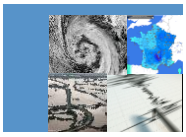
Post Fukushima Research, IRSN views on external events

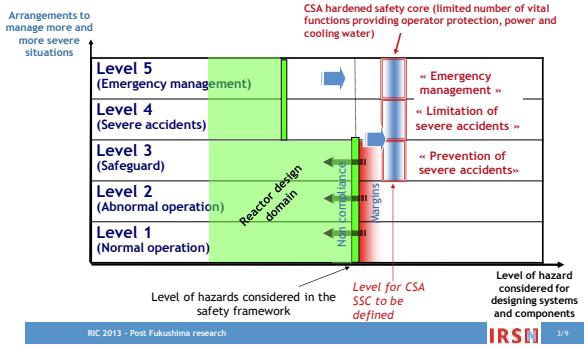
RIC 2013, JC MICAELLI et al., IRSN



French context

- **The French nuclear energy policy should be fixed by the end of 2013, after conclusions of the underway debate on energetic transition**
  - **What energetic mix at 2025 horizon?**
- **Stress tests have been carried out (in France but also in all the nuclear European countries)**
- **Decision to reinforce defense in depth, by adding a « hardened core of vital safety functions » to each PWR**
  - **The principle has been accepted and the corresponding requirements are under discussions**
- **Decision to reinforce IRSN R&D on nuclear in several directions**

The hardened safety core in the Defense-in-Depth



Hazards to be considered for the hardened safety core design

European Nuclear Safety Regulators Group (ENSREG) reviews

Safety frameworks status

Occurrence frequency of considered hazards

⇨ 10^{-4} /year

Hardened Safety Core

"The review team recommends to consider extreme meteorological conditions in the required definition of the "hardened safety core"

French Context

Hardened safety core - Considered Hazards

✓Earthquake

✓Flooding + some related events

Some hazards considered with significantly smaller reference time scales

Examples : Winds, tornados, temperatures…

Hazards to be considered for designing the hardened safety core

L'IRSN considers that reactor robustness to hazards other external events than earthquake or flooding shall be assessed

For the hardened safety core :

Investigations already initiated for **defining the other external events** than earthquake and flooding that should be assessed.

Robustness to these other extreme hazards will require **arrangements to be defined**

These arrangements might be **different from arrangements for the "Seismic-flooding hardened safety core"**

Main goals for renewed efforts in nuclear safety

- **Better understand relevant dangerous phenomena and associated uncertainties**
  - **External Events (EE: seism and structure behavior, flooding, harsh weather, …)**
  - **Fuel behavior (LOCA, spent fuel pool)**
  - **Efficiency of severe accident mitigation**
- **Improve severe accident modeling capabilities**
- **Better understand success or failure elements in HOF during normal or emergency operations**
- **Improve (and disseminate with decision makers) knowledge on severe accident economic and societal costs (cost/benefit factor).**

Seismic, flooding hazards R&D

- **Seismic hazards:**
  - Characterization of the activity of a fault, discovery of new active faults in France
  - Study of site effects (such as amplification of seismic movements in sedimentary basins)
  - Soil structure interactions, structure response (non-linear effects)
  - Quantification of uncertainties (development and assessment of propagation methodologies)
- **Flooding hazards:**
  - Identification and characterization of phenomena that can contribute to the flooding risk and of their dependencies
  - Site per site determination of the probability of events occurrence
  - Model improvement (such as streaming of rain water)

Probabilistic Safety Assessment

- **IRSN PSA**
  - Screening for each French site of the risk associated to all plausible external events (2013-2014)
    - Hazard assessment and review of protective measures associated
    - Review of all possible consequences
    - Simplified probabilistic assessment
    - More complete probabilistic assessment for events/site representing the highest risk level
  - Earthquake / PWR 900 (2015)
    - Under development in the perspective of the preparation of the 4th ten-yearly review of PWR 900 MWe
  - PSA "climatic events" (2015)
    - To be launched in the perspective of the 4th ten-yearly review of PWR 900 MWe (2015)
- **Quantification of very rare external initiating events**
  - Cross cutting topic
  - Research program under reflection (reflection that should be enlarged to the international community)
    - Objectives:
      - To improve existing methodologies for earthquakes and flooding
      - To propose methodologies for other external and extreme events

Conclusions

- **The Fukushima accident led to renewed R&D efforts of IRSN in several domains and, in particular, in the external event related domains**
- **The most important efforts devoted to external events concern earthquakes and floods, and more attention will be paid to other hazards in particular harsh weather (storms, extreme temperatures …)**
- **Safety research was and is the place of wide and efficient international collaborations in major domains such as severe accidents, thermalhydraulics or fuel safety, thanks in particular to NEA/CSNI**
- **International cooperation should be reinforced in the domain of external events to clearly identify the knowledge gaps and initiate joint R&D programs that should aim to close these gaps as efficiently and quickly as possible.**