a new emergency centre there in March 2013, designed on the basis of the best international standards. This centre has been tested successfully in the course of some ten exercises.

2.2 OFF-SITE ORGANISATION IN POST-ACCIDENT EMERGENCY SITUATIONS

In the event of an accident in a nuclear installation such as one of EDF's NPPs, the emergency organisation is based on an on-site emergency plan (PUI) that is the responsibility of the licensee, and an off-site emergency plan (PPI) that is the responsibility of the Prefect. This organisation is regularly tested during emergency exercises.

ASN's role in this organisation is to approve the PUI and communicate its elements to the Prefect for the development of the PPI. ASN also plays a role, as one of the actors in the emergency organisational structure, by fulfilling its four duties as detailed in 2.1.2.

2.2.1 Principles governing the emergency organisation in France

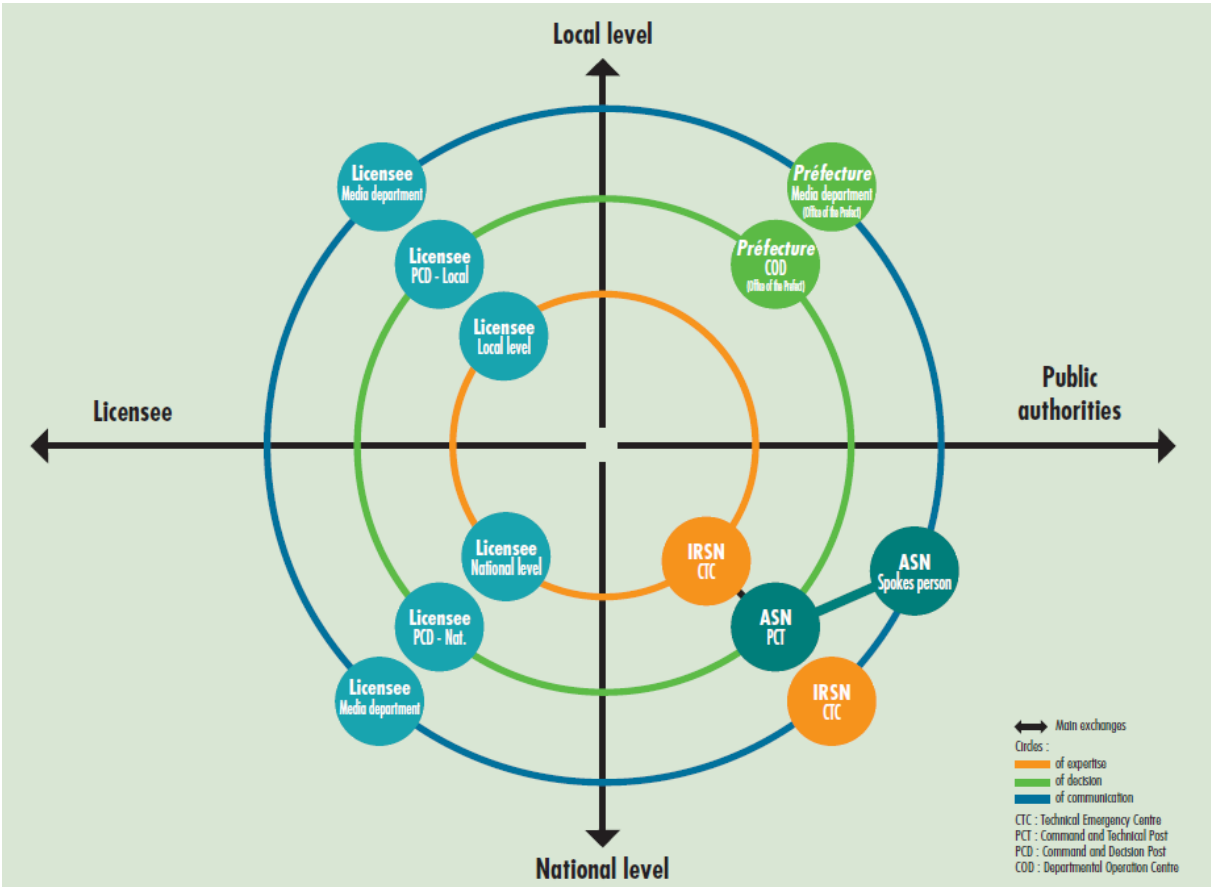
The emergency organisation implies establishing coordinated emergency plans:

- **the on-site emergency plan (PUI),** under the responsibility of the licensee, designed to control the situation at the nuclear facility level. The PUI describes the measures necessary to protect the site personnel, the population and the environment, and to control an accident and its consequences;
- **the off-site emergency plan (PPI),** under the responsibility of the public authorities, to ensure the protection of the populations. On the basis of the PPI, the Prefect can mobilize environment monitoring systems (measurement plan) and take, after consulting ASN, any necessary measures to protect the population.

