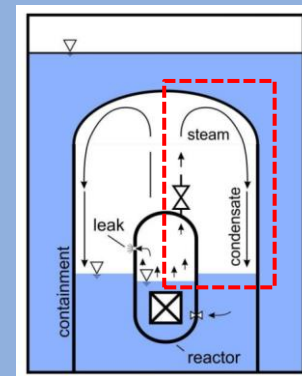
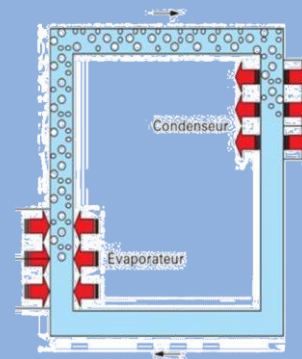


DEVELOPING NUCLEAR RESEARCH CAPACITY

IRSN
Karim Ben Ouaghrem



CONTENTS

1. Research to support nuclear safety expertise worldwide
2. Research at IRSN
3. IRSN Case study on research

1 - « Nuclear expertise is science based »

IAEA Nuclear and radiation safety Resolution GC(66)/RES/6 Sept. 2022

*« (I) Acknowledging that research, development, the introduction of innovative methods and technologies and the **availability of research and testing facilities** are of continuing and long-term fundamental importance in improving nuclear safety worldwide; »*

G7 Nuclear Safety and Security Group 2019

« to preserve the remaining operating research facilities, when appropriate, to ensure durability of scientific expertise »



