AREVA Complementary Safety Assessments
La Hague reprocessing plant

Atomic Energy Society of Japan

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Christophe Loy : AREVA La Hague Safety Deputy Director
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La Hague Plant brief presentation
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  - Identification of Severe Accident Scenarios
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  - La Hague “Complementary Safety Assessment”
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Conclusions
La Hague Reprocessing Plant

Brief presentation
La Hague Plant brief presentation
French governance

in nuclear safety matters
French governance in nuclear safety matters

Parliament
Parliamentary office for assessment of scientific and technological choices

Decrees and orders

Government
The Mission for Nuclear Safety and Radiological protection
(Mission de la Sûreté Nucléaire et de la Radioprotection - MSNR)

Nuclear Safety Authority (ASN)

Inspection of installations
Decisions of general or individual significance

IRSN: Institute of radiological protection and nuclear safety

Permanent groups of experts

Central Commission for pressurised equipment
Permanent nuclear section
French governance in nuclear safety matters

The hierarchy of standards applied in French nuclear sector

Constitution
The environmental charter

International Law
AIEA

Community Law
Euratom Safety Directive

Environnement regulation
“Nuclear Security and Transparency” and “Radioactive waste” Act

Decree
“TSN Procedures” Decree of 2 November 2007

Order
Order of 7 February 2012 setting the general rules relative to basic nuclear installations

Individual Authorisations
(ASN Resolution)

ASN
Technical resolution (Former RFS)

ASN
Guides

ISO Standards

AREVA
Group Directives

AREVA
Complementary Safety Assessment – Atomic Energy Society of Japan – June 2013 the 3rd

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Fuel Cycle Industry - AREVA La Hague
Complementary Safety Assessments (CSA)

Phase 1: May 2011 to January 2012
La Hague Complementary Safety Assessments
Phase 1 – General context

15 September 2011

- AREVA sent reports on Complementary Safety Assessment post Fukushima to ASN for each site

Table of contents consistent with WENRA “Stress tests” specifications for reactors

1. IMMEDIATE LEARNING FROM FUKUSHIMA EVENT
2. GENERAL DATA ABOUT SITE AND ENVIRONMENT
3. GENERAL DESCRIPTION OF SITE ACTIVITIES
4. ACCIDENTAL SCENARIOS
5. EARTHQUAKES
6. FLOODING
7. EXTREME WEATHER CONDITIONS
8. LOSS OF ELECTRICAL POWER AND LOSS OF COOLING
9. SEVERE ACCIDENT MANAGEMENT
10. USE OF CONTRACTORS
11. CONCLUSION
La Hague Complementary Safety Assessments
Phase 1 - Severe Accidents Scenarios

- La Hague spent fuel reprocessing utilities
  - Loss of heat transfer chain
  - Explosion with radiolysis hydrogen accumulation
  - Loss of containment in legacy waste storage facilities

- MELOX MOX Fuel Fabrication plant
  - Loss of cooling function in fuel rod storage
  - Loss of containment functions

- Tricastin Uranium conversion and enrichment utilities
  - Chemical release:
    - hydrogen fluoride gas HF, hexafluoride UF₆, chlorine trifluorine ClF₃, chlorine Cl.

- Romans FBFC Fuel fabrication plant
  - Chemical release: HF, UF₆
  - Criticality accident
Conclusions of AREVA CSA for La Hague reprocessing plant in September 2011

- 3rd level of defense in depth resilient to natural extreme event
- 4th level of defense in depth not always taken into account in design
  - To be reinforced
- 5th level of defense in depth to be reinforced
  - Creation of a national intervention team shall be analyzed in AREVA group (FINA)

3rd January 2012: ASN delivered its report on the CSA to the Prime Minister, who forwarded it to the European Commission

- ASN considered that no shut down of any facility was required
- ASN has issued an opinion n° 2012-AV-0139 concerning CSA providing provisions to improve the robustness of facilities to extreme situations
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Complementary Safety Assessments (CSA)

Phase 2 : January 2011 to April 2013
La Hague Complementary Safety Assessments  
Phase 2 - Scope of work

