



**Complementary
Safety Assessments
within the EDF
nuclear fleet
And
Long Term Operation
of the 900 MW Units**

**Alain Keramsi
And Noel Camarcat EDF –
Generation and
Engineering Direction**



CSA-a targeted reassessment of the NPP's safety margins with extreme natural events challenging the safety functions

1

In-depth review of existing barriers with regard to current reference safety standards:

- Protection systems, dikes, embankments, anchor points, diesel generators, cooling water supplies, etc.
- Design-base accident management
- All systems supporting the safety case

2

New assessment beyond the scope of current safety reference standards:

- Effectiveness of protection systems, margins, “cliff-hanger” effects
- Management of extreme conditions, regardless of their likelihood
- “Hardened safety core” of systems and equipment items designed to prevent large radioactive releases like those that occurred at Fukushima

Provision of additional resources if required:

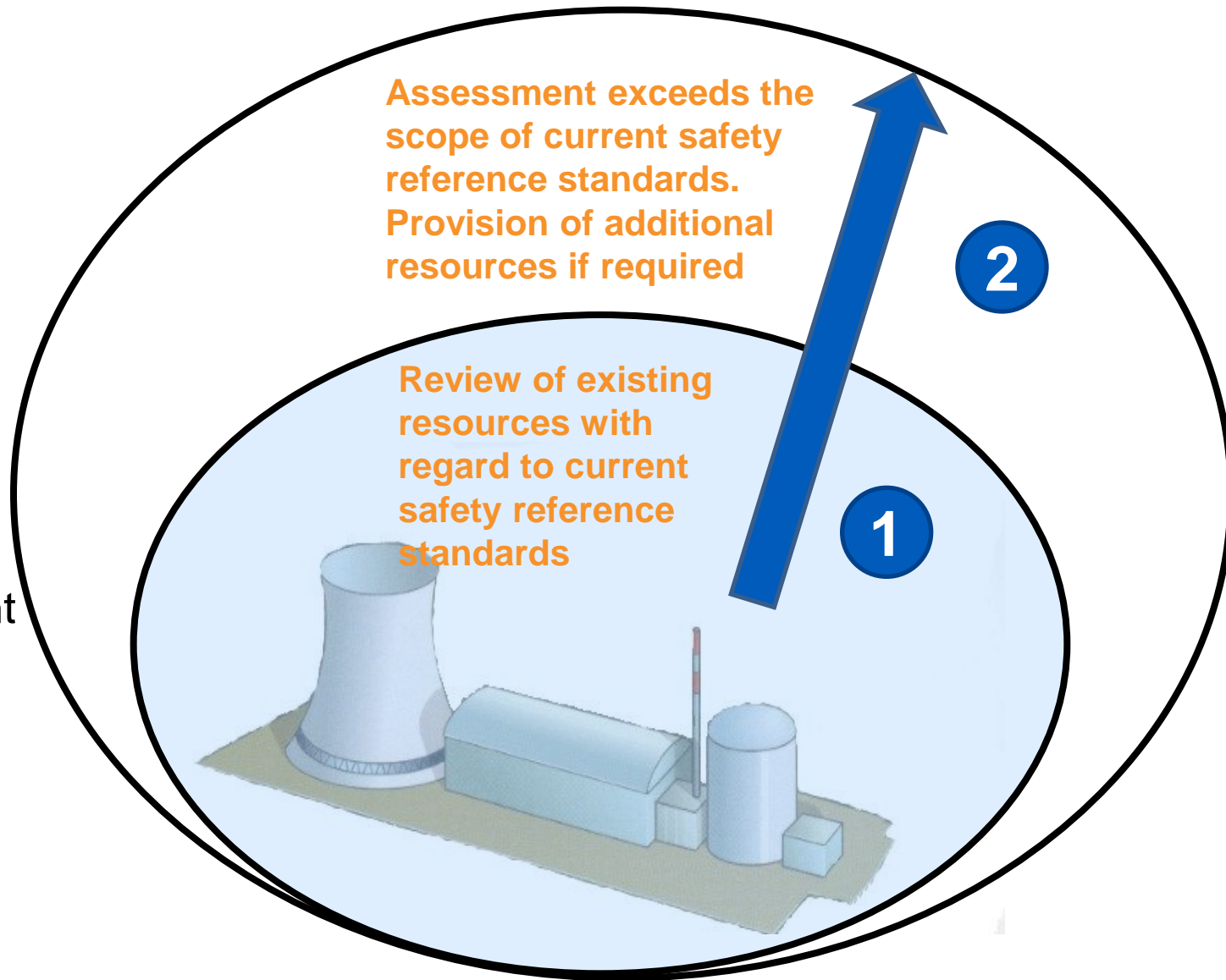
Equipment; personnel; plant-specific and corporate organizational structures



