

**IRSN**  
INSTITUT  
DE SÉCURITÉ PROTECTION  
ET DE SANTÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

## The Role of Technical Scientific Organizations (TSO's) in support to Nuclear Safety Authorities

Jacques Repussard  
Director General IRSN  
President of ETSO

US/NRC/RIC 2014




---

---

---

---

---

---

---

---

### Contents

- The concept of scientific and technical support
- Rule making technical support
- Inspection technical support
- Regulatory decision making technical support
- Conclusion

RIC – March 2014 **IRSN** 2

---

---

---

---

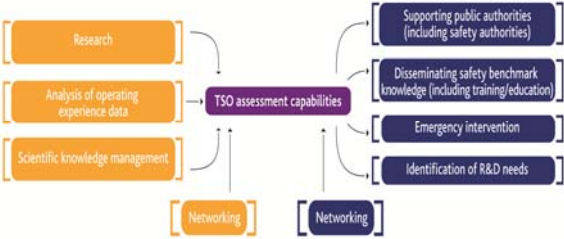
---

---

---

---

**Nuclear safety needs to be science-based: How do nuclear safety authorities ensure timely access to relevant scientific expertise?**



```

graph LR
    subgraph Inputs
        R[Research]
        A[Analysis of operating experience data]
        S[Scientific knowledge management]
    end
    subgraph Enablers
        N1[Networking]
        N2[Networking]
    end
    TSO[TSO assessment capabilities]
    subgraph Outputs
        O1[Supporting public authorities (including safety authorities)]
        O2[Disseminating safety benchmark knowledge (including training/education)]
        O3[Emergency intervention]
        O4[Identification of R&D needs]
    end
    R --> TSO
    A --> TSO
    S --> TSO
    N1 --> TSO
    N2 --> TSO
    TSO --> O1
    TSO --> O2
    TSO --> O3
    TSO --> O4
  
```

Whether in house or not, expertise capability at the highest level requires permanent and carefully coordinated management and resources

RIC – March 2014 **IRSN** 3

---

---

---

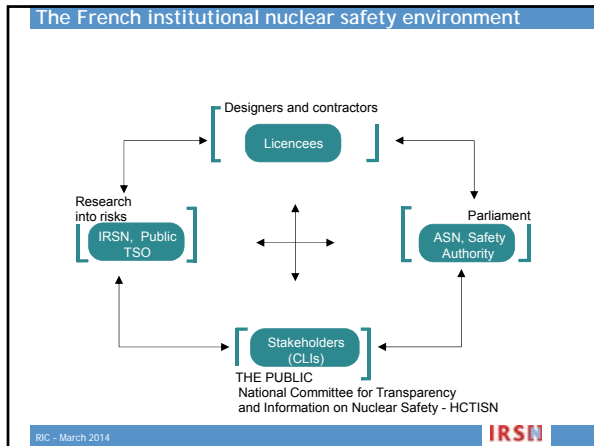
---

---

---

---

---




---

---

---

---

---

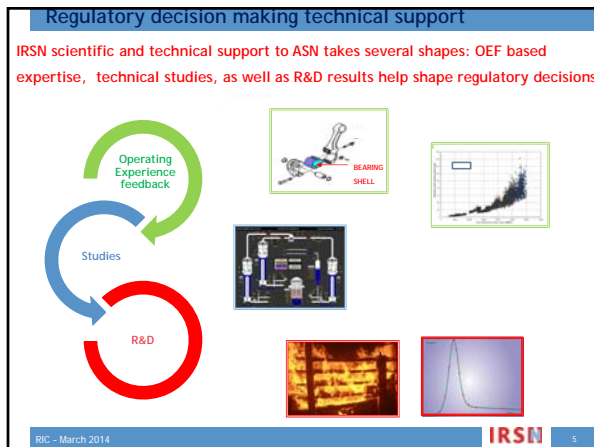
---

---

---

---

---




---

---

---

---

---

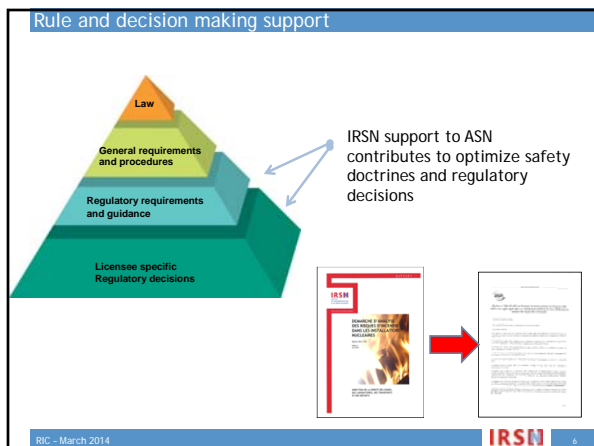
---

---

---

---

---




---

---

---

---

---

---

---

---

---

---

## Inspection support

IRSN plant safety indicators help ASN in defining its yearly inspection program in the French nuclear facilities, and IRSN often assist ASN inspectors with specific thematic expertise

IRSN operates ongoing OEF analysis on the basis of safety relevant events declared by operators (about 1000 per year, mostly without actual safety consequences), and derives a set of plant safety indicators which are used by ASN for priority setting of its inspection program. IRSN also publishes a yearly public report on plant safety, which complements ASN Annual report with more technical information.

