THE SAFETY REASSESSMENT OF RESEARCH REACTORS IN FRANCE

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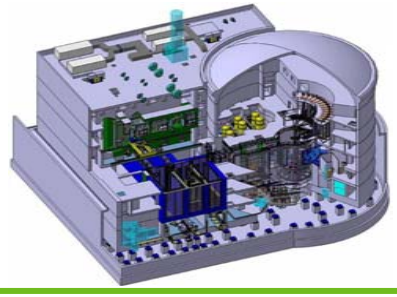
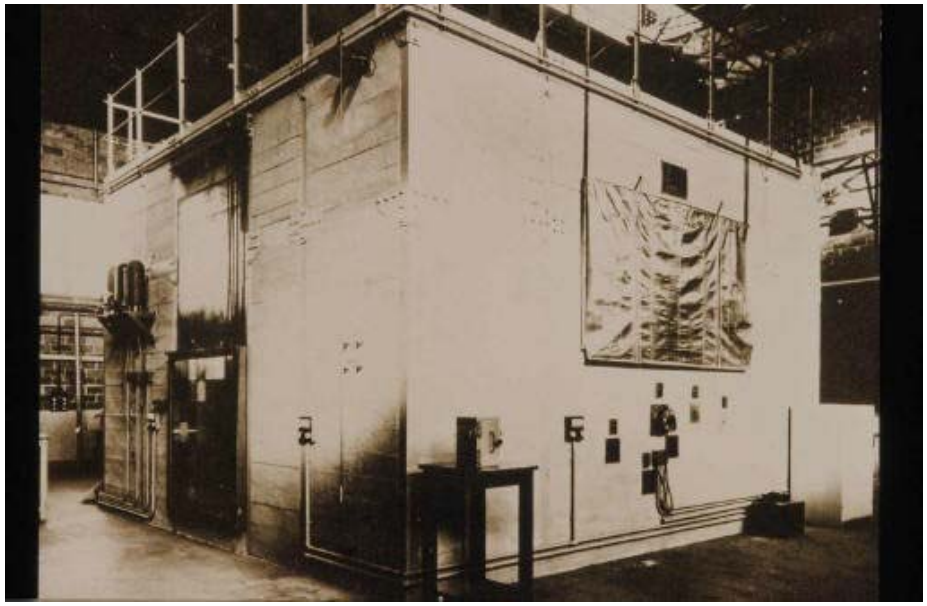


Plan of the presentation

- 1] A Brief History of the Research Reactors in France
- 2] The Present Fleet of Research Reactors in Operation
- 3] The Safety Reassessment of Research Reactors in France
- 4] The CEA Strategy on Research Reactors
- 5] Example of Safety Reassessment: the MASURCA Reactor

1] A Brief History of the Research Reactors in France (1/2)

About 30 RR built between 1948 and 1980
(a large experience…)



From ZOE
(1948-1976)

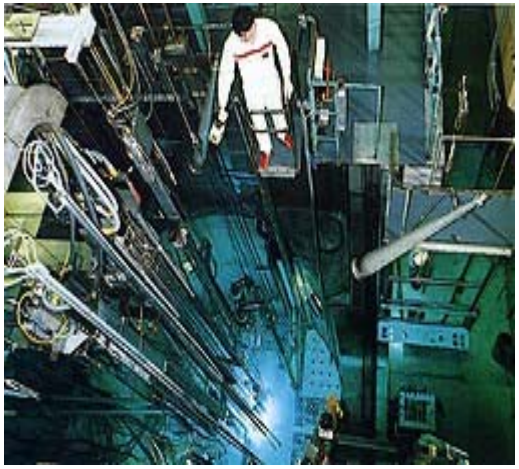
To

Jules Horowitz Reactor(JHR)
(2014~ 2075)

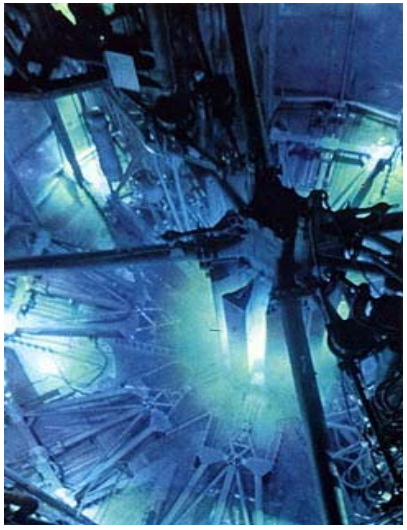
1] A Brief History of Research Reactors in France (2/2)