CSA: a two-pronged approach

**6 review areas
(specified by
the ASN):**

- Earthquake
- Flooding
- Loss of cooling water supply
- Loss of power
- Severe accident management
- Contractors



CSA results

- ▶ On the basis of its findings, EDF can confirm **that a high level of nuclear safety is being maintained on its nuclear power plants**. Compliance with reference safety standards is the over-riding priority.
- ▶ **Additional measures have been proposed in the light of new assessments exceeding the scope of all previous assumptions** and making full use of lessons learned from the Fukushima accident
- ▶ These measures will play an instrumental role in **continuing to raise the high standards of nuclear safety** already being observed on EDF nuclear power plants



4 actions selected for deployment further to assessments

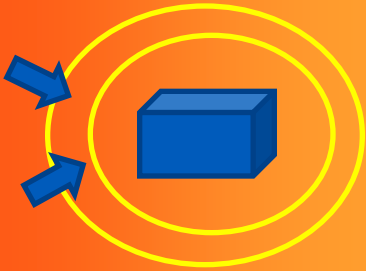
- ▶ **Enhancing robustness** of systems designed to protect plant facilities against external hazards (earthquakes, flooding, etc.).
- ▶ **Increasing** water make-up and electrical power supply capacity
- ▶ **Minimizing** radioactive releases in the event of a severe accident (to avoid significant long-term contamination of surrounding areas)
- ▶ **Reinforcing** site and national emergency preparedness organizations (personnel and equipment).

Key additional measures:

- ▶ **“Hardened safety core”** of systems, structures and components designed to prevent large radioactive releases to the environment in extreme conditions considered by ECS reviews.
 - ▶ Measures taken to protect the “hardened safety core” against hazards exceeding the scope of the current design basis.
- ▶ **Nuclear Rapid Response Force (FARN)**, available on site within 24 hours.

Action 1: Greater protection against hazards

Greater protection
against hazards



- ▶ **Reinforced or raised embankments and dikes, enhanced building integrity**
- ▶ **Reinforced switchyard flood protection**
- ▶ **Greater earthquake resistance for selected electrical components**
- ▶ **Stronger support structures and anchor points**

Action 1: Greater protection against hazards

Examples of flood protection systems

Protection against extreme flooding:

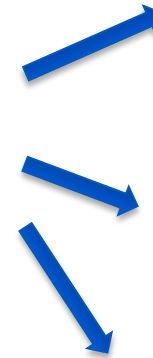
◆ Flood barriers:

- ◆ *Manual: Modular systems*
- ◆ *Mechanical: motor-operated and other types of barrier*
- ◆ *Or automatically operated barriers*

◆ Sealed doors:



And/or raising the height of peripheral barriers

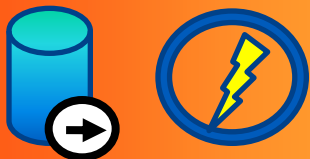


Action 2: Increase water make-up and power supply capacity

For each reactor, provide emergency power and cooling water supply:

Emergency power supply

Emergency water supply



▶ **Electricity: Ultimate back-up diesel (DUS in French)**

- Restore supply: Emergency feedwater pump, primary system or spent fuel pool make up, I&C, etc.
- Installation of small temporary diesel generators

▶ **Water: ultimate supply to the steam generators, the primary system or the spent fuel pool (residual heat removal)**

- From the water table, reservoirs at the top of the cliff or another source of water