IRSN experts provide specialized technical support (civil engineering, welding, fire safety, safety systems, radiation protection, ...) to ASN staff for inspections either at operating plants (about 500 inspections per annum), or at new build sites (EPR,...)

RIC - March 2014

IRSN

7

---

---

---

---

---

---

---

---

## Expertise in support to licensee specific regulatory decisions

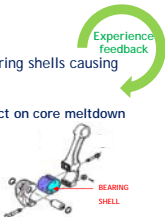
### Example 1: Bearing shell malfunction on EDF NPP diesel generators

Origin: EDF notifies ASN and IRSN of malfunctions of bearing shells causing premature shut down of diesel engines during tests

Precursor analysis performed by IRSN shows significant impact on core meltdown probability

On the basis of IRSN analysis, ASN orders EDF to implement

- A compensation program to ensure diesel availability :
  - monitoring of particles levels in oil
  - Procedure for ensuring diesel back up from one plant reactor to another
- A revised qualification program for bearing shell procurement



RIC - March 2014

IRSN

8

---

---

---

---

---

---

---

---

## Expertise in support to licensee specific regulatory decisions

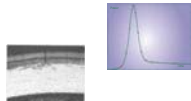
### Example 2: RIA criteria

At the time of reactor design, RIA safety limits based on SPERT data

CABRI program (1993-2000): tests revealed rod failures for enthalpy values smaller than SPERT ones for rods with higher burnup

Additional criteria based on CABRI tests for high burnup assemblies:

- Fuel enthalpy increase < 57 cal/g
- Pulse width (at half maximum) > 30 ms
- Clad temperature < 700 °C
- Corrosion thickness : 108 μm



After IRSN analysis, initial criteria remain acceptable only for unspalled fuel rods

RIC - March 2014

IRSN

9

---

---

---

---

---

---

---

---

Expertise in support to licensee specific regulatory decisions

### Example 2 bis : Zircaloy-4 fuel cladding oxydation

Origin: EDF notifies measurements of clad oxidation thickness greater than expected


IRSN analysis based on earlier fuel safety research :

- > Increased risk of in-reactor oxide layer spallation
- > Potential impact on fuel rod behavior in accidental conditions (LOCA, RIA)

ASN orders EDF to take compensation measures within a year:

- Limitation of clad oxidation thickness
- Limitation of the consequences in case of RIA accident (rod insertion limitation)

As a result, EDF will speed up the replacement of Zircaloy-4 fuels by fuels with improved performance with regard to oxidation (M5, Zirlo)



RIC - March 2014 **IRSN** 10

---

---

---

---

---

---

---

---

---

---

---

---

Expertise in support to licensee specific regulatory decisions

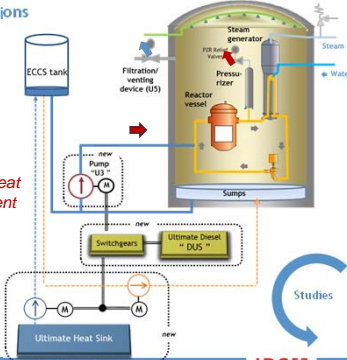
### Example 3: Post Fukushima Hardened safety core

Additional requested provisions

- For residual heat removal
- Addressing beyond design plausible extreme hazards

EDF feed and bleed approach: Residual core heat removal into the containment (safety relief valves), and water make up (with new pump U3)

Containment heat removal from the containment (filtration and venting device)



RIC - March 2014 **IRSN** 11

---

---

---

---

---

---

---

---

---

---

---

---

Expertise in support to licensee specific regulatory decisions

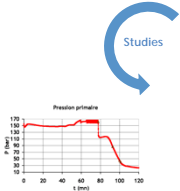
### Example 3: Hardened safety core : analysis by IRSN of EDF proposal leads to modified design

IRSN launched an in depth study of EDF proposal using its PWR simulator and ASTEC code. The conclusion reached was that EDF proposal

- Does not necessarily avoid core melt risk
- With only the first barrier left, doesn't meet the objective of limitation of massive radioactive releases

Revised solution approved by ASN for the "hardened core" conception:

- Primary cooling by the SG (new make up for the SG)
- Containment cooling (new heat exchanger for CCS)



RIC - March 2014 **IRSN** 12

---

---

---

---

---

---

---

---

---

---

---

---

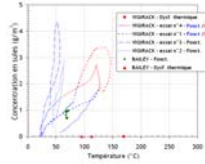
Expertise in support to licensee specific regulatory decisions

Example 4: Fire PSA

EDF proposes the use of a single 100°C criterion limit for electronic cards malfunction fire testing



IRSN own experimental tests (CATHODE) demonstrate thermal effect and soot effect (coupled effects) at lower temperatures



The modification of the malfunction criterion (down to 65°C) in fire PSA leads to an increase of core meltdown probability by a factor of 2 to 3.

---

---

---

---

---

---

---

---

---

---

Conclusion

- Access to high level expertise is critical for high level regulatory performance
- Often, dedicated scientific tools enabling the execution of specific studies and counter-calculations (independent from the licensee) are needed to feed the regulatory support expertise
- R&D, including experimental programs will remain essential to provide the necessary knowledge base, to train new generations of experts, and to support the expertise capability.
- The high cost of such programs are a key driver for international cooperation. Such cooperation can also enhance greatly the performance of expertise in support to regulatory decisions.

---

---

---

---

---

---

---

---

---

---

Thank you for your attention

---

---

---

---

---

---

---

---

---

---