For the PUI of the NPPs, EDF has adopted an organisation comprising two complementary levels, one local (on site) and one national, with their respective responsibilities and duties clearly defined. The organisational structure is identical on all the sites, as the NPP fleet is standardised. The local level concentrates on the operation of the facility while the national level focuses on how the situation could evolve. New post-Fukushima baseline emergency requirements are currently being deployed on all the French NPPs.

The national emergency organisational structure is based on tight relationships between relevant public entities, the Government and the Safety Authority, licensees and technical experts. These relationships are organized according to three circles of expertise, decision-making and communication, in which audio conferences are regularly set up.

The following diagram shows the decision-making circle and the exchanges leading to decisions and guidance pertaining to the safety of the installation and to the protection of the population. It must be stressed that this diagram shows a simplified version of a complex organisation which also involves ministerial levels.



The communication circle, which now incorporates IRSN, enables entities to coordinate communication methods and content, in order to deliver clear and reliable information to the local population and to the general public, notably through the national and local media.

2.2.2 Identified avenues for improvement

Further to the Fukushima Daiichi NPP accident, public authorities initiated a reflection on ways of improving nuclear accident management with the ministries, the technical support organisations and the licensees. Certain study areas relate to the emergency plans (PUI and PPI) and are presented below.

2.2.2.1 Protection of populations

The relationship between the various measures to protect the population and the existing plans (ORSEC, PPI, iodine plan, etc.) is one of the areas for improvement in crisis management.

In order to start reflection on this topic, an inventory has been drawn up, notably under the authority of the Interior Ministry. It has revealed the weaknesses of existing plans while identifying the ways of strengthening them:

- alerting and informing the local population in the zone were protective measures have been taken, by a geolocation system (cell-broadcast);
- completion of the doctrine pertaining to evacuation, which constitutes, along with sheltering and the taking of stable iodine tablets, one of the three important measures under a PPI.

2.2.2.2 Means of communication and alert

As part of the stress tests conducted in France, one of the technical prescriptions addressed by ASN to the licensee EDF concerns reinforced means of communication which are vital for emergency management, and comprise in particular:

- means of alerting and informing the emergency teams and the public authorities,
- the means used to alert the populations if the PPI is triggered in the reflex response phase by delegation from the Prefect.

These complementary means of communication and alert will be integrated by the licensee in the "hardened safety core" of material and organisational measures to control the basic safety functions in extreme situations (see Section 1).

Pursuant to ASN prescriptions, stand-alone means of communication allowing direct contact between the site and the national emergency organisation entities (Prefect, ASN, EDF national, in particular) have been put in place.

2.2.2.3 The international approach

This accident highlighted the difficulties that would be encountered by ASN, IRSN, and their European counterparts in managing a large-scale accident in Europe. The nuclear safety regulators confirmed the need for mutual assistance mechanisms. Moreover, the radiation protection authorities are currently conducting reflections (WGE emergencies, HERCA-WENRA) in order to coordinate population protection measures on either side of national frontiers (see §2.3.1). Although authorities have already undertaken work to improve their response organisations, several years will be needed to succeed in concrete results. As set out in § 2.3, ASN is actively involved in the work conducted at European level.

Lastly, ASN also takes part in the IAEA's work to improve notification and information exchanges in radiological emergency situations. It participates in defining the strategy for international assistance needs and resources, and in the development of the Response Assistance Network (RANET). ASN is a member of the IAEA's National Competent Authorities' Coordination Group (NCACG), in which it has represented the competent authorities of Western Europe since 2005.

2.2.2.4 Post-accident phase

In 2005, at the request of the Government, ASN set up the "CODIRPA", a post-accident phase steering committee, associating numerous actors concerned by post-accident management: public authorities, licensees, associations, experts. The procedure followed by the CODIRPA led to the development of constituents of a first national doctrine for the post-accident management of a moderate scale nuclear accident leading to short-duration releases. A document designed for the local and national actors concerned was published in November 2012. It is available at www.asn.fr. It is intended to both incite these bodies to reflect upon the preparation for such a situation and to guide them in the management of a real emergency situation.