▶ **Primary injection thermal pump.**

▶ **Means of managing the fuel pool**

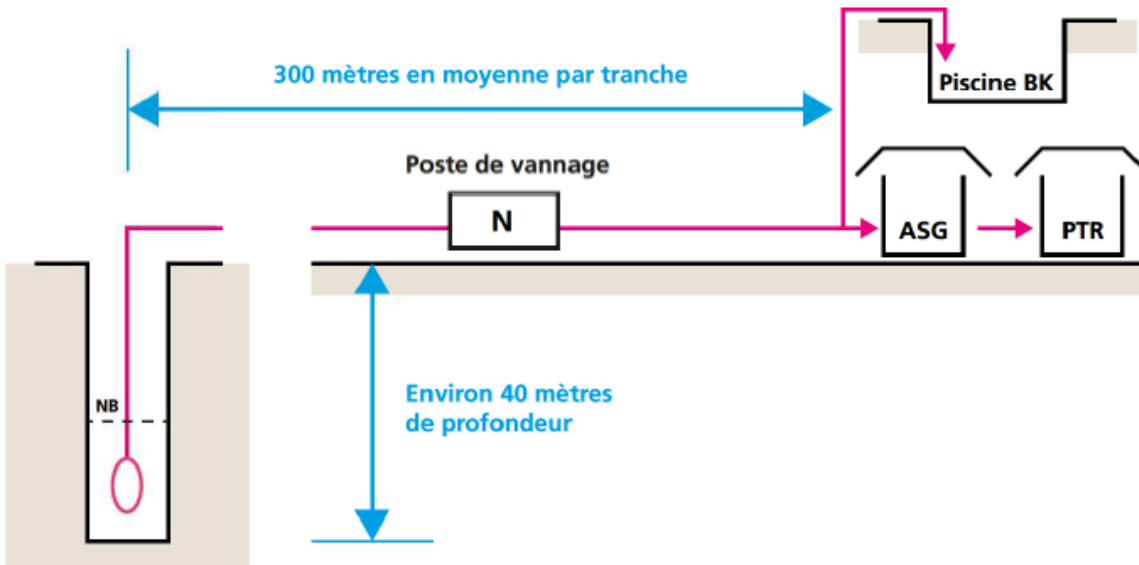
Level and temperature meters, fuel handling, etc.

Action 2: Increase water make-up and power supply capacity

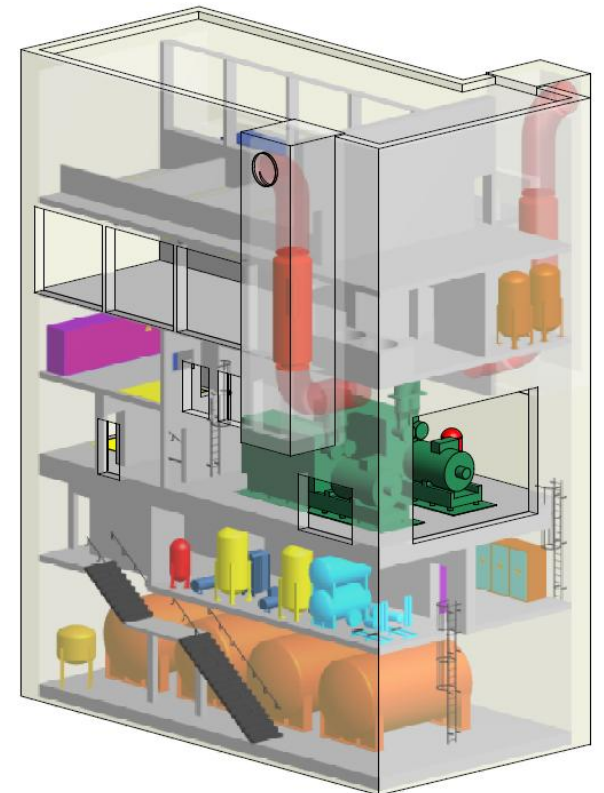
illustrations



Un appoint ultime en eau par tranche



Diesel d'Ultime Secours (DUS)



Action 3: Limit radiological releases as far as possible in the event of a severe accident

Limiting releases in the event of core meltdown: robustness and efficiency of filtering

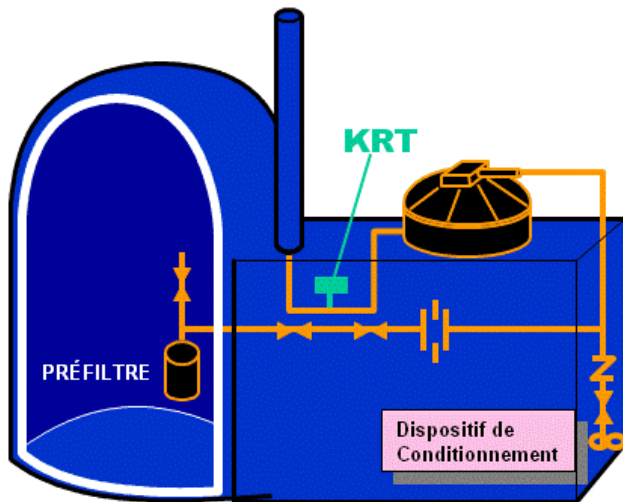


- ▶ **A filtering system in the event of depressurization of the reactor building containment**
 - Seismically strengthened,
 - Improved filtering capacity (iodine, noble gases?)
- ▶ **Base pH of reactor building sumps (iodine retention),**
- ▶ **Studies of additional mitigation measures**
 - To avoid any ground water pollution in the event of melt through of the reactor vessel by the corium.

