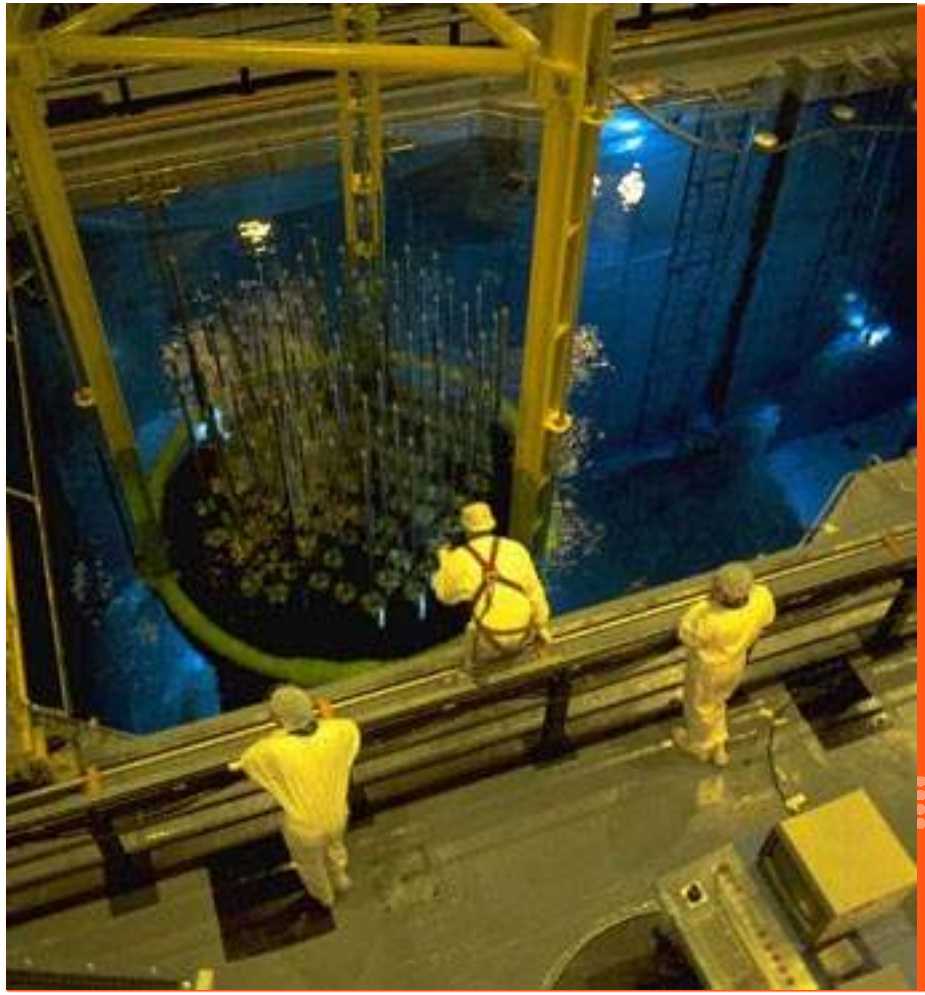
François HEDIN, Deputy Director of the Basic Design Department, EDF, France

- Graduated from Advanced Technics University Level College and from Naval Engineering,
- Previously Director for Maintenance of the NPP fleet at the NPP Division Headquarters ,
- Related to strategic and technicno-economical aspects of PLiM,
- Design of EPR, Gen III+ and Gen IV.



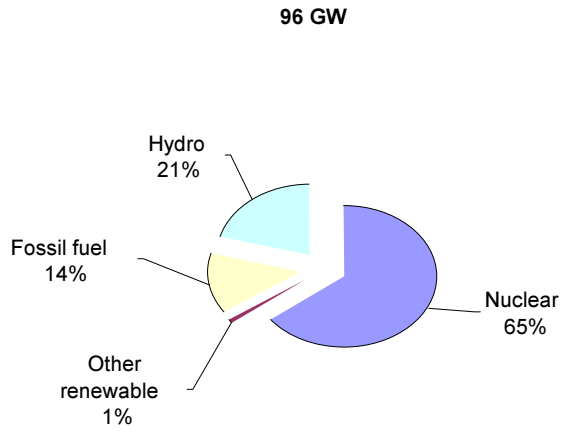
IAEA
2nd International Symposium on Nuclear Power Plant Life Management

