

**IRSN**

INSTITUT  
DE RADIOPROTECTION  
ET DE SÛRETÉ NUCLÉAIRE

*Faire avancer la sûreté nucléaire*

# IAEA Technical Meeting

## Design Extension Conditions for Storage Facilities for Power Reactor Spent Fuel

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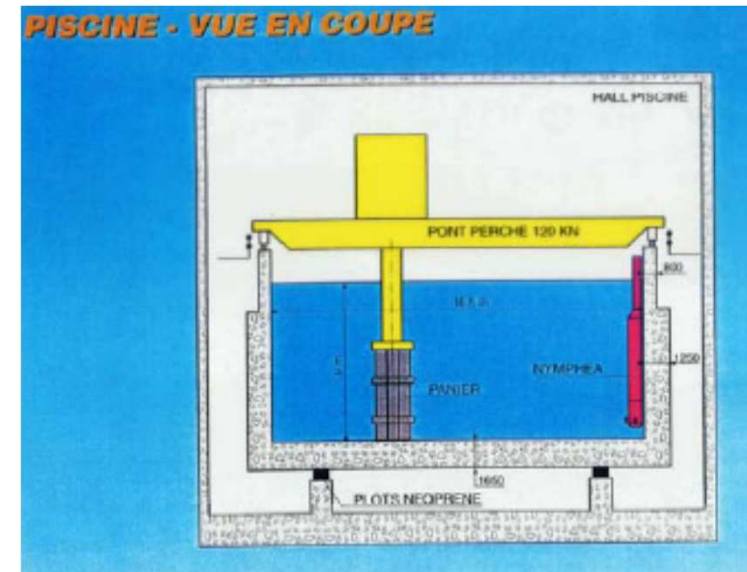
# DECs for Storage Facilities for PR SF : the case of AREVA NC La Hague wet storage Stress tests