Action 3: Limit radiological releases as far as possible in the event of a severe accident

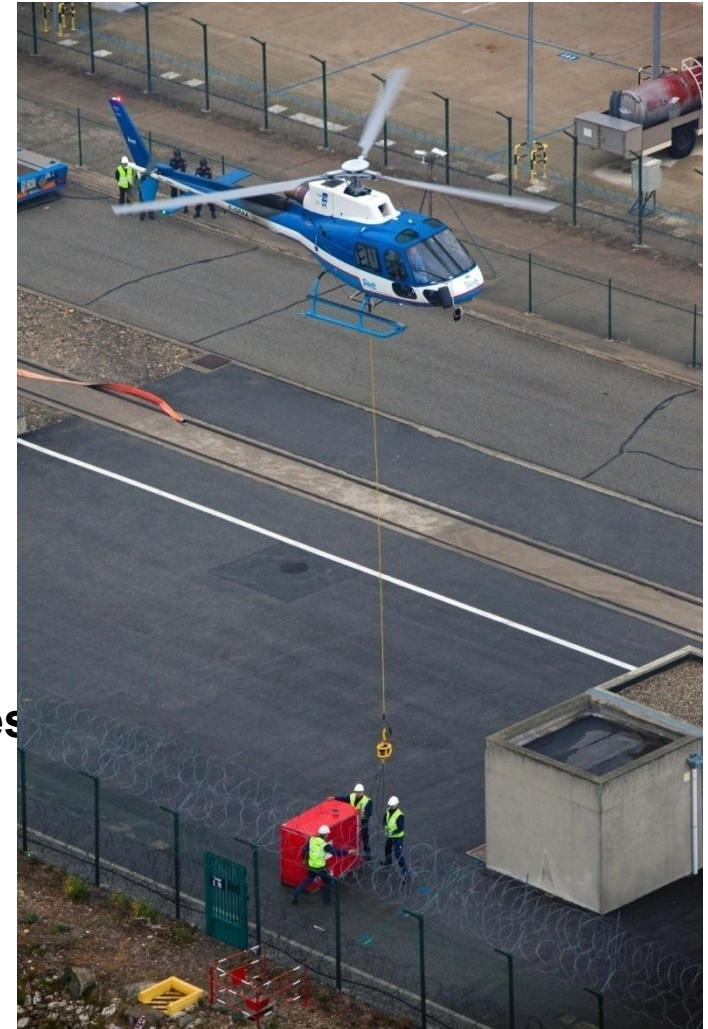
Examples

Studies of dose rates in the event of a severe accident, taking existing protection systems into account (sand-bed filter: see photo – example of N4 series) and possible improvements.



Action 4: Strengthen emergency arrangements and related resources

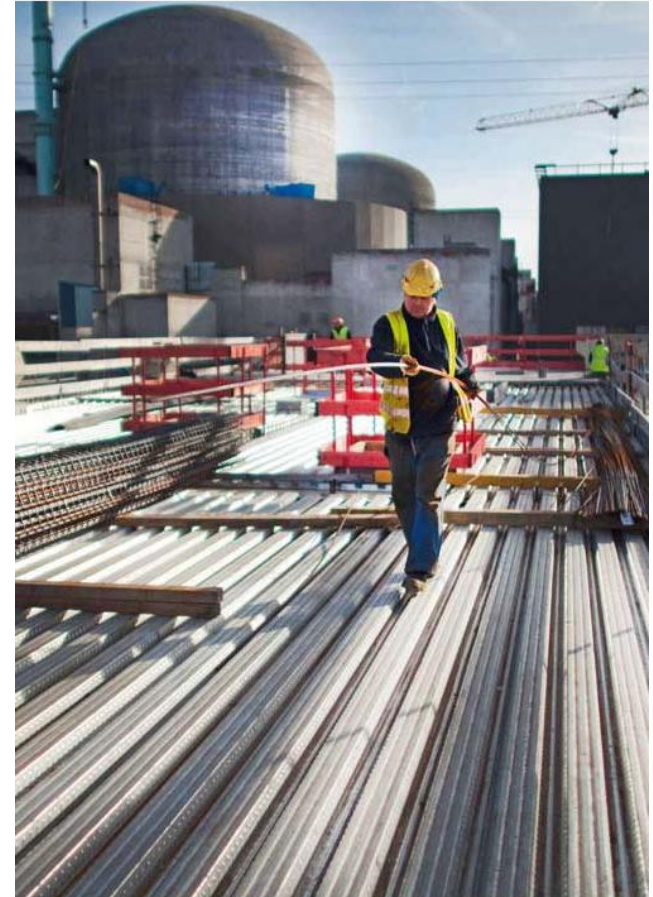
- ▶ **Strengthening of skills permanently present on the station**
- ▶ **Optimised arrangements and procedures**
 - Exercises and training courses and increased equipment operability and reliability,
- ▶ **Nuclear Rapid Response Force,**
- ▶ **Local emergency resources – Regional and national emergency resources,**
- ▶ **“Plug and play” water and electricity supplies**
- ▶ **Local emergency centre (CCL in French):**
 - More robust emergency management premises, designed to cope with an emergency affecting the whole station over a long period ...