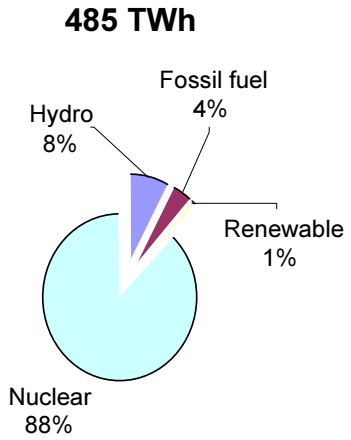
Approaches to plant life management in France

François HEDIN
EDF – Generation / Nuclear Engineering
Deputy Director, Basic Design Department

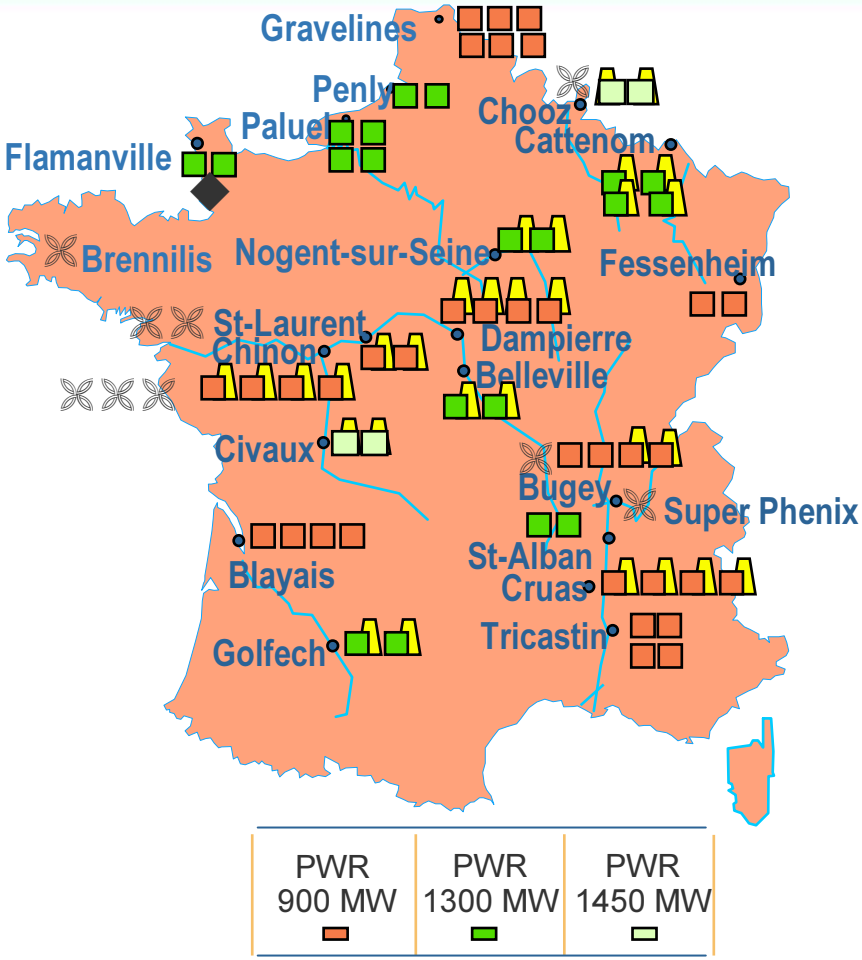
EDF in some figures

- 37,8 million Customers worldwide, including 28,2 in France
- 128,2 GWe installed capacity, of which 96 GWe (2006) in France
- Electricity Generation : 633 TWh, including 607 TWh in Europe, and 485 TWh in France.
- France :





EDF Pressurised Water Reactor fleet



EDF Nuclear Power Plants in France

- Largest fleet in Europe, homogeneous and concentrated

– 9 reactors in decommissionning ✂,

– 58 reactors in operation,

– spread out over 19 sites,

– single technology : PWR (Pressurised Water Reactor) Power : 63 GW, 429 TWh (2006),

– 3 series in operation :