- Heavy building activity between the 50's and the 70's

  - Neutron physics studies for Reactors
  - Material science (fuel and structure behaviour under irradiation)
  - Safety studies
  - Fundamental research on matter…



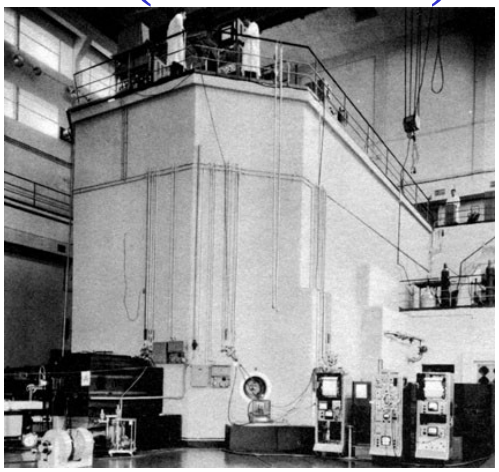
SILOE(1963-1997)



PEGASE(1963-1974)

ORPHEE(1980)

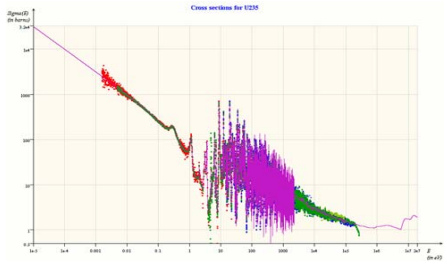
MELUSINE (1958-1988)



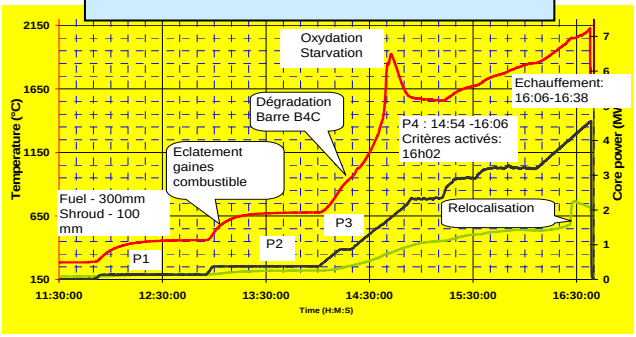
2] Present Fleet of Research Reactors in France

- 11 RR operated in France (10 by CEA – HFR by ILL) in a wide range of activities :
  - 3 Zero Power Reactors for reactor physics studies
  - 2 dedicated reactors for safety experimentation
  - 2 neutron source reactors for fundamental research
  - 1 Material Testing Reactor for studies under irradiation
  - 2 education and training reactors (1 to be stopped end of 2007)
  - 1 prototype fast reactor (to be stopped end of 2009)