The Cruas Exercice - 2011

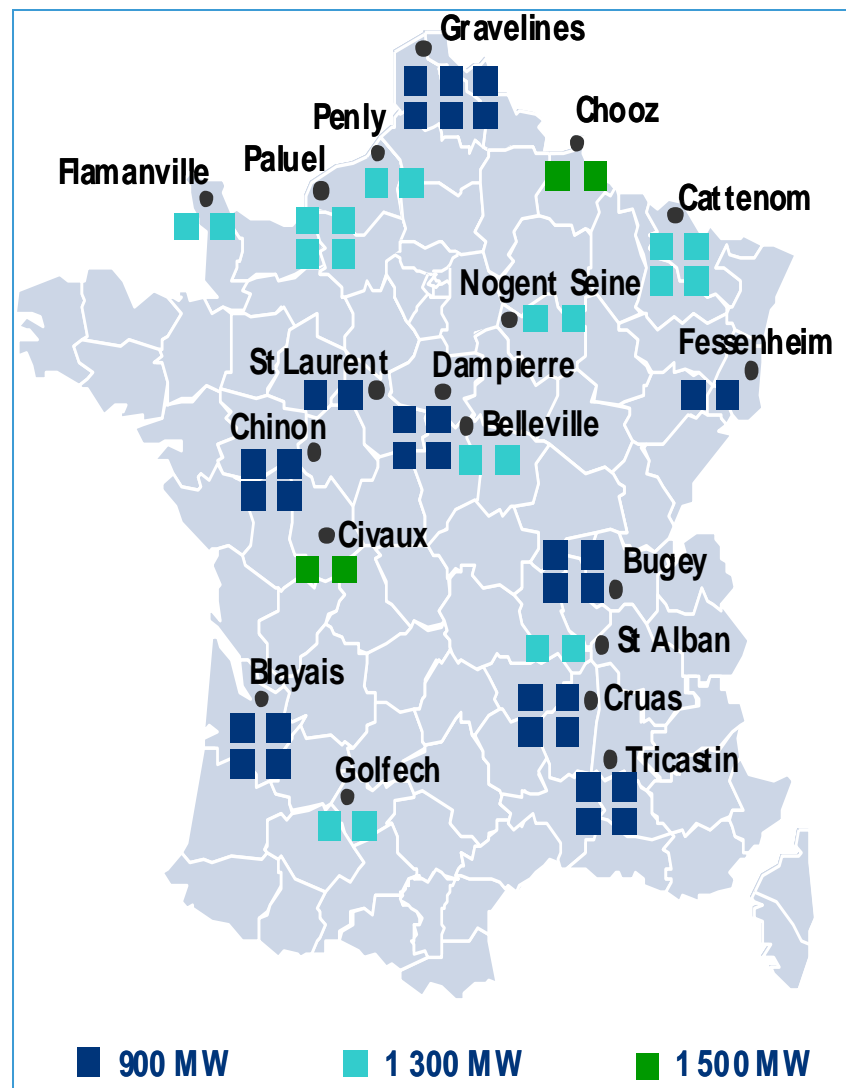
The nuclear regulator's conclusions

- ▶ On 3 January 2012, the chairman of the nuclear regulator (ASN in French), André-Claude Lacoste, presented the conclusions of his ECS report.
- ▶ “... the level of operating safety on plants is sufficient not to require immediate shutdown of any of them”
- ▶ The present seismic margins of EDF's nuclear reactors are satisfactory
- ▶ The complete re-assessment conducted following the flooding of Blayais nuclear power plant in 1999 gives nuclear power plants a high level of protection against the risk of flooding.
- ▶ The improved design of the EPR already gives better protection in terms of severe accidents.