TSO Forum

ETSON

EUROPEAN
TECHNICAL SAFETY
ORGANISATIONS
NETWORK

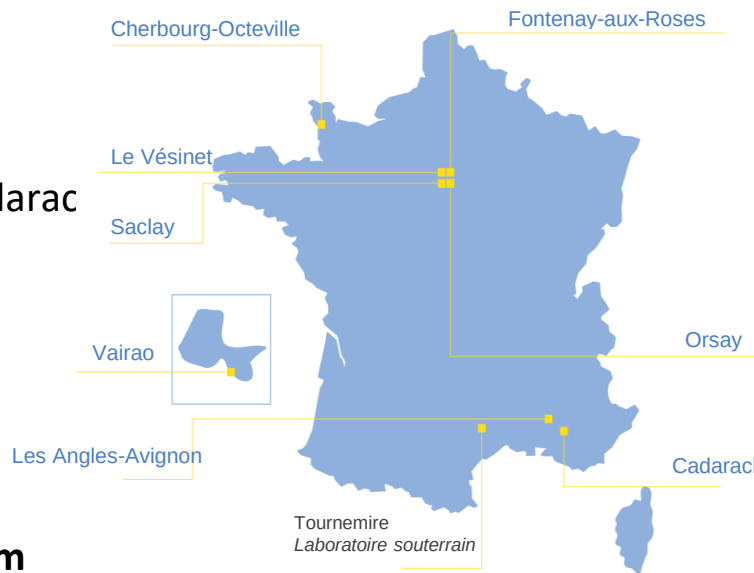


PIANOFORTE



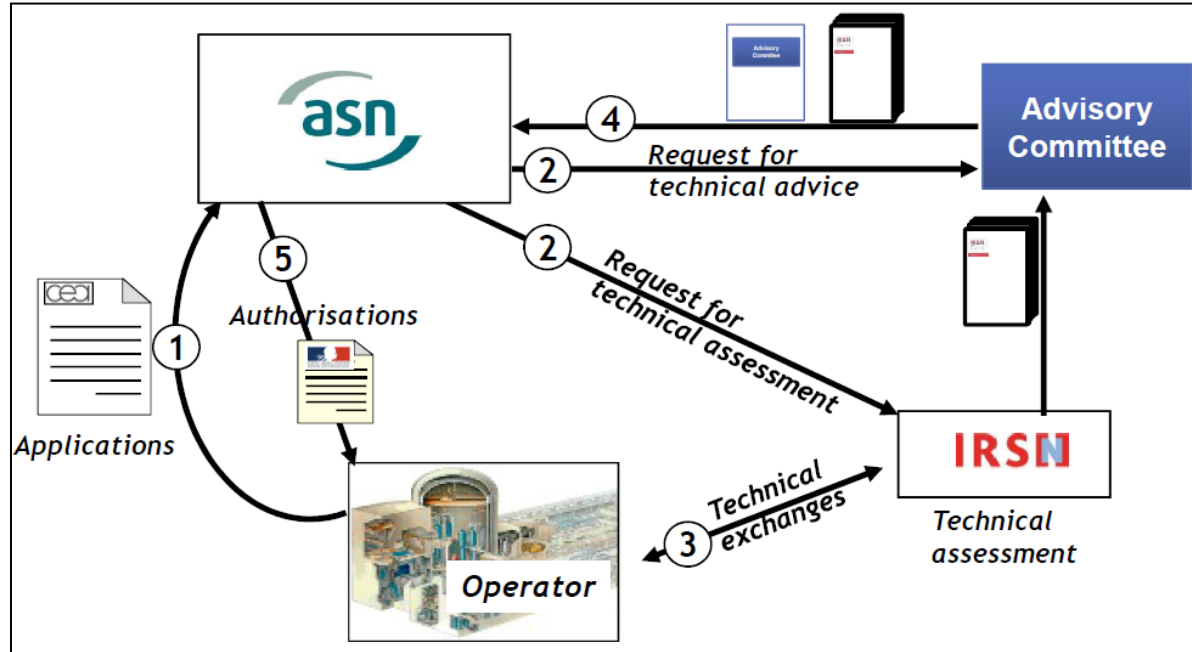
2 - IRSN, a scientific and technical organization dedicated to radiation and nuclear safety and security

- **Supervised jointly by 5 ministers :**
Environment, Energy, Defence, Research and Health
- **More than 1 800 collaborators spread over 9 sites**
3 major sites: Fontenay-aux-Roses, le Vésinet and Cadarac
- **More than 1000 specialists**
- **700 technical reports per year,**
mostly open to the public
- **300 M€ budget**, of which almost **40 % is devoted to research**
- **A Technical Crisis Centre (CTC) and a mobile emergency team**
- **Environment monitoring:** 450 Teleray stations, 8000 annual environmental samples





Assessment processes



8 Advisory Committees of Experts (ACE/GP) on various topics

	GPR	GPU	GPD	GPT	GPESPN	GPRAD	GPMED	GPDEM
Specialty	Reactors	Laboratories and plants	Waste	Transport	Nuclear pressure equipment	Radiation protection	Medical exposure	Decommis-sioning
Number of members	34	32	36	26	28	27	30	34

IRSN Safety Research

16 laboratories, 250 permanent staffs and 45 additional post-graduate and post-doctoral researchers

■ **Fuel behaviour**

■ **Severe accident / corium**

■ **Containement**

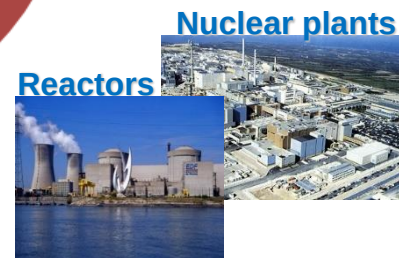
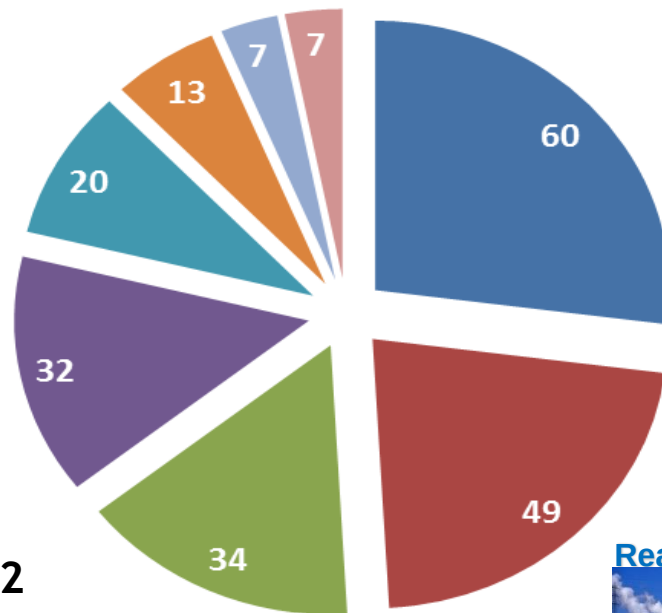
■ **Fire/explosion**