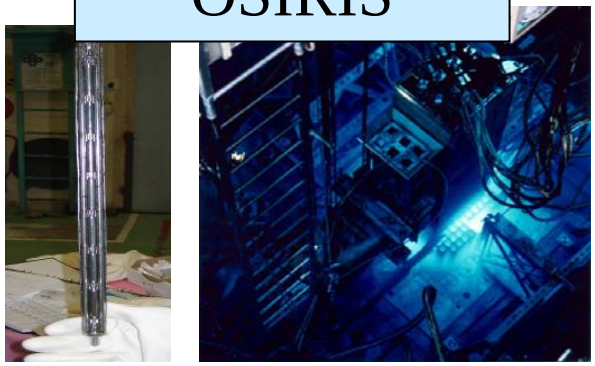
MINERVE



PHEBUS

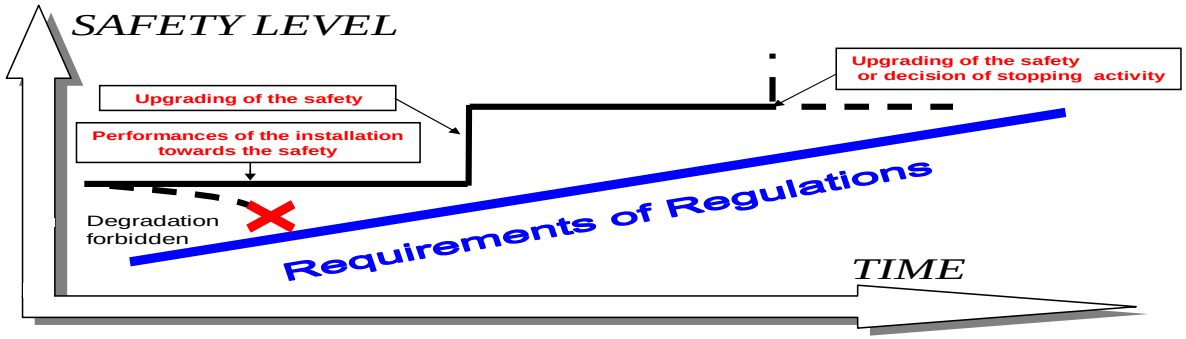


OSIRIS



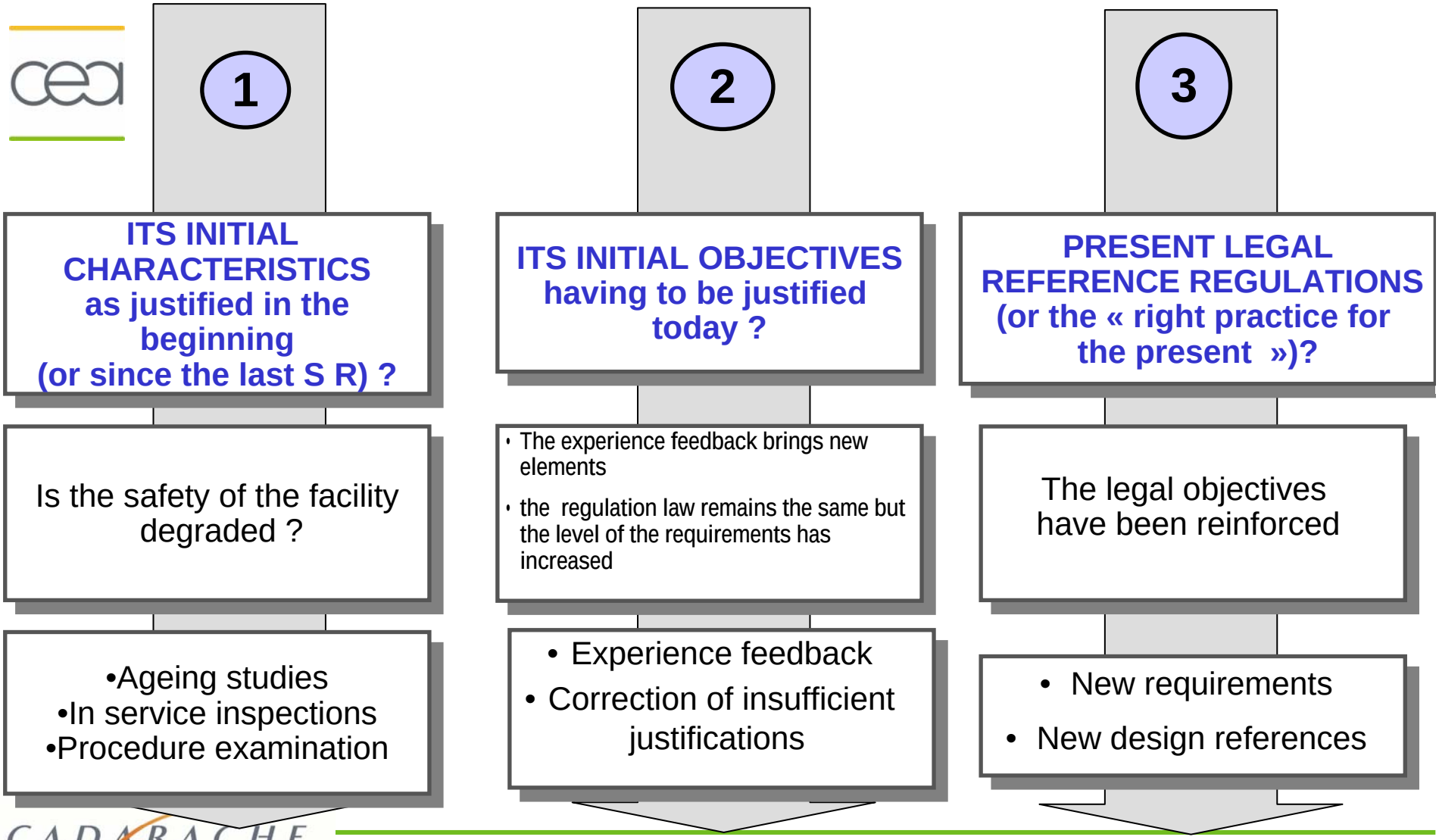
3] The Safety Reassessment of RR in France(1/5)