Long Term Operation : 3rd 10 years Periodic Safety Review of 900 MW units

- ▶ Periodic Safety Reassessment required by french 2006 law every 10 years
- ▶ 34-900 MW Units, Generic Approval for 30 to 40 years given in 2008
- ▶ Modifications on Tricastin 1 and Fessenheim 1 started in 2009
- ▶ Extended operation approved by regulator in November 2010 for Tricastin1 (30 to 40 years)
- ▶ Extended operation of Fessenheim 1 approved by regulator in june 2011 during the CSA process, provided **pre CSA** requirements are met
- ▶ January 2012 report, after CSA assessments : the same
- ▶ Modifications for 9 units in 2010-2011 – 4 units in 2012



Thank you for your attention

ASN requirements

- ▶ **A “hardened safety core” for each plant**

To prevent a severe accident or limit its development, the ASN asks EDF to define “**a hardened safety core**” identifying the equipment and organisational measures needed to control the basic safety functions in emergency situations, **before 30 June 2012**.

- ▶ **An emergency response force**

FARN should contain specialized teams and equipment which will be able to respond in less than 24 hours on a station. Deployment will begin in late 2012 and be completed in late 2014.

- ▶ **Human resources**

The ASN asks that supervision of contractors working on nuclear plants should not be delegated by the operator when safety-related work is concerned. The ASN report refers to the draft basic nuclear installation order which does however stipulate that the operator can buy in assistance for this supervision, provided justification is given. Operators will have to justify that their arrangements ensure the availability of the skills necessary in the event of an emergency, if contractors are employed.

- ▶ **Operating reference safety standards**

The ASN wishes to see more stringent operating reference safety standards for nuclear plants, in particular for seismic and flooding aspects, and for risks related to other industrial activities in the vicinity of power plants.



The next key steps

- ▶ **ASN technical requests (TSN act – nuclear transparency and safety)**
 - ▶ Draft for official consultation with operators received mid-February.
- ▶ **Definition of the industrial modification programme to be submitted to ASN on 30/06/2012**
 - ▶ over 500 actions identified (ECS, GP instruction, etc.)
 - ▶ Short-term modifications: FARN, temporary mobile equipment (small diesel generators, thermal motor-driven pumps, etc.), “plug and play” connections
 - ▶ Medium-term modifications: ultimate back-up diesel (DUS), ultimate heat sink, local emergency centre, anticipation of changes in operating reference safety standards: earthquake, flooding, loss of power supply, etc.
 - ▶ Long-term modifications: close interaction with Long Term Operation safety objectives and related modifications

5.

FARN

The Nuclear Rapid Response Force

(Force d'Action Rapide Nucléaire)

Organization and Implementation of FARN (Nuclear Rapid Response Force)

► Why FARN?

- Right after the first analysis of the Fukushima event, EDF decided to reinforce its national crisis organization, especially by implementing national means able to provide quickly assistance to a plant facing big difficulties.

On April 29th, 2011 EDF's CEO announced the implementation of a Nuclear Rapid response Force, the FARN

- The implementation of FARN belongs to the most important commitments taken by EDF in its Complementary Safety Assessment Reports (called stress tests reports elsewhere).
- The FARN reinforces the overall national and local crisis organization by providing EDF Corporate means to be deployed on the field.

OBJECTIVES-ASSUMPTIONS-FEATURES

FARN objectives

Intervene in the areas of **operation, maintenance** and **logistics service** on a site where **an accident occurred** in order to **restore electricity and water supplies within 24 hours** :

- to limit the degradation of the situation
- to confine liquid and/or solid radwaste (for instance re-inject liquid waste into the reactor building)
- and where possible, to avoid core meltdown

first in assistance and then taking over from the shift teams which have been implementing the first emergency actions on site.

Assumptions for FARN

- **Only one site out of the 19 in accident condition** (the largest)
- **Important destruction** of the infrastructures (including access to the site)
- **On-call teams potentially unavailable**
- **Possibility of cumulative risks** (radiological and/or chemical)
- FARN mobilization by PARIS HQ upon Site Manager's request
- Site Manager remains the nuclear operator
- FARN's actions are performed within the frame of the National Emergency Crisis organization

Main features of FARN's intervention

- **To liaise** permanently with the national Crisis Centre and the Site Management
- Dedicated **EDF** staff (position to be held for at least 3 years, multi-skilled people)
- FARN personnel actions **fully comply with the occupational safety and radioprotection rules** which have been defined for such a situation
- 2 stages organization (Reconnaissance & short term and mid- & long term)
- To work **autonomously** during several days on a site which has been partially damaged.