In late 2012, the CODIRPA, chaired by ASN, decided to continue its work, primarily driven by the need to take account of the lessons learned from the post-accident management implemented in Japan in the wake of the Fukushima Daiichi accident, but also to ensure support for the preparatory work to be organised in the regions. Some questions are also still on hold, pending the outcome of the first phase of the CODIRPA's work and the thought that has so far been given to intermediate scale accidents must be extended to include the management of severe accidents.

In this context, three areas for focus were proposed:

- test and supplement the elements of doctrine with respect to the different accident situations;
- assist with the regional implementation of the post-accident management findings;
- take into consideration and share international work carried out on the post-accident theme.

Post-accident management of a nuclear accident is a complex subject involving numerous aspects and players. The ongoing thought being given to this subject must continue to benefit from the support of a pluralistic structure based on the current participants of the CODIRPA, plus other stakeholders involved in the preparation of post-accident management.

2.3 INTERNATIONAL COOPERATION

At international level, the ASN's action will fall within the following recommendation of the second extraordinary meeting of the Contracting Parties to the Convention on Nuclear Safety: "The Contracting Parties encourage international cooperation through the IAEA and the networks of regulators, operators and technical support organisations to share information on the lessons learned from the Fukushima Daiichi accident".[9]

2.3.1 International action at European level

ENSREG

ASN will continue to participate actively in the post-Fukushima activities of the European Nuclear Safety Regulators Group (ENSREG), in both the plenary sessions and the working groups.

ASN will participate in the peer review of the national action plans in early 2015, and in the seminar to be organised in April 2015.

WENRA

In 2011, WENRA (Western European Nuclear Regulators' Association), an informal club created in 1999 on the initiative of the ASN chairman, continued its work on the harmonisation of safety rules for reactors and waste management facilities. Right from the meeting of 22 and 23 March 2011, all the WENRA members, including the ASN chairman, considered that the association should be a driving force in Europe to learn lessons from the Fukushima accident.

On the invitation of the European Council as of 24 and 25 March 2011, and as part of the post-Fukushima initiatives, the WENRA Reactors Harmonization Working Group (RHWG) played a key role in preparing the specifications for the stress tests of the European nuclear reactors.

ASN will continue to play a leading role within WENRA, notably by ensuring the technical secretariat for WENRA and the RHWG.

ASN is also participating in the reflection on the emergency situation preparedness and management component

HERCA

HERCA (Heads of European Radiological Protection Competent Authorities), an association formed by 55 radiation protection competent authorities from 31 European countries (including the 28 Member states of the European Union), has set itself the goal of developing a joint approach to radiation protection and practices, and thereby contributing to a high level of radiation protection in Europe. ASN ensures the technical secretariat of the association.

The Fukushima accident has had a large impact on the work of HERCA, as it has for other organisations, and ASN is strongly involved in the actions undertaken in this context. It is noteworthy to emphasize the works of HERCA aiming at coordinating and, if possible, harmonising the public protection measures in the event of near (within Europe) or distant accidents.

A new approach baptised the "HERCA Approach" has been developed in the area of emergency situation preparedness. It aims at achieving better European coordination of emergency situations. This approach, which is based on the principles of mutual knowledge, exchange of information, trust and position alignment, should allow the implementation of more consistent protection measures at European level. It should also serve as a basis for application of article 99 of the new BSS directive (Euratom Directive 2013/59) on international cooperation in terms of emergency situation preparedness and management. The approach was tested during a workshop organised in 2013 in Cologne, in which ASN was strongly involved.

[9] Point 4 of the press release of 31st August 2012 containing the main conclusions of the extraordinary meeting.

In the same area, but considering the case of a distant accident, HERCA has approved a document containing practical measures for better harmonising the responses of European countries in the event of a nuclear or radiological emergency in a non-European country.

The "HERCA approach" for emergency situations has been presented in the main professional forums, both European (2nd ENSREG conference, the committee of Article 31 of the Euratom Treaty, etc.) and international (NEA, IAEA). To avoid duplicating the work in other forums, HERCA has taken measures to ensure better coordination of the post-Fukushima actions with other organisations and clubs (WENRA, NEA, etc.). In line with ENSREG's post-Fukushima action plan, where ENSREG asked HERCA and WENRA to work together to produce mutual assistance guides, HERCA and WENRA coordinated their actions in this area. This resulted in a reinforcing of the collaboration between the two regulators' clubs.