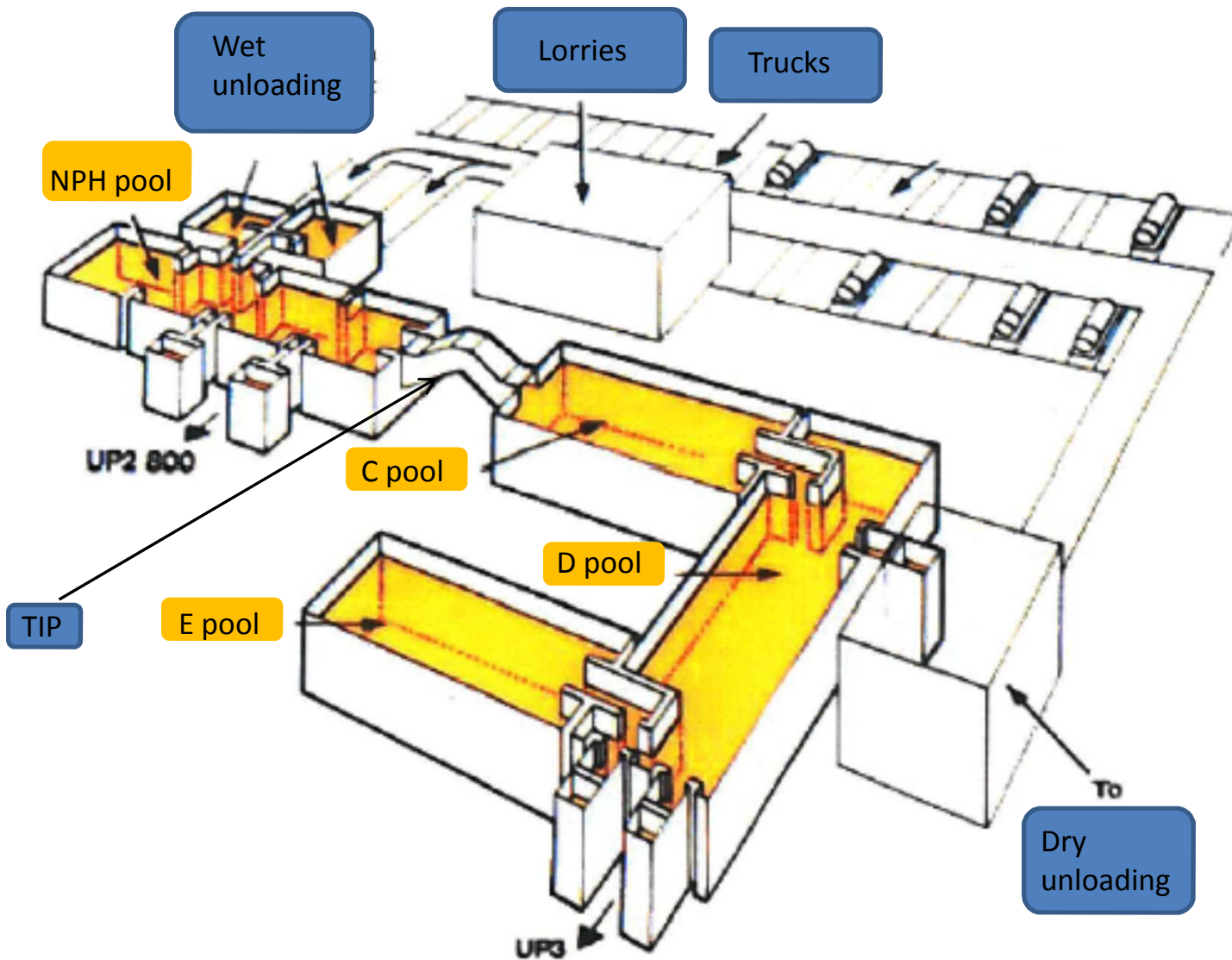
# AREVA NC La Hague SF wet storage

After a few years in BK desactivating pool, spent fuel is transferred to la Hague reprocessing plant

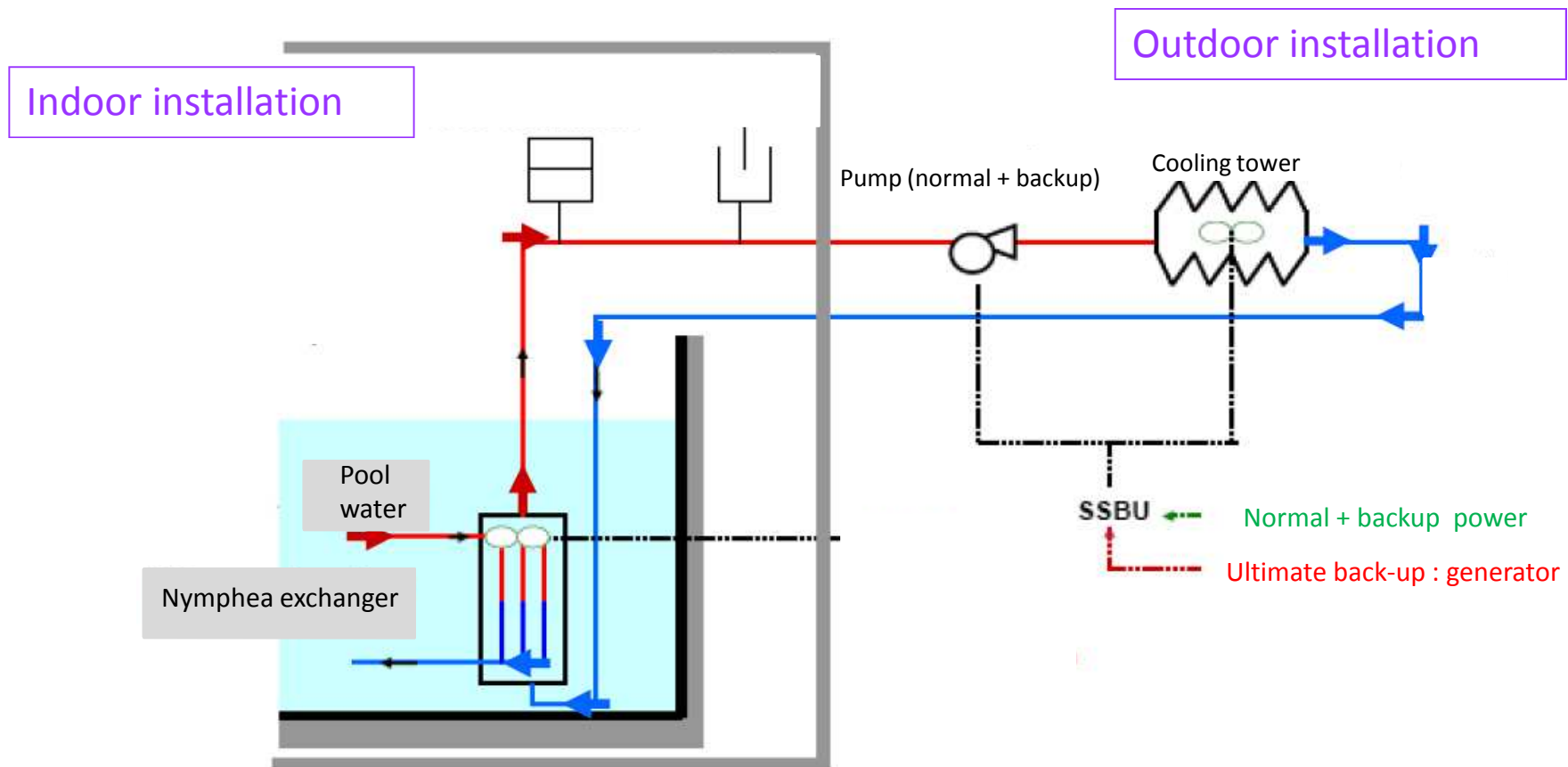
- 4 pools : NPH, C, D, E (inter-connected)
- Built between 1976 and 1988
- 10 000 to 14 000 m<sup>3</sup> / pool (water 9 m high)
- 500 to 1 000 baskets / pool
- 9 PWR or 16 BWR FA / basket
- 8 to 16 MW / pool
- Water activity < 37 kBq/L
- Essential safety function : keeping water level ensuring the cooling