ACTIONS

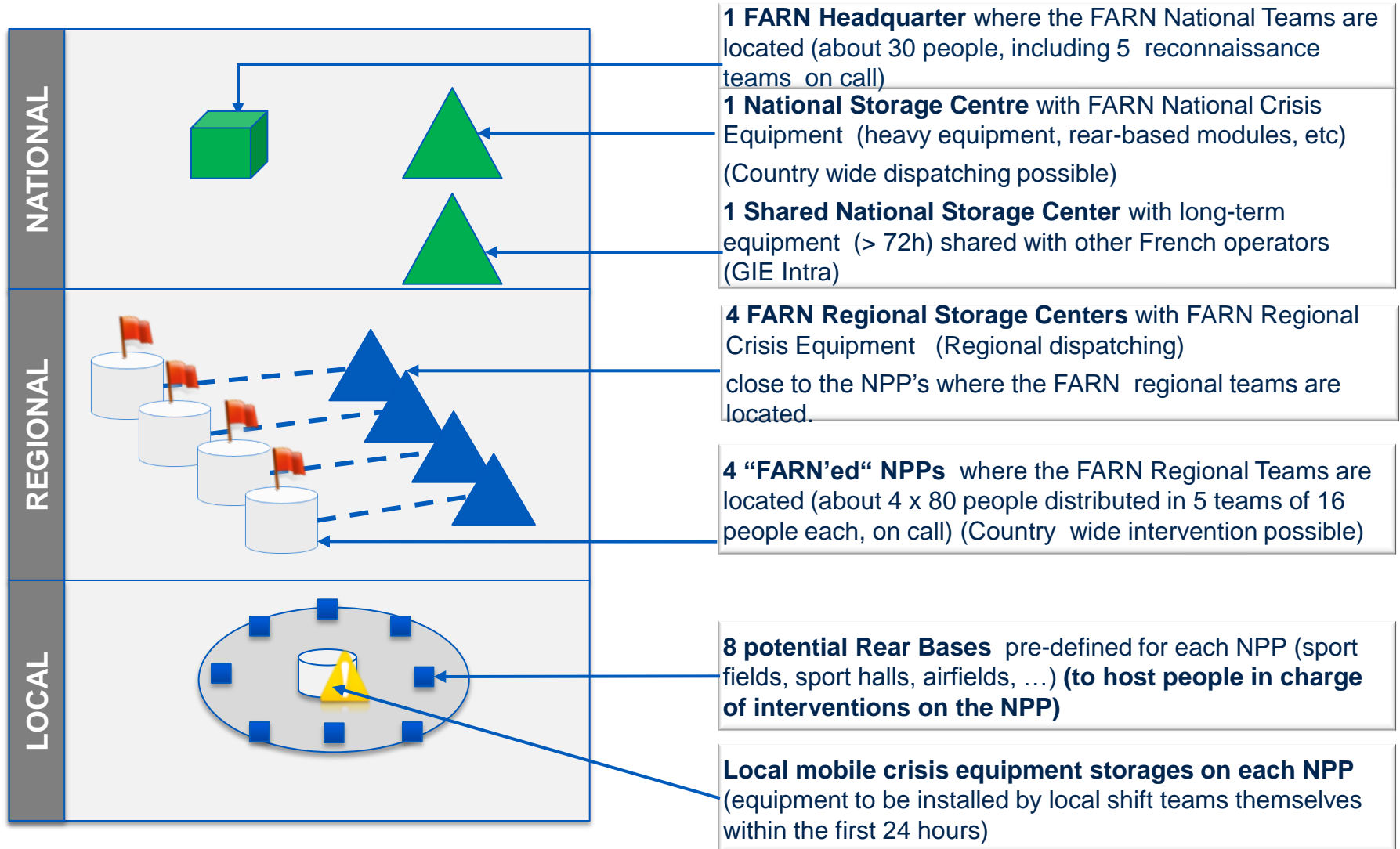
On site short-term actions

- To bring in operation skills to help and take –over from the shift team
- To bring, install and start within less than 24 hours additional equipment for supplying electricity, water (borated and non borated) and compressed air (SGs, Primary circuit, SFP, Primary Circuit water bulk tank) making use of standardized and already installed and prepared electrical and mechanical connections («plug & play» concept)
- To perform the **radiological monitoring** of the environment
- To bring on site after 24 hours all the necessary logistics to ensure a reliable operation of the safeguard systems
- To bring on site a team of psychologists to support staff & families.