- Periodic Safety reassessment compulsory by law
  - Strict Guidelines (methodology,rules) similar to NPP
- Objectives:
  - Check the conformity of the safety system of reference in use
  - Perform an inventory of nuclear safety in relation to present rules



3] The Safety Reassessment of RR in France (2/5)

Is the facility in conformity with:



3] The Safety Reassessment of RR in France (3/5)

Conformity Exam and Safety Reassessment

↓

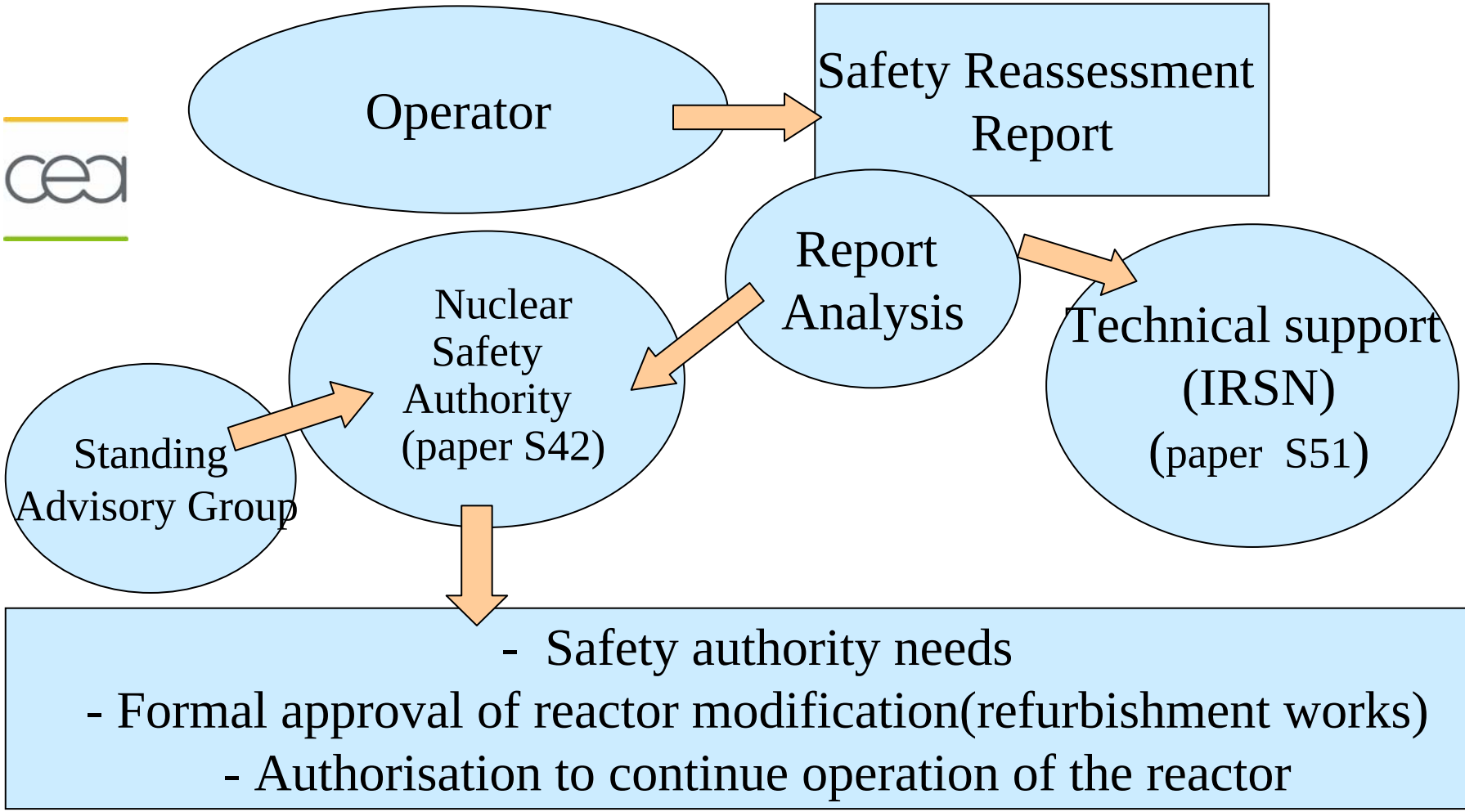
Identification of the gap between the situation and the requirements due to present rules