- $T_{\text{water}} < 45 \text{ } ^\circ\text{C}$  : in-pool “Nymphaea” combined ion exchange / cooling systems
- Designed for an earthquake (~MSK VIII)
- Except for NPH : common foundation raft, elastomere bearings pads, under-pool water retention
- Ponds and channels covered by a 4 to 6 mm thick liner made of stainless steel
- Drainage system for leak detection
- Siphon breakers on water pipes with high points



# Cooling system



# Emergency plan (PUI) scenarios

Emergency plan defined to organize crisis management

Beyond Design Basis Accidents

Use of design parameters to evaluate consequences and discharges

■ **TIP (NPH-C inter-pool lift transfer) stopping while FA are uncovered at top-position**  
(both engines stopped and failure of the hydraulic manual unblocking system)  
Cofferdam in the transfer canal if FA basket immobilized for too long to prevent contamination spread

■ **Leakage due to a breach in the pool**

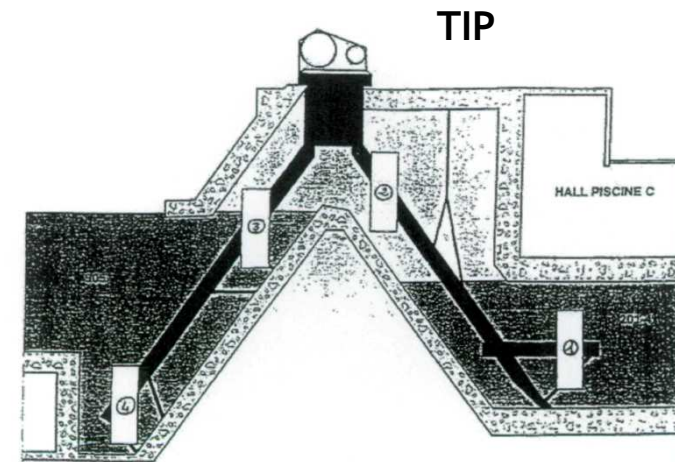
If possible, use of clogging device

⇒ for C, D & E pools : use of a **pump** to re-inject in the pool water which has leaked in the retention

Taken into account before F-D accident, after F-D accident : pump pre-positioned

⇒ for NPH pool : water refilling from **external source** while the breach is not repaired or a recycling system is not installed

Scenario added in the emergency plan after F-D accident



# Complementary safety assessments (CSAs=Stress tests)

- | Assessments performed by the licensees after Fukushima-Daiichi accident in 2011
- | Robustness beyond design basis requirements
- | Evaluation of safety margins and identification of cliff-edge effects
- | Use of realistic plant parameters
- | Definition of the **feared situations** : situations resulting from an extreme natural event or from a total loss of electrical power and /or cooling systems which can lead to a cliff-edge effect with off-bounds consequences
- | Definition of the **hardened safety core** of robust organisational and material means designed to prevent feared situations or limit their consequences
  - both prevention and mitigation means
  - both new and previously-existing means
- | Evaluation by the TSO IRSN of CSA studies, including identification of feared situations, identification of hard core SSCs, demonstration of robustness of hard core SSCs.

# Feared situation for SF pools : complete loss of cooling

- 1st cliff-edge effect : no human intervention possible by the pool
- 2<sup>nd</sup> cliff-edge effect : dewatering of FA
- Hardened safety core : external water supply sources, pumps, pipes, connexions, filtration and distribution mobile unit, trucks
- Loss of cooling of all 4 pools (and combination with other feared situations for the site)