Mid-term actions

- To implement **the larger and heavier equipment** (large electricity power supply equipment, large feedwater supply equipment, logistics base close to site, additional sealing equipment for the site,...)
- This equipment will be shared within the GIE Intra framework.
- To prepare the actions and activities required in case of a **long lasting degraded situation** (including logistics)
 - **to limit** the consequences of radiological releases in the environment , hence striving to restore the buildings confinement and to treat the radwaste

Nuclear Rapid Response Force (FARN) : a 3 level organisation

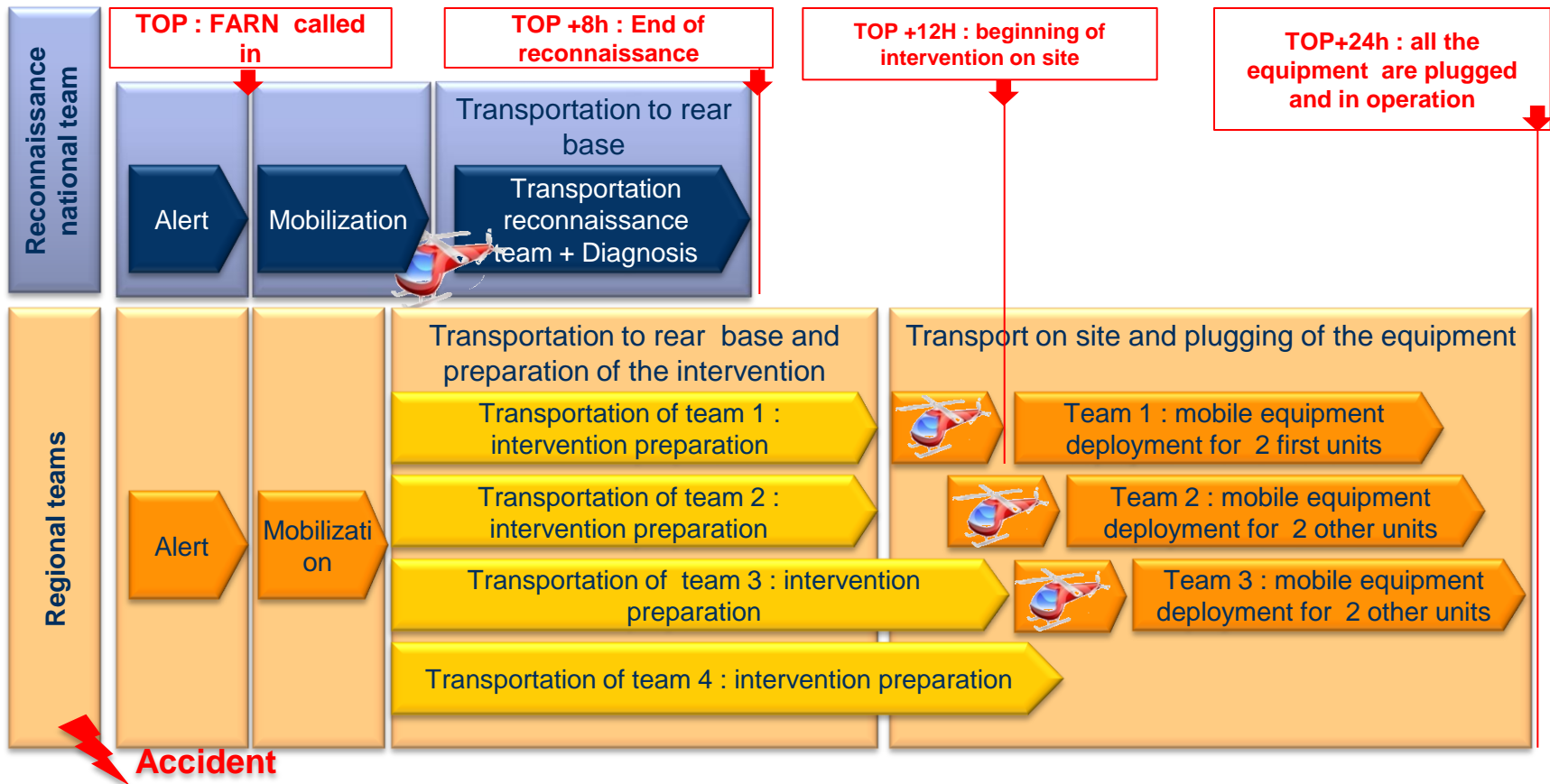




Legend	
	Name of the NPP
	River
	Potentially flooded zone
	Earthquake hazard
	Chemical hazard
	CNPE FARN (base et dépôt)

Organization and Implementation of FARN (Nuclear Rapid Response Force)

► FARN Intervention Chronogram



FARN : the daily activities

Once fully implemented :

- ▶ FARN will be composed of the headquarter and regional services
- ▶ The local staff on “FARN’ed” NPPs will share its working hours between training and normal activities to be carried out on a plant