Thus, in January 2014, in the area of emergency management, HERCA and WENRA created a joint task force whose purpose is to harmonise the decisions taken in severe accident situations. The aim of this task force was to submit proposals to the two associations in October 2014 concerning "reflex" actions to take in a precise situation, namely that of a severe accident where the authorities have very little information on the condition of the installation concerned. The task force brought together 21 members of the safety and radiation protection authorities of 14 different countries. Under the chairmanship of Philippe Jamet, ASN Commissioner, the task force held four working meetings between March and October, which enabled the member countries to converge towards joint positions on the basis of existing approaches in this area (HERCA approach, Nordic approach and the German approach NERDA). The final document produced by the task force was presented to the HERCA and WENRA Boards at an extraordinary meeting held in Stockholm on 22 October 2014. The HERCA approach was approved by WENRA at that same meeting. Each European nuclear safety and radiation protection regulatory body will start discussions, at national level with the authorities in charge of civil protection, in order to assess the implementation of the recommended actions. The collaboration between HERCA and WENRA in this area should also continue in the coming months. ASN will support this collaboration.

2.3.2 International actions on the multi-lateral plane (outside Europe)

IAEA

ASN will continue to follow the recommendations given in the nuclear safety action plan developed by the International Atomic Energy Agency (IAEA) further to the Fukushima accident, and those of the *Final Summary report* of the second extraordinary meeting of the contracting parties to the Convention on Nuclear Safety Nuclear (CNS) (CNS/ExM/2012/04/Rev.2). This concerns the following points in particular:

- Recourse to the peer reviews such as:
    - The IRRS (*Integrated Regulatory Review Service*) missions: in November 2014 ASN received an IRRS mission tasked with examining its entire field of action (called a "full scope" mission).

      ASN will moreover continue its involvement by having its experts participate in IRRS missions organised both within and outside Europe;
    - the OSART (Operational Safety Review Team) missions: each year France receives an OSART mission on a nuclear power plant, and a follow-up mission for a previous OSART.
      In November 2014 the head office departments of EDF received a "Corporate OSART" mission.
      ASN will continue to make public the reports relative to these missions.
- ASN is actively participating in the work to prepare the Diplomatic Conference to examine the Swiss amendment proposal concerning Article 18 of the Convention on Nuclear Safety (CNS);
- Report on the application of international conventions: ASN will continue to make public the reports produced in application of the Convention on Nuclear Safety and the Joint Convention

Furthermore, ASN will continue to take part in the IAEA's work to improve notification and information exchanges in radiological emergency situations. It is involved in defining the strategy for international assistance needs and resources, and in the creation of RANET (Response Assistance Network).

G8/NSSG

France played an important role in engaging discussions and deciding concrete actions at the highest levels of State responsibility, particularly in 2011 when France chaired the G8-G20. After March 11th it worked actively to have the G8 Heads of States and Governments adopt a proactive statement on the questions of nuclear safety at the Deauville summit (May 26th-27th, 2011).

A ministerial meeting on nuclear safety was jointly organised in Paris by France and the Nuclear Energy Agency (NEA) on 7th June 2011 to bring together the ministers responsible for nuclear safety in the G8-G20 countries. The conclusions of this interministerial meeting of 7th June 2011, which focused on risk prevention and improving emergency management, were widely disseminated.

Following on from these actions, and more particularly in the framework of the G8 Nuclear Safety and Security Group (NSSG), ASN will continue to work within the French delegation for the harmonisation of the positions to promote the continuous development of nuclear safety in the world, particularly in the area of the decommissioning of nuclear installations, which is the priority of the German chairmanship.

Nuclear Energy Agency (NEA) of the OECD

Further to the Fukushima Daiichi accident, the NEA set up a cross-organisation task group (Senior-level Task Group on Impacts of the Fukushima Accident) to identify the subjects that could be addressed by the NEA's various committees and working groups. In September 2013, this working group comprising experts from the regulators and certain technical support bodies published a report entitled "the Fukushima Daiichi NPP accident – OECD/NEA nuclear safety response and lessons learnt". On the basis of the conclusions of this report, complementary work is currently being carried out within the NEA technical committees on varied subjects (defence in depth, safety culture, emergency situation preparedness, etc.).

