Nuclear Safety in France

Upcoming challenges

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Unprecedented challenges

- Nuclear safety faces **unprecedented challenges** :
  - For the industry
  - For the regulator (ASN) and itsTSO (IRSN)

- Combination of **two factors** :
  - Massive investments – and related technical files within a few years
  - economic difficulties, budgetary constraints, changes in organisations

Massive investments…

- NPPs and fuel cycle facilities reach 40 years of operation
  - Extending reactors' lifetime **beyond 40 years**
  - Periodic safety review of research reactors and fuel cycle installations
- Fukushima actions plan follow-up
- Decommissioning
- New facilities (EPR, RJH, Iter, Cigeo)

… and current events

- Conformity issues
- Carbon content anomalies in large forged components
- An (up to now) beyond belief fact : manufacturing irregularities and suspicions of falsifications

Life extension of NPPs beyond 40 years (1)

- ¾ of the NPP fleet built between 1979 and 1989
  - Is about to reach 40 years at the same time
  - Huge investments are expected on each plant

- Decision making process
  - April 2016 : ASN position on the work programme
  - Generic position from ASN expected in 2020-2021
  - Specific positions after the decennial outages
  - Including consultation of the public

Life extension of NPPs beyond 40 years (2)

- 2017-2018 : ASN contributes to the ENSREG Topical Peer Reviews on ageing management

- Technical discussions on reasonably practicable improvements (implementation of EU directive 2014) : core melt management, fire protection…

PSR of Research Reactors and Fuel Cycle Facilities

- **2015 Energy Transition for Green Growth Act**: extension or PSR to research reactors and fuel cycle facilities

  20-25 PSR files being assessed, 30 files expected in 2017

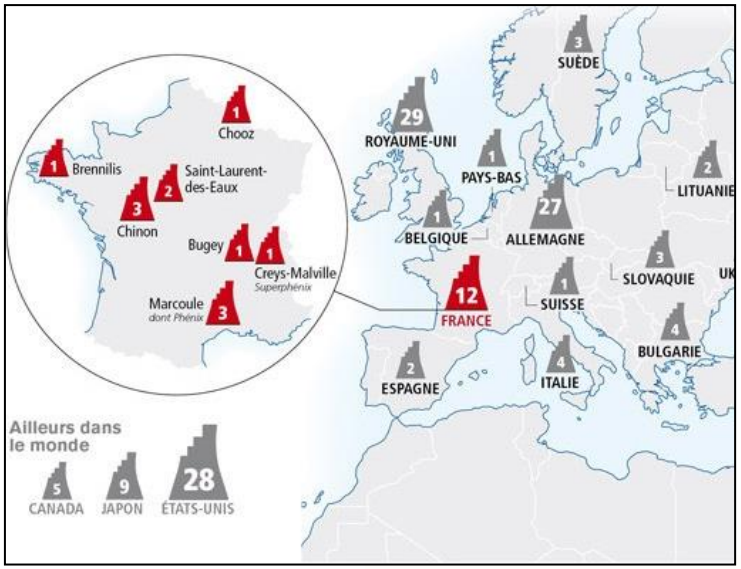
- **Specificities**
  - No generic aspect (unlike NPPs): each facility faces unique challenges and is at a different stage in its operation (incl. decom.)
  - 1st PSR for many facilities → conformity check and implementation of requirements for facilities commissioned more than 40 years old for some of them
- **Sample of conclusions**
  - Osiris (CEA Saclay): facility shutdown (after partial PSR given the planned shutdown date)
  - INB 116 et 117 (Areva La Hague): discovery of an advanced corrosion issue of fission products concentrating evaporators.

