



French Approach to European Stress Tests

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ASN Immediate Actions

- **Campaign of targeted inspections**
- **“Stress test” analysis of the safety of nuclear facilities**
 - Applies to 150 nuclear installations in France (58 NPP, NPP under construction, fuel cycle facilities, research reactors, etc.)
 - Covers:
 - extreme natural events (earthquake, flooding,...)
 - loss of the ultimate heat sink or loss of electrical power
 - severe accident management
 - Is complementary to existing safety improvement processes
 - periodic safety reviews
 - integration of operating experience feedback

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Stress Tests at the European Level

- **Stress Tests performed in France under the control of ASN in the framework of “European Stress Tests”**
- **Common Terms of reference for all European countries**
- **European approach included benchmark and peer reviews**
- **All results were made available for the public**

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Regulatory Milestones for the Stress Test Process

- **ASN initial requirement**
Utilities to perform "stress tests" (May 2011)
- **ASN position on stress tests results**
Conclusion on Stress Tests Results (January 2012)
- **ASN general requirements**
EDF to implement measures to strengthen safety (June 2012)
- **ASN complementary requirements**
Hardened Safety Core objectives and design (January 2014)

Utilities required to propose and justify technical measures

IRSN and experts standing group provide with technical expertise



ASN Position on Stress Tests Results (January 2012)

Main conclusions

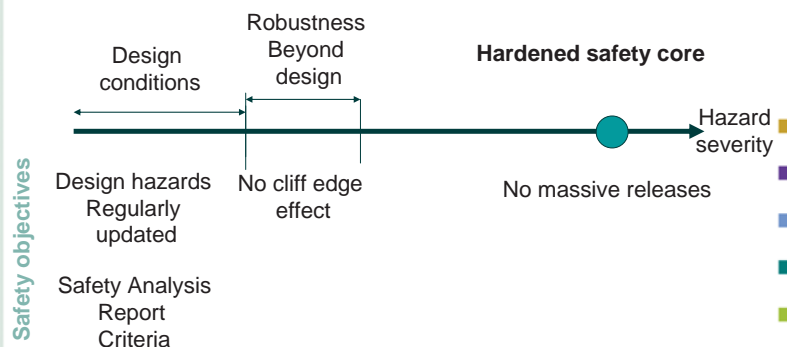
- No need for immediate shutdown
- Need to increase robustness of facilities to withstand extreme situations beyond safety margins as soon as possible

Main measures to be taken:

- **Hardened Safety Core:** limited number of material and organizational dispositions to guarantee safety functions in extreme situations
- **Nuclear Rapid Response Force:**
 - Intervention team
 - Able to supply local team (trained staff and materials)
 - Fully operational on a site in 24 hours



The Hardened Safety Core





ASN General Requirements (June 2012)

For each site, EDF requested to:

- **Reinforce safety margins** beyond design-basis earthquake and flooding
- **Implement new and robust safety measures** rather than performing sophisticated analysis
- Implement safety improvements **as soon as possible**, not waiting for the next **Periodic Safety Reviews**



ASN General Requirements (June 2012) Hardened Safety Core

Safety goals for the Hardened Safety Core in situations considered in the Stress Tests

- To prevent or mitigate severe accidents
- To mitigate large-scale radioactive releases
- To enable the licensee to perform its emergency management duties



ASN General Requirements (June 2012) Hardened Safety Core

Strengthened equipment including

- An **additional ultimate electricity generating set / reactor**
- A **diverse emergency cool-down water supply / reactor**
- **New crisis management premises** resisting hazards, accessible and habitable at all times and during long-duration emergencies
- **Mobile equipments and means of communication** essential to emergency management
- Technical and environmental **instrumentation**



ASN General Requirements (June 2012) Nuclear Rapid Response Force

Nuclear Rapid Response Force (FARN): specialized teams available in less than 24 hours to:

- Take over from the personnel of a site affected by an accident
- Deploy additional emergency response equipment
- Insure simultaneous intervention on all reactors:
 - of a 4-reactors site by the end of 2014
 - of a 6-reactors site by the end of 2016



ASN Complementary Requirements (January 2014) Hardened Safety Core

Detailed safety goals for the Hardened Safety Core

- Prevent core melting by giving priority to cooling by the secondary system
- Ensure performance of the containment
- Allow residual heat removal from the containment without opening the venting system



ASN Complementary Requirements (January 2014) Hardened Safety Core

EDF requested to:

- **Define the list of SSCs composing the hardened safety core and their qualification requirements**
 - New SSCs designed according to industrial standards
 - Existing SSCs verified according to industrial standards, or verified according to methods allowed during Periodic Safety Reviews





ASN Complementary Requirements (January 2014) Hardened Safety Core

- Definition of seismic hazard for hardened safety core design (return period - 20 000 years)
- Requirements regarding external hazards (other than earthquakes and flooding)
- Requirement to ensure dropping of control rods under hardened safety core situations