ASN will continue to contribute to these various undertakings, by taking the chair of certain groups, as is the case with the group set up to work on defence in depth, which is chaired by JL Lachaume, Deputy Director General of ASN).

2.3.3 Bilateral actions

Thanks to the longstanding bilateral relations between ASN and its counterparts, information exchanges - which were particularly intense - during the Japanese emergency, continued in a sustained manner

ASN has renewed its cooperation agreement with its Japanese counterpart, integrating its change of status and areas of competence.

An annual cooperation action plan is drawn up to define the subjects of common interest. Several meetings are organised by the two parties, giving rise to dynamic and productive interchanges.

3 IMPLEMENTATION OF THE ADDITIONAL MEASURES PRESCRIBED BY ASN : SUBCONTRACTING

The social, organisational and human factors, which are key elements in safety, received particular attention during the stress tests performed in France : the technical specifications, developed at the European level, have been supplemented by elements on sub-contracting, a topic which was then subject to a specific evaluation. On completion of the various investigations, ASN indicated that it was retaining three priorities in this area:

- the renewal of the licensees' workforce and skills.
- the organisation of subcontracting, which is a major and difficult issue,
- the research into these subjects, for which programmes must be initiated at national or European level.

After the stress tests, ASN has set up a pluralistic working group on these subjects called the CoFSOH (Social, organisational and human factors steering committee). This committee includes, apart from ASN, representatives of institutions, environmental protection associations, personalities chosen for their scientific, technical, economic, social, or information and communication expertise, persons in charge of nuclear activities, nuclear industry professional federations and representative employees' unions.

Seven plenary meetings of this committee were held since 2012, notably to start the discussions on the following subjects: conditions of subcontracting and relations between the ordering customer and subcontractors, the relationship between "managed security" and "regulated security", management of skills in a context of staff renewal, and the evaluation of organisation or the use of relevant human and organisational factors (HOF) indicators to assess safety.

Since the beginning of 2013 and in parallel with the plenary meetings, the work of the CoFSOH has been continuing through three working groups. The twenty eight meetings held to date have addressed the following subjects:

- subcontracting in normal operating situations: work organisation and conditions;
- management of emergency situations;
- the legal questions raised by the subjects addressed in the other two working groups.

Furthermore, the order "setting the general rules relative to basic nuclear installations", called the "BNI Order", was signed on 7 February 2012. The provisions of this order cover the organisation and responsibilities of the BNI licensees in particular. Several articles in the BNI order cover subcontracting:

- The licensee must have the necessary in-house technical competence to oversee the activities that directly concern the safety of the installation;
- The licensee must establish and implement a policy that gives priority to nuclear safety and protection of the environment, disseminate this policy and ascertain that it is known, understood and applied by all the personnel required to implement it, including outside contractors' personnel.
- The activities important for protection, their technical control, the verifications and assessments are carried out by persons with the necessary skills and qualifications. The licensee ascertains that the outside contractors take the necessary training measures to maintain these skills and qualifications and, where necessary, to develop them;
- The licensee takes all necessary measures to enable outside contractors to detect the deviations that concern them and report them to the licensee without delay.
- The licensee monitors the outside contractors.
- Monitoring of performance of activities important for nuclear safety and radiation protection of the environment by an outside contractor must be ensured by the licensee, who may not subcontract this task. This being said, in particular cases the licensee can be assisted in the monitoring, on condition that it retains the skills necessary to maintain control of said monitoring (article 2.2.3).

4 TRANSPOSING WENRA SAFETY REFERENCE LEVELS FOR EXISTING REACTORS INTO THE FRENCH REGULATORY FRAMEWORK

The WENRA safety reference levels (RLs) were initially developed in the first half of the 2000s. Consistent with ASN Chairman's commitment, as all other WENRA members' commitment, to incorporate the RLs into the national regulatory framework, ASN drafted an action plan to develop several ministerial orders and ASN guidance to reflect WENRA RLs. This action plan was finalized early in 2006.

The publication of the Transparency and Nuclear Security act (TSN act) mid-2006, establishing ASN as an independent administrative authority and giving ASN power to issue technical regulations ("decision") which were legally binding, as well as the publication late 2007 of several governmental decrees précising the act, lead ASN to revisit its action plan. As a result, a new roadmap was defined in 2008, based on the following principles :

- one ministerial order drafted, in close cooperation with the Minister responsible for nuclear safety, addressing all types of nuclear installations, and not only NPP;
- several ASN technical regulations, most of them detailing provisions of the ministerial order;
- as far as possible, ASN technical regulation setting requirements applicable to all types of nuclear installations and stating preferably result to be achieve rather than means for achievement;
- legally binding requirements are preferred supplemented by guides developed by ASN, when a legally binding requirement would not be appropriate.