↓

Definition of refurbishment works

⇒ ***Increase of the safety level of the reactor***

3] The Safety Reassessment of RR in France (4/5)



3] The Safety Reassessment of RR in France (5/5)

- **The most sensitive points :**
  - **Dimensioning of the confinement barriers**
  - **Treatment of internal risks (criticality,fire, flood…)**
  - **Treatment of external risks (earthquake,airplane crash…)**
  - **Incidental and accidental situation analysis (with radiological impact)**

4] The CEA Strategy on Research Reactors(1/5)

- **Key Roles of RR for scientific and industrial needs but costly facilities**

  → **importance of a *comprehensive strategy* :**

  - **Up-to-date high performance experimental capacities for the development of safe and reliable nuclear energy**
  - **Rationalisation of the RR fleet (refurbishing? Shutting down facilities facing ageing issues or lack of programs)**
  - **Provide efficient operation conditions within strong international cooperation**
  - **Take special care for the training of young generation**

4] The CEA Strategy on Research Reactors (2/5)

1)General question: what are the needs in terms of international scientific and/or industrial interest ?

2)After safety reassessment these important questions arise:

- ***What is the level of difficulty in terms of refurbishment work to meet safety requirements ?***
- ***What is the overall cost/benefit of the refurbishment ?***

→ **Consistent decisions on :**

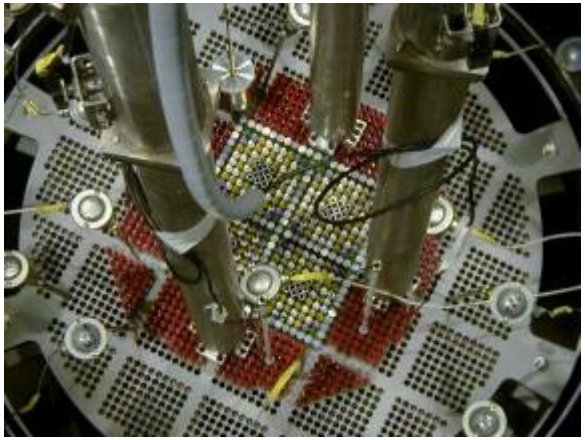
- ***The lifetime of the facility***
- ***The level and schedule of refurbishment***
- ***The possible renewing of the facility***

4] The CEA Strategy on Research Reactors: the ZPR(3/5)

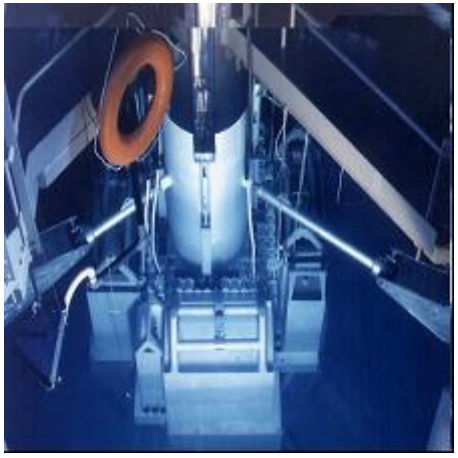
Importance of the 3 ZPR for neutrons physics studies:

- Pu utilisation in PWR and ABWR,
- Support of French PWR (GEN II and GEN III),
- Waste incineration studies,
- New concepts of GEN-IV Forum (SFR,GFR).