■ **criticality / neutronics**

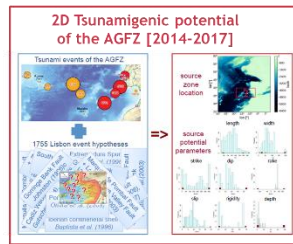
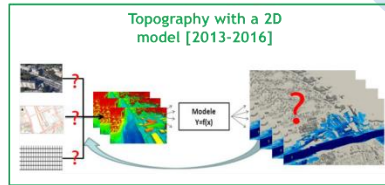
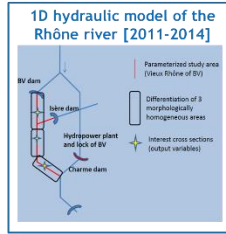
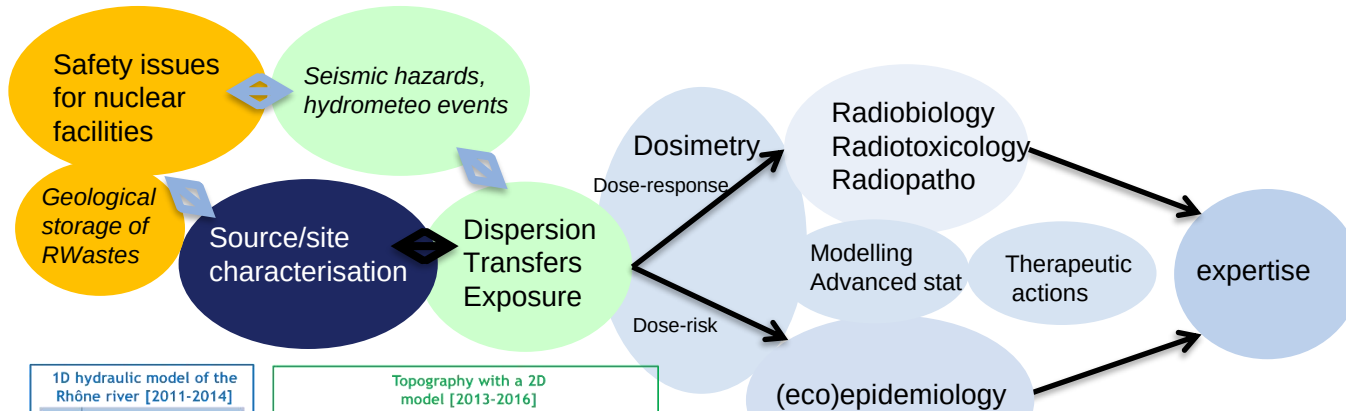
■ **Ageing**

■ **Human factors**

■ **New generation of plants SMR, EPR2**



IRSN Safety Research



Research for Radiation protection

126 permanent staff – 55 PhDs, 8 PsDoc;

- to assess the radiological risk **to human health and ecosystem health** and **to put it into perspective of other risks**
- based on robust interpretation of **(eco) epidemiological studies** and **on results from radiobiology / radiotoxicology and dosimetry research** for human and non-human species; based on the **advanced characterization of exposure sources** whatever the situation

« Nuclear research to face current and future safety challenges »

Open issues on the current fleet:

- Long Term Operation : ageing, obsolescence...
- Fuel and severe accidents
- Human and Organizational Factors
- External hazards,
- Stress corrosion cracking,
- Passive safety systems,
- Safety in time of war,
- Impact of climate change

Research topics on new technologies (New advanced reactors, SMRs, Accident Tolerant Fuel (ATF)):

- Effectiveness and reliability of passive safety systems to be demonstrated
- Dedicated research: TANDEM (SMR), ELSMOR (SMR licensing)

IRSN PASTIS Project



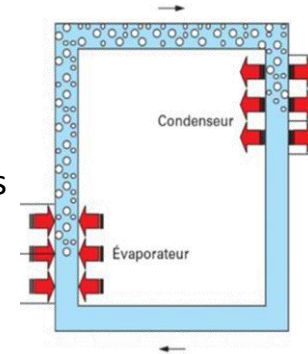
Overview

- **Phase 1 [2022-2025]:** Construction of an experimental platform made of two facilities
- **Phase 2 [2026-20xx]:** Realization of experiments and development and validation of models