The drafting process included an initial specification of the various RLs, or sometimes Issue, to take into account in a specific draft. For example :

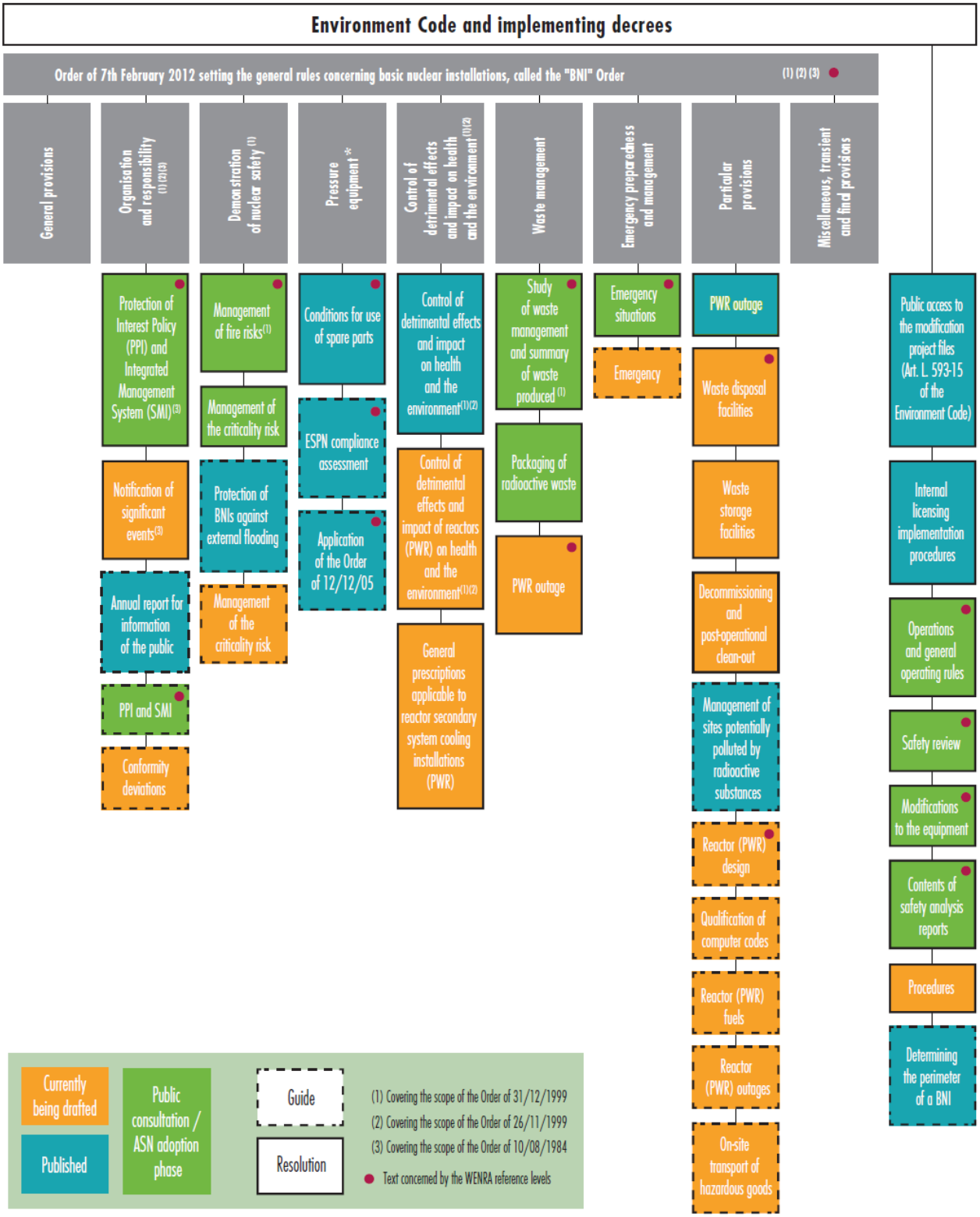
- RLs of Issue P on Periodic Safety Review (PSR) are already partly covered by the TSN Act and the remaining RLs are expected to be addressed in the ASN technical regulation on PSR process;
- RLs of Issue N on the Content of the Safety Analysis Report (SAR) are already partly covered by the TSN act and the 2007 Procedure decree and the remaining RLS are expected to be addressed in the ASN technical regulation on the content of SAR;
- Most of RLs of Issue E and F will be addressed in an ASN guide on the design of NPP although some RLs are already addressed in the ministerial order.