Fukushima Follow-up

- **Organizational provisions have been implemented**
  - EDF's **Nuclear Rapid Response Force** (« FARN »), designed to deploy from its 4 bases and intervene as quick as possible after an accident to provide equipment and to ensure the cooling and electric supply of the damaged plant.
- **Still much work remaining to implement a « hardened safety core » on each site**
  - Design improvements to prevent a severe accident, mitigate the consequences and handle emergency management.
  - Back-up diesel generators, diverse ultimate heat sink, bunkerised emergency management center…
  - nearly unrivaled worldwide
- **Similar provisions on other nuclear facilities**

Decommissioning of nuclear facilities

- Decommissioning: a current and future challenge for France
  - 12 reactors are already being dismantled (« graphite-gaz » type, experimental reactors). The operator must justify its strategy to ASN.
  - Gen. 2 reactors, commissioned from the 1970s to the 1990s.
- 2015 Energy Transition for Green Growth Act (2015)
- → « Immediate Dismantling » Principle



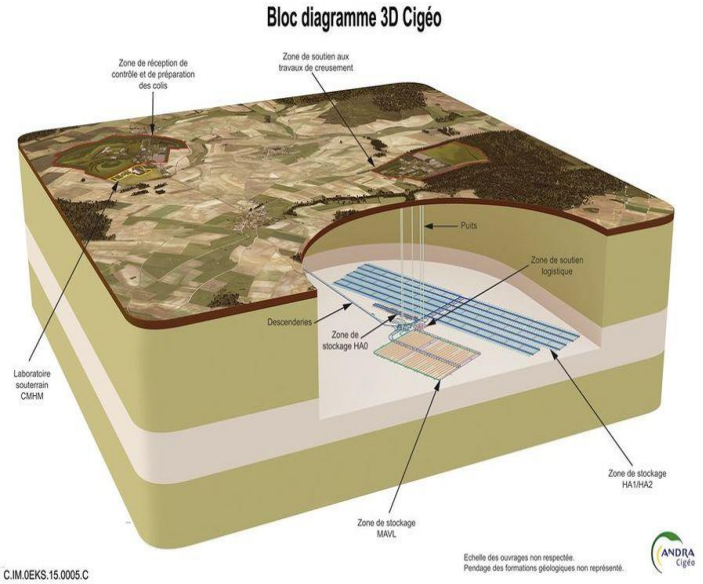
New facilities

- Good design, major safety improvements
  - Can be used as a reference to improve safety of existing facilities

- Lack of construction practice leads to delays
  - Up to 6 new NPPs / year in the 80's
  - Loss of competencies in the subcontractors and supply chain

Cigéo: Deep geological disposal

- Cigéo: a reversible disposal for high and intermediate long-lived waste
  - 500m below ground, between two layers of clay
  - 100 years of operation (period of reversibility)



- 11/2016: IAEA ad hoc peer review.
- 2017: Assessment by IRSN, meeting of ASN Advisory Expert Group, ASN position on the Safety Options File

- Andra application expected in 2019, subject to government's position

Conformity issues

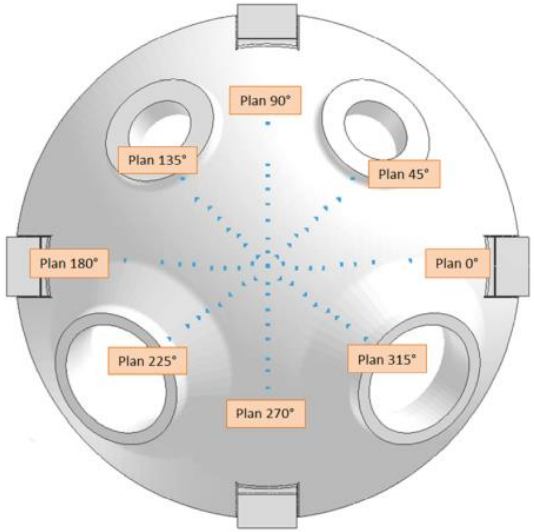
- **Several technical anomalies detected by EDF on various equipments**
  - Diesel generators auxiliary systems
  - Fire fighting pipes
  - Most of these anomalies are related to a lack of resistance to earthquake and exist since the construction of the plants

- **Lessons and questions**
  - Mainly detected by EDF : good safety culture ; however too much tolerance towards non-conformities ?
  - Why not detected before ?
  - Specificity of French plants or same (undetected) anomalies in other countries ?