CEA strategy: maintain the facilities in operation
→ strong refurbishment work



EOLE

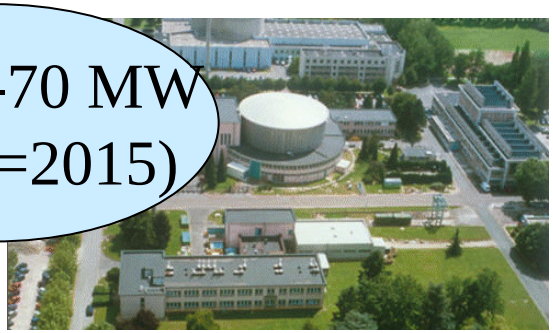


MINERVE

MASURCA

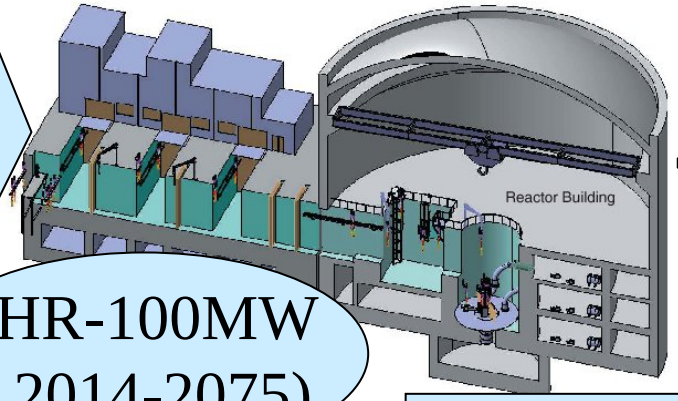
4] The CEA Strategy on Research Reactors: the MTR(4/5)

OSIRIS-70 MW
(1966<=2015)



SILOE-40 MW
(1963-1997)

Broad survey (OECD,European Commission…)
«Given the age of current MTRs, need of a new European MTR »



JHR-100MW
(2014-2075)

A **user-facility** reaching the needs
of the **international community**:
-*flexibility* with irradiation loops
-*high flux* capacity to address
GEN II, III and IV needs
-*training* of new generation.

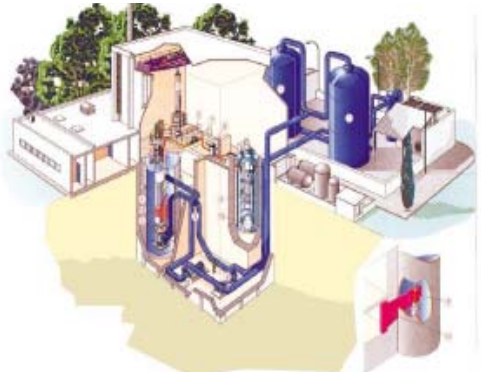
Safety Standards of JHR :
-systematic assessment of external and internal hazards
-confinement design to face severe accident
-irradiation devices as a potential aggressor of the facility

4] The CEA Strategy on Research Reactors: the Safety Reactors (collaboration with IRSN-see paper U-30) (5/5)

- **Two Research Reactors dedicated to safety experiments:**

1) PHEBUS on LOCA and severe accidents (last test Nov 2004)→ long period without experiment (« cocoon mode »)