1. Extend the work on conformity check to the whole facility
2. Perform some supplementary studies on severe accident scenarios regarding an available grace period
3. Defined Material and Organization reinforced arrangements
   - Definition of “hardened safety core” in terms of:
     - material and organisational supplementary arrangements
     - specifications and procedures to improve the robustness in exceptional situations
4. Upgrade crisis management tools and organisation for beyond design accident
   - Availability of robust emergency management rooms satisfying basic safety functions requirements of Hardened safety Core
Following severe accident situations are taken into account possibly resulting from External aggression exceeding the Design Basis Events (DBE)

- Risks associated with heat transfer chain
  - Loss of power supply and/or loss of cooling
    - Cooling of spent fuel storage pools
    - Cooling of tanks with Fission Products (FP tanks)
    - Cooling of evaporators condensers
    - De-clogging of agglomerated fine fuel particles in Pendulum Centrifuge Decanters (PCD) to avoid ruthenium ($\text{RuO}_4$) release
    - Cooling of $\text{PuO}_2$ containers storage of facility whose design does not forecast natural convection cooling

- Risk of explosion associated with radiolysis hydrogen accumulation
  - Loss of power supply leading to loss of hydrogen dilution devices
    - Fine fuel suspended particles tanks
La Hague Complementary Safety Assessment
Phase 2 – Delays before cliff edge effect

$t = 0$

- Radiolysis Hydrogen (7.5h to 85h)
- DPC (14h)
- FP Tanks (16h to 26h)
- PuO$_2$ Storage (20h)
- FP Evaporators (34h to 48h)
- Spent Fuels Storage pools (145h to 268h)

$t = 268$ hours

Legacy waste Silos
A few weeks (mitigation)
Purpose of Hardened Safety Core Equipment

- Ultimate protection to guarantee or to ensure appropriated management of consequences of a severe accident, due to:
  - an external and huge aggression out of design basis
  - long duration loss of power supply and cooling
  - supposed failure of design basis protection means (due to an exceptional and huge event)

- Hardened Safety Core of material and organisational arrangements, specifications and procedures includes elements which contribute:
  - to prevent or limit a severe accident
  - to limit massive discharge (radioactive/chemical release)
  - to allow severe accident management
Defense in depth and Hardened Safety Core

Provisions to manage situations increasingly degraded

Hard Core: limited number of SSC (Systems, Structures and Components)

- **Level 5**
  - (« crisis » Means)
  - « Crisis Management »

- **Level 4**
  - (« SA » Means)
  - « Limitation of consequences of SA »

- **Level 3**
  - (« back-up » Means)
  - « Prévention of SA »

- **Level 2**
  - (« Detection » Means)
  - Deviations of conformity

- **Level 1**
  - (Normal Operations means)
  - Resilience

SA = Severe Accidents
CSA = Complementary Safety Assessments
BDBE = Beyond Design Basis Event

CSA BDBE (hardened Core)
Hardened Safety Core Equipment
Water Recovery for ponds and PF tanks

(4) FA ponds: Avoid loss of water due to boiling, leading to a too high dose level

(27) Highly Active storage tanks of concentrated solutions of fission products: Restore cooling to avoid boiling and release in the atmosphere
# Hardened Safety Core Equipment

## Water Recovery for ponds and PF tanks

<table>
<thead>
<tr>
<th>Function</th>
<th>Remediation Strategy</th>
<th>Hardened Core Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooling of Spent Fuels storage pools</strong></td>
<td>To supply SF pools with lost water in order to maintain constant the water level of ponds (from West Pond and/or Moulinets dam)</td>
<td>- Fixed and mobile pipes of general and specific (pools) network</td>
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<td></td>
<td></td>
<td>- Fixed or mobile Moto pumps</td>
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<tr>
<td></td>
<td></td>
<td>- Clarinets for water supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Portable data acquisition system (water level and temperature)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Supplementary fixed pipe for ultimate backup</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Water level and temperature measurements safety system</td>
</tr>
<tr>
<td><strong>Cooling of FP Storage Tanks and Buffers CPF</strong></td>
<td>To supply water, with an « open loop », to internal loops for cooling of Fission Product Tanks (from West Pond and/or Moulinets dam)</td>
<td>- Fixed and mobile pipes of general and specific (pools) network</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Fixed or mobile Moto pumps</td>
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<tr>
<td></td>
<td></td>
<td>- Supplementary specific nozzles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Portable data acquisition system (temperature)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Supply pipes + cooling coils inside tanks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Temperature measurement safety system</td>
</tr>
</tbody>
</table>
Fuel Cycle Industry - AREVA La Hague
Complementary Safety Assessments (CSA)