Carbon content anomalies in large forged components

Review of all forged heavy components

- Review asked by ASN
- Several SG bottom channel heads affected
- High probability of carbon segregation
- Charpy V-notch tests results (approximately 30J at 0°C): no compliance with French regulation on a qualification component
- Potential risk: fast fracture
- ASN asked EDF to justify the structural integrity of these components



Carbon content anomalies in large forged components
EPR reactor pressure vessel

- The question raised by ASN has required extensive studies and tests by the manufacturer
- Numerous experts involved in the review process
  - IIRSN and ASN's specialised department
  - GPESPN, with foreign experts invited
- Decision-making process involving stakeholders
  - NGOs associated to technical discussions
  - Draft ASN position submitted to open consultation (13000 comments received)
- Acceptable but periodic NDE required ; not feasible on the head => Requirement to replace the head before 2024

Manufacturing irregularities

- **2015:**
  - Several cases of **nonconformance** in the products manufactured at Le Creusot
  - ASN requests **inspections of past manufacturing products**, which exhibit **noncompliant** results
- **2016:** **New inspections** launched by AREVA
- **2017**: **Full examination** decided - 6000 files in the nuclear field (2.4 million pages), more than 170 people involved in examinations

April 2016

Discovery of « marked files »

→

July 2016

Discovery of irregularities in « unmarked files »

→

From September 2016

Full examination process

Manufacturing irregularities

- **New SG in Gravelines – ASN request to check files**
- Irregularity discovered in a **unmarked** file
- Changes made to the results of mechanical tests on the upper shell
- **File archived by Le Creusot ≠ File transmitted to licensee and ASN**

Archived File (Le Creusot)

REPERE	SENS PRELEVEMENT	TEMPE	ENERGIE de RUPTURE (IMPACT ENERGY) JOULES			FIBROSITE DUCTILE	EXPANSION LATERALE lateral
ITEM	ORIENTATION	RATURE °C	IMPOSEE REQUIRED	RESULTATS RESULTS	MOYENNE AVERAGE	FRACTURE VERFORMUNG	expansion seitliche ausdehnung
NR	PROBENLAGE	TEMP	SOLLWERT	ERMITELT	MITELWERT	%	mm
Z5887							
VD1	Circonférentiel (Longitudinal)	0°C	≥ 80 Moy.	170	159	80	2,2
VD2	"	"	≥ 60 Indi.	139		50	1,8
VD3	"	"	"	167		75	2.1
AD1	Axial (Travers)	0°C	≥ 80 Moy.	42	83	5	0,7
AD2	"	"	≥ 60 Indi.	42		5	0,7
AD3	"	"	"	165		70	2,2

Transmitted File

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VD2	"	"	≥ 60 Indi.	139		50	1.8
VD3	"	"	"	167		75	2.1
AD1	Axial (Travers)	0°C	≥ 80 Moy.	98	128	25	1.5
AD2	"	"	≥ 60 Indi.	120		40	1.7
AD3	"	"	"	165		70	2.2

Consequences of these irregulaties

- The current supervision system does not take into account the possibility of falsifications
- ASN working group set up to identify how to adapt the control procedure to such possibilities
- First ideas (examples)
  - Make all players accountable (liability on supplier supervision; reliability of supervision system)
  - Adapt inspection methodologies (questioning attitude; networking on detected case)
  - Rely upon third party organization
  - Enhance data's integrity and traceability
  - Adapt communication and information tools

Facing unprecedented challenges : Analysis and conclusions

- ASN is better prepared than 10-15 years ago to face such challenges :
  - Status since 2006 : independent authority
  - Regulatory framework : enforcement powers, technical regulation
  - Transparency policy, public participation
  - Additional staff granted by the Government (+50 between 2015 and 2017)

- ASN reflects upon control methodologies such as :
  - Graduated approach
  - New types of challenges such as **C**ounterfeit **F**raudulent **S**uspect **I**tems.

Facing unprecedented challenges : Analysis and conclusions

- Building on the national frameworks, international cooperation is key in addressing these challenges – shared for most of them, within the European Union and beyond :
  - Ageing Management : TPR
  - Reasonably practicable improvements : WENRA
  - New NPP designs : MDEP
  - Deep Geological Repository : DGRRF

- Need for the TSO to continue their cooperation in order to share common evaluation methods for the benefit of the regulators.