Certain steps in the process for developing statutory resolutions or guides give rise to a detailed ASN internal report on the taking into account of reference levels. Furthermore, in order to have an overall view of the transposition of the reference levels, the traceability of their integration in the various published regulatory texts and guides is provided by a summary table internal to ASN.

Following Fukushima Daiichi accident, WENRA developed an updated set of RLs which were published in September 2014. Most changes are introduced in Issue E and Issue F and a new Issue T on natural hazards was created. Up to now, WENRA did not make any specific statement on the timing for transposition into national regulations.

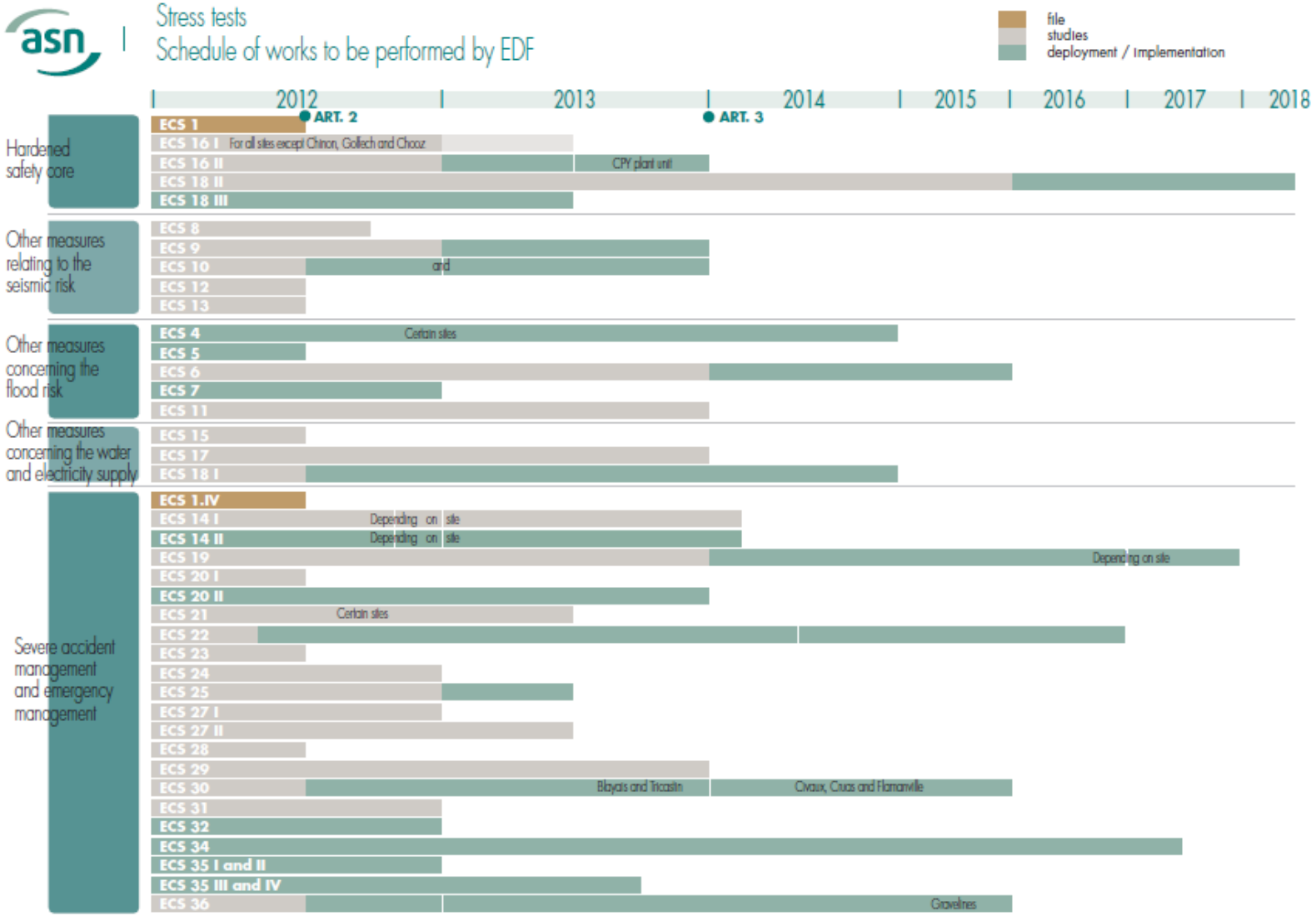
As France has not yet completed the transposition of the 2008 RLs into France regulatory framework, the drafters of ASN regulations were notified of this new set and the updated RLs are expected to be included in those drafts which have not yet been submitted to public consultation, which is for example the case for the guide on NPP design. ASN is currently considering how to address RLs of issue T in France regulatory framework.