Phase 2: Upgrade crisis management tools
Initial state is defined on the basis of a synthetic information on the source terms contained in the facilities requiring a priority intervention

- Operational arrangements are made in order to collect information based on the last value of process parameter recorded before extreme event occurrence
- A diagnosis of the correct or incorrect operating of the safeguard system of equipment concerned by the serious accidents

Monitoring after natural external event

- Priority is given to the equipment associated with the mitigation of serious accident scenarios
- The requisite information is relayed to the crisis management structures located as near as possible to the facilities and/or the Emergency Centre headquarter
- Complementary mobile means are provided in case of failure
1st phase: human resources available for the intervention which are a major asset in the management of accidental situations
   - Local Security units, operational teams, Health Physics and maintenance shift teams

2nd phase: arrangements still exist to ensure that the site concerned is provided with the requisite resources to face the potential situations examined from the Site Emergency Plan (P.U.I.) organization
   - On-site recall of the trained and experienced on call staff able to meet the requirements related to potential serious scenarios

3rd phase: AREVA aims at implementing an organization on the Group scale enabling an efficient mobilization, within 48 hours, of available human and practical means for the damaged site
   - FINA: National Intervention Team of AREVA Group
La Hague Complementary Safety Assessments
Phase 2 - AREVA Organisation

Event

T0 + few hours

Emergency management in autonomy with minimal staff on site

Diagnosis (State of Facilities, Collect the last value of process parameter,
Alert (Group, Authority)

Intervention dedicated to severe accident situation

AREVA National Emergency Organization

T0 + 48 h

AREVA National Intervention Team FINA

CEA EDF AREVA mutualized intervention means (GIE INTRA)
La Hague Complementary Safety Assessments
Phase 2 - Hardened core organisational arrangements

Event

Standard organization in normal operation with minimum safety emergency workforce

Normal operating

Alert

Diagnosis

Safeguard system «OK»

Availability of safeguard system

Collect the last value of process parameters

Check first observable function 'Ok or not OK'

Coordination and Remediation preparation

Remediation and then monitoring

Only the equipment used for remediation

Upgrade number of workforce

All people are used for concerned equipment remediation

PUI organization

Pools

(R2) UP2-800

(BC UP3) UP3

Pools

UP2-800

UP3

Pools

UP2-800

Pools
La Hague Complementary Safety Assessments
Phase 2 - new crisis emergency buildings

- Construction of new buildings which meet the hardened core requirements on the 4 sites

<table>
<thead>
<tr>
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<tr>
<td>Commandment</td>
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<tr>
<td>(command, alert, communication)</td>
</tr>
<tr>
<td>Storage</td>
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<tr>
<td>(Facilities - ISO containers Shed)</td>
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<tr>
<td>Emergency Rescue Brigade FLS</td>
</tr>
</tbody>
</table>

- ECC
  - Adaptation of UP3 Control Room
  - Adaptation of R2 Room

- Supply and implementation
  - Satellite communication means
  - Diagnosis means
  - 1st intervention team and clearing means
La Hague Complementary Safety Assessments
Phase 2 - Fuel Cycle Industry

30 June 2012:
Transmission of AREVA studies requested by ASN Resolution for this date

13th December 2012:
“Permanent Group of Experts” performed a review of Licensees reports for reactors with technical support IRSN

- Aiming at the validation of “hardened safety core” level natural aggressions (Earthquake, Flooding, extreme wind…) beyond current baseline safety standard proposed by licensees

3rd and 4th April 2013:
“Permanent Group of Experts” performed a review of AREVA reports with technical support IRSN

- Definition of material and organization reinforced arrangements
- Crisis management process
- Emergency management centres resilience
Conclusions of Complementary Safety Assessment – Phase 2

- Hardened Safety Core strategy has been globally approved by Permanent Group of experts and IRSN reports
- AREVA took several commitments to perform complementary studies between 2013 and 2014 to definitely justify the perimeter of severe accident scenarios, the natural extreme event description and hardened safety core prevention/mitigation means proposed
- Commitment to perform major Investments in Phase 3 between 2013 and 2017 were taken by operating managers
  - Emergency building center
  - Hardened Safety Core Equipment

AREVA is pro active for exchange about post Fukushima lessons learned with other International operators

- Collaboration with Sellafield Ltd (UK) or JNFL (Japan)
- Adhesion of AREVA La Hague to WANO