ALCINA – « NATural Circulation AnaLysis »

Studies of natural circulation in closed loop :

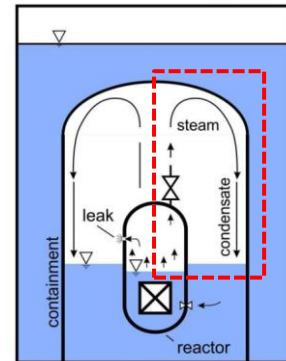
- Thermo-fluid dynamics and pressure drop in various geometrical configurations
- Analysis of parameters influencing natural circulation in a two-phase loop



KoKoMo – « COndensation in a COntainment MOdél facility »

Studies of condensation phenomena within an immersed containment :

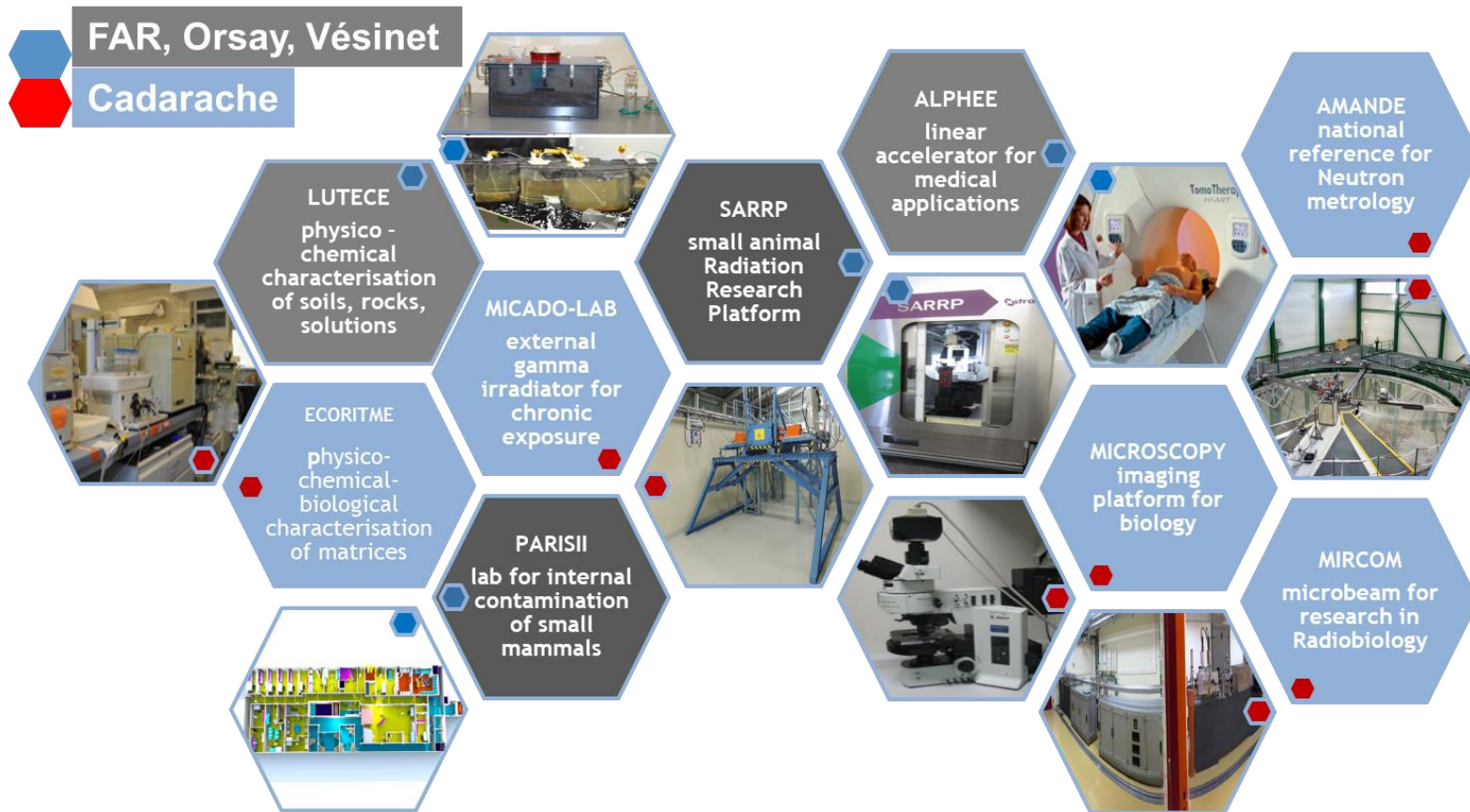
- Effects of non-condensable gases on condensation heat transfer
- Analysis of parameters influencing stratification in large volumes