2) CABRI for RIA type accident studies

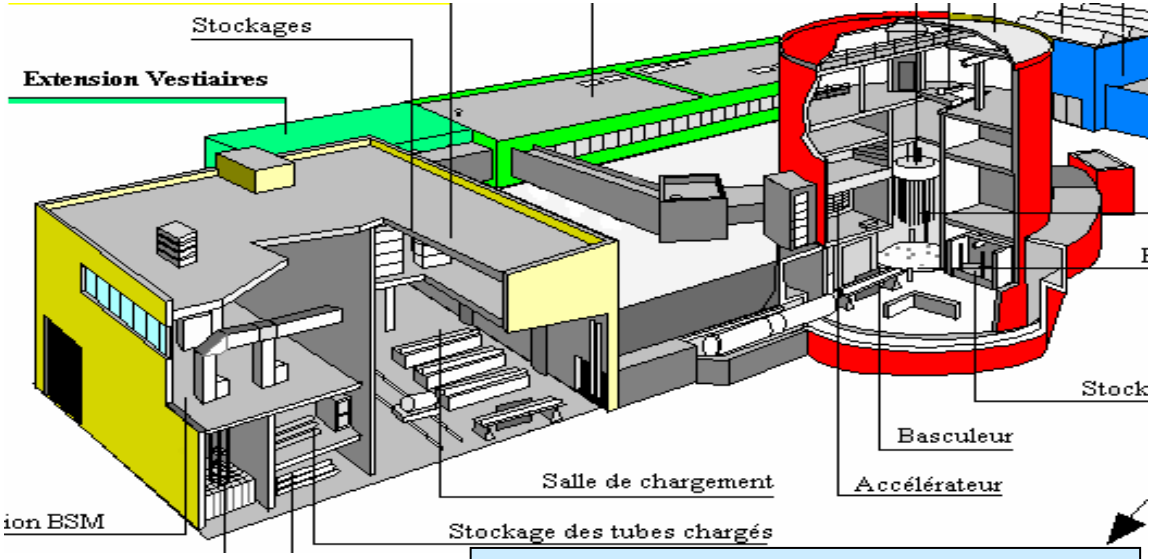


→Heavy refurbishment project

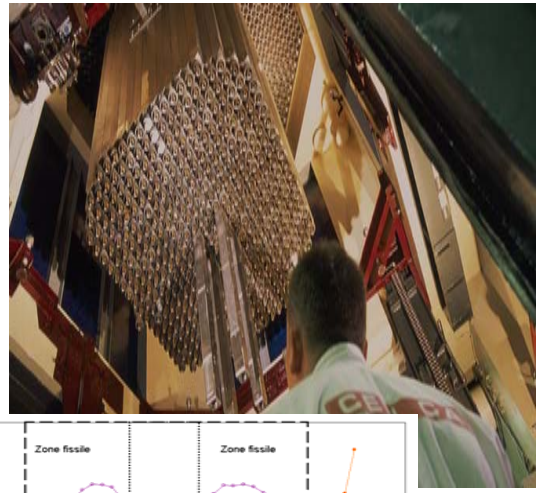
→New water loop

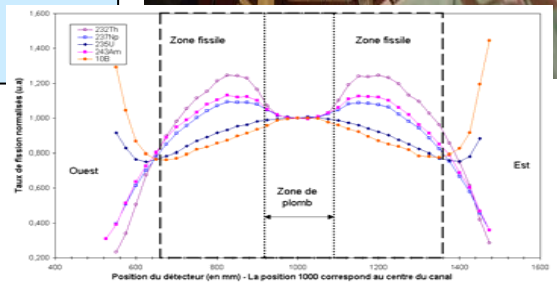
→Scientific program start end of 2009 (led by IRSN)

5] Example of Safety Reassessment: the MASURCA Reactor (1/4)



A flexible ZPR
for neutron physic studies
of fast spectrum reactors
(1966-20xx)





5] Example of Safety Reassessment: the MASURCA Reactor (2/4)

Objectives of the Safety Reassessment (2002-2006):

- ***Conformity exam***
- ***Feedback experience*** **and position of the safety level according to present rules**
- ***Analysis*** **of:**
  - **Safety-criticality**
  - **Electric supply**
  - **Command/control**
  - **Confinement/ventilation**
  - **Radioprotection**
  - **Fire/explosion risk**
  - **Flooding risk**
  - **Human factor**
  - **Seismic risk**

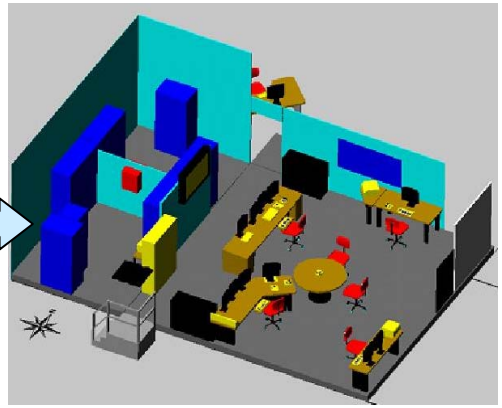
5] Example of Safety Reassessment: the MASURCA Reactor (3/4)

Safety reassessment process (see 3])

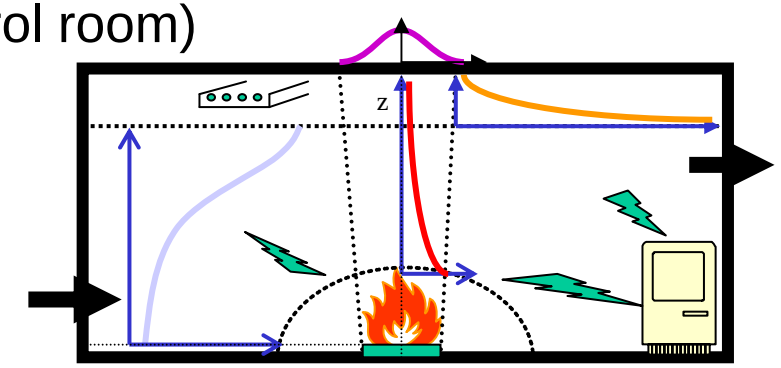
→

Approval of the refurbishment program proposed by CEA

- Electric Supply (new architecture, no common modes…)