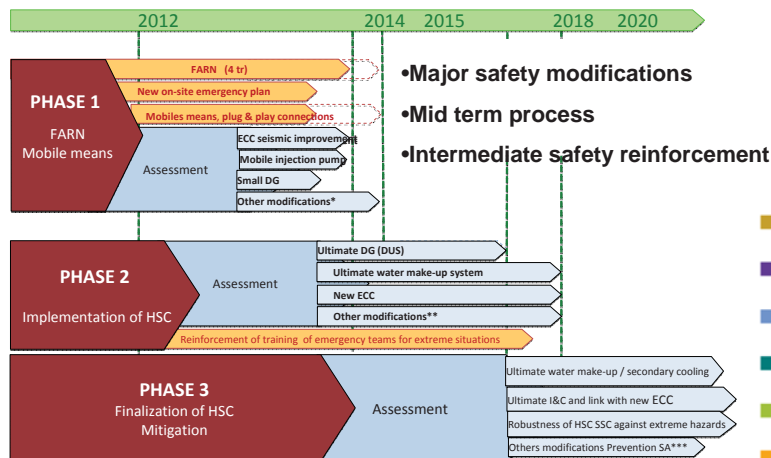


ASN Complementary Requirements (January 2014) Hardened Safety Core

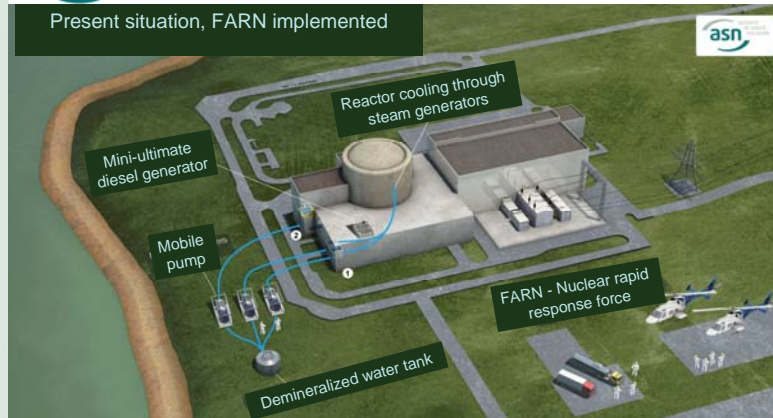
- Required independence of hardened safety core I&C and electrical systems from existing ones
- Required definition of hardened safety core instrumentation
- Required verification of pools structural resistance and absence of dewatering of the fuel assemblies under hardened safety core situations



Time schedule

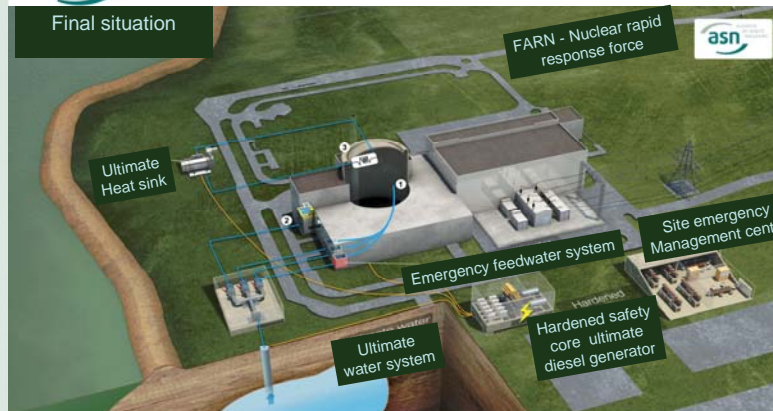


Present situation, FARN implemented



1 : Reactor cooling system
2 : Fuel pool cooling system

Final situation



1 : Reactor cooling system
2 : Fuel pool cooling system
3 : Reactor containment cooling system

- Complete experience feedback from Fukushima accident will take at least 10 years
- Stress Tests performed in European framework. European Benchmark to be continued
- Stress Tests lead to strengthen the robustness of NPPs for beyond design situations to prevent accidents resulting from unforeseen/extreme natural hazards and to limit their consequences
- Two main set of measures are defined: hardened safety core and nuclear rapid action force
- Before full implementation, transitory measures are requested

Acronyms

- **ASN** French nuclear regulatory body
- **DUS** Ultimate diesel generator
- **ECC** Emergency Control Centre
- **EDF** *Électricité de France*
- **FARN** Nuclear Rapid Response Force
- **HSC** Hardened Safety Core
- **IRSN** French Institute for Radiation Protection and Nuclear Safety
- **PSR** Periodic Safety Review

Lessons Learned (European Level)

- **Necessary development of European guidance on assessment of natural hazards and margins**
- **Importance of Periodic Safety Reviews for continuous improvement of safety**
 - Necessity to re-evaluate natural hazards at least every 10 years
 - PSR of the existing reactors should be guided by the objective of avoiding off-site contamination.



- **Need to maintain containment integrity**
 - Urgent implementation of recognized measures (H2 explosion prevention...) for NPPs where not yet implemented
- **Need to implement measures to prevent and limit consequences of accidents in case of extreme natural hazards and limit their consequences**