Research and Assessment : Experimental platforms



Research and Assessment : Experimental platforms



IRSN case study for the TSO Forum

“Research as a driving force of the TSO capabilities in France”

by François Barré, Deputy head of **Nuclear Safety Research** Department

- ☐ French context
- ☐ Synergy between research and expertise
- ☐ IRSN scientific strategy

www.irsn.fr/EN/Presentation/governance/Pages/IRSN-Scientific-strategy.aspx

- ☐ International cooperation
- ☐ Projects per research topics, research infrastructures, simulation tools

IRSN case study

Research as a driving force of the TSO capabilities in France

Nuclear research originally concentrated within CEA (created in 1945).

Then, nuclear safety research for safety assessment driven by IRSN (created in 2002 from the merge of OPRI and IPSN (entity within CEA) for the required separation between public authorities and operators' expertise and research functions.

Synergy between research and expertise is the DNA of the Institute

« Nuclear research to face current and future safety challenges »

Open issues on the current fleet:

- Long Term Operation : ageing, obsolescence...
 - Fuel and severe accidents
 - Human and Organizational Factors
 - External hazards,
 - Stress corrosion cracking,
 - Passive safety systems,
 - Safety in time of war ...
- Impact of the Climate Change:
 - Flooding, extreme wind, tornados, intense local rainfall may affect electrical power supply and safety systems and generate clogging of the heat sink, combination of hazards (e.g. high wind and flooding)
 - Extreme heat may affect the heat sink
 - Extreme cold and ice may also affect the safety (impact on off-site power)
 - Accessibility to the facility of emergency teams

Research topics on new technologies (New advanced reactors, SMRs, Accident Tolerant Fuel (ATF)):

- Effectiveness and reliability of passive safety systems to be demonstrated
- Dedicated research: TANDEM (SMR), ELSMOR (SMR licensing)

IRSN case study

Research as a driving force of the TSO capabilities in France

Reviews should be impartial and scientifically sound.

Mainly based on data and information provided by Licensees.

Relevance and independence of the Institute assessment is based on its capability to perform complementary or contradictory studies, develop its own computational tools and research activities to challenge Licensees' statements (overall assessment of safety margins and identification of weak points).

IRSN case study

Research as a driving force of the TSO capabilities in France

Expertise is mainly a short or midterm issue while the development of research program is a longer-term process.

Researchers and safety experts work on different time scale and analyse problems or situations with different perspectives.

To foster the synergy between researchers and safety assessment experts, IRSN modified its internal organization and implemented a process of research program development considering safety reviews needs.

IRSN case study

Research as a driving force of the TSO capabilities in France

TSOs have often not a clear perception of the mid / long term industrial policy of the Licensees and can have difficulties to anticipate expertise needs.

When developing a new research program, attention is paid to enlarge the scope, to make it as generic as possible, for being able to develop models and competences that could be used in broader contexts.

To create broad skills, generic knowledge, smart database, flexible experimental infrastructures is clearly a huge challenge for research.

IRSN case study

Research as a driving force of the TSO capabilities in France

Research outcomes to directly answer expertise practical matter

Main outcome of Research is to make high level skills available for safety assessment

... to develop and maintain a comprehensive understanding of matters relevant for reactor safety covering both the present technologies in use in Europe and those foreseen in the future ...,

... and to explore subjects that operators consider to be excluded or correctly treated.

IRSN case study

Research as a driving force of the TSO capabilities in France

IRSN scientific strategy

www.irsnn.fr/EN/Presentation/governance/Pages/IRSN-Scientific-strategy.aspx

Criteria

- the importance of the scientific product for risk management;
- the potential for increasing the Institute's independence of judgment;
- the ability for capacity building or to maintain strategic skills;
- the potential for generating collaborative partnerships;
- the technical and financial risks

Thank you for your attention