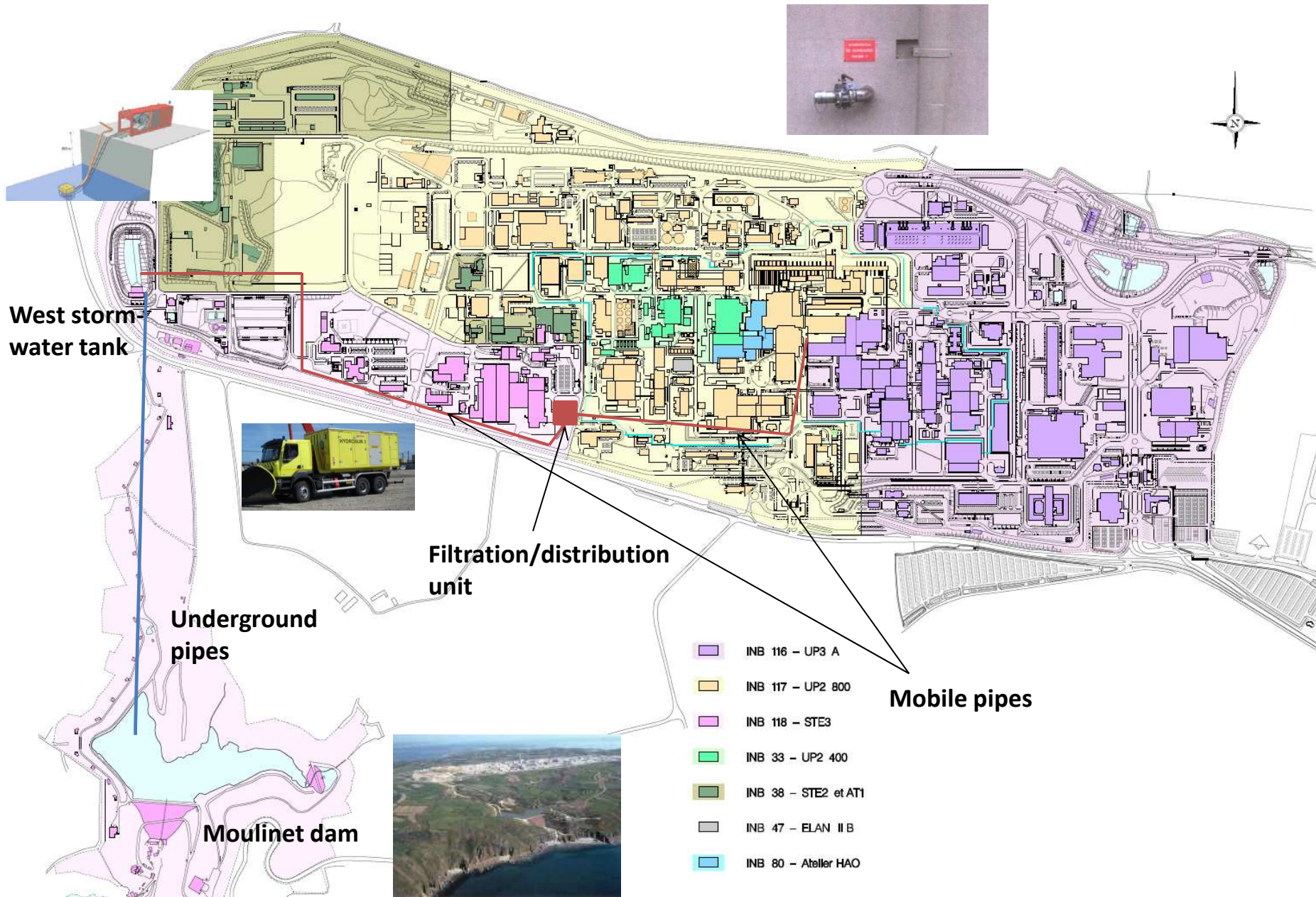
The licensee even takes into account at the same time emergency plan scenario of major leakage of NPH pool (most fast-evolving scenario) after IRSN request motivated by the unknown state of the liner

TIP (NPH-C interpool lift transfer) emergency plan scenario is not considered because the licensee has demonstrated that the manual deblocking system is functional after an extreme earthquake and can be used before any FA degradation



## Safety core for the SF pools

<p><b>Interfacing SSCs</b> (necessary to put in action safety core SSCs, same requirements as safety core)</p>	<p>Pool buildings Safety core equipment storage building Liners, concrete walls, bearing pads</p>
<p><b>Existing safety core SSCs</b></p>	<p>Moulinet dam West storm-water tank Water-level measurement devices</p>
<p><b>New safety core SSCs</b></p>	<p>Pumps Pipes Trucks Filtration unit Connexions Fuel Additional water-level measurement devices</p>



# Conclusion and perspectives

## *Today*

- PUI and CSA means : another layer of defence-in-depth
- CSA means in place by December 31st 2016
- But no purely level 4 disposition
- No mitigation of radioactive releases possible but high degree of confidence in the hard core and remediation scenario

## *Near future (DEC in the regulation)*

- Periodic safety reviews expectations
- New pool expectations...