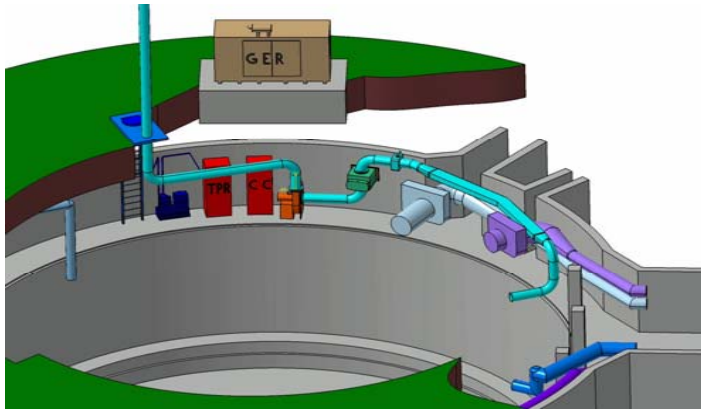
- Command/Control(new control room)



- Fire protection (zoning, fire-wall,wire protection…)

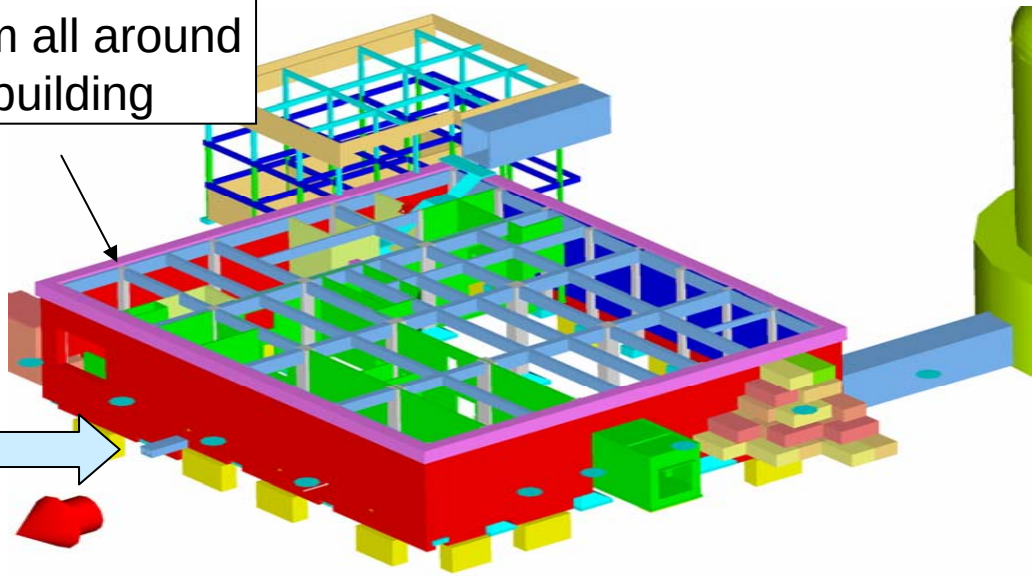
5] Example of Safety Reassessment: the MASURCA Reactor (4/4)

Ventilation:
implementation of
an emergency system
for post-earthquake monitoring



concrete extension
of 60 cm all around
the building

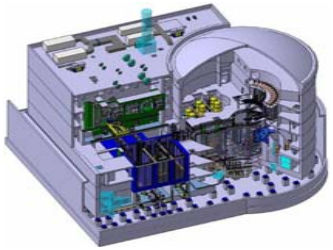
Seismic reinforcement:
important building work
for the nuclear fuel
storage building



Conclusion

- **Wide panel of activities with 11 Research Reactors available in France**
- **Safety Reassessment of Research Reactors is a mature process leading to up-to-date facilities (in regards to high level safety requirements)**
- **Comprehensive strategy of CEA for Research Reactors within a European Context (ZPR, MTR,Safety Reactors…)**
- **Open to international collaboration (safety review and/or technical project) :**
  - **exchange with senior scientists**
  - **special care for the training of the young generation**

Thank you for your attention



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