The goal, as well as relation to WENRA RLs is summarized in the figure below.



* Title V entitled "Pressure equipment specially designed for basic nuclear installations" of the BNI Order refers to the Order of 10th November 1999 concerning the monitoring of main primary system and main secondary system operations in pressurised water nuclear reactors and the Order of 12th December 2005 concerning nuclear pressure equipment. Projects for modification of these orders are currently being drafted.

5 GENERAL SCHEDULE



Stress tests
licensee: EDF

Hardened safety core
Earthquake
Flooding
Water and electricity supplies
Severe accident management and emergency management

Art.2 :	Implementation schedule for all the measures
Art.3 :	Interim assessment of lessons learned from the accident
ECS - 1:	Defining the structures and components of the "hardened safety core", including the emergency management premises Defining the requirements applicable to this hardened safety core Hardened safety core based on diversified structures and components
ECS - 4:	End of the Blayais experience feedback (REX) work
ECS - 5:	Conformity of the volumetric protection
ECS - 6:	Reinforcement of protection against flooding, above the current safety baseline
ECS - 7:	Measures to cope with site isolation in the event of flooding (Cruas, Tricastin)
ECS - 8:	Conformity of seismic instrumentation with RFS1.3.b
ECS - 9:	Reinforcement of the seismic interaction approach
ECS - 10:	Reinforcement of team preparation in the event of an earthquake
ECS - 11:	Robustness of the Fessenheim and Tricastin embankments
ECS - 12:	Verification of the seismic design basis of the fire-fighting system
ECS - 13:	Study of the implementation of automatic shutdown in the event of an earthquake
ECS - 14.I:	Integration of industrial risks in extreme situations
ECS - 14.II:	Coordination with neighbouring industrial operators in the event of an emergency
ECS - 15:	Heat sink design review
ECS - 16.I:	Emergency water make up system
ECS - 16.II:	Emergency water make-up in the reactor coolant system, for shutdown states
ECS - 17:	Reinforcement of the facilities to manage long lasting situations of total loss of heat sink or total loss of electrical power supplies
ECS - 18.I:	Reinforcement of battery autonomy
ECS - 18.II:	Ultimate backup diesel generator sets
ECS - 18.III:	Installation of provisional emergency generator sets
ECS - 19:	Redundancy of instrumentation for detecting reactor vessel melt-through and hydrogen in containment
ECS - 20:	Reinforcement of pool condition instrumentation
ECS - 21:	Additional measures to prevent or mitigate the consequences of a fuel transport package falling in the fuel building Studies of the consequences of a package falling in the fuel building
ECS - 22:	Reinforcement of the measures to prevent accidental rapid draining of the pools
ECS - 23:	Placing a fuel assembly in safe position during handling
ECS - 24:	Thermohydraulic development of a pool accident
ECS - 25:	Reinforcement of the provisions for managing a transfer tube leak
ECS - 27.I:	Study of the feasibility of installing a geotechnical containment or a system with the same effect
ECS - 27.II:	Updating of the hydrogeological sheets
ECS - 28:	EPR - Reinforcement of the provisions for managing the pressure in the containment
ECS - 29:	Reinforcement of the U5 venting-filtration system ("sand-bed filter")
ECS - 30:	Designing the emergency premises to withstand earthquakes and flooding
ECS - 31:	Modifications to ensure facility management further to releases
ECS - 32:	Multiple plant unit emergency organisation
ECS - 34:	Updating of agreements with hospitals
ECS - 35. I and II:	Feasibility of emergency management actions in extreme situations
ECS - 35. III and IV:	Accident management training
ECS - 36:	FARN (Nuclear rapid intervention force)