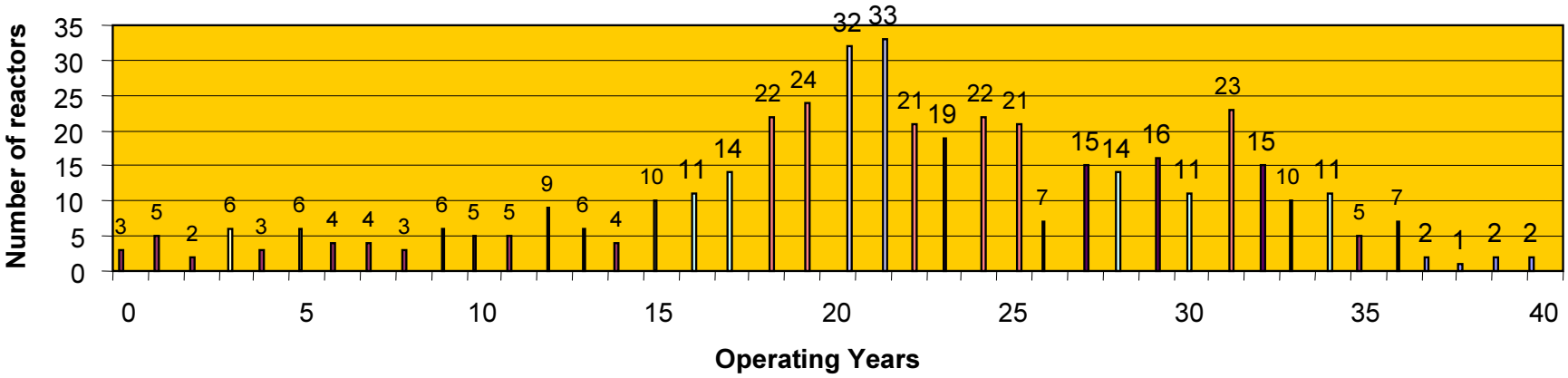
  - 900 MW : 34 units, i.e 31 GWe
  - 1300 MW : 20 units, i.e 26 GWe
  - 1500 MW (N4) : 4 units, i.e 6GWe

– first of EPR Flamanville 3 (2012) ◆

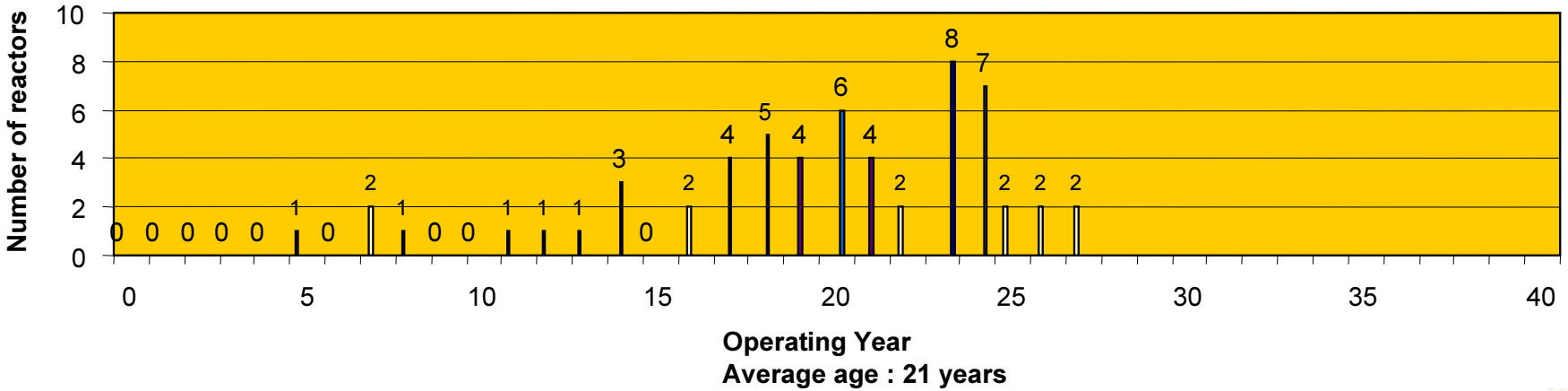
- EDF owns the nuclear facilities and the sites themselves.

World 441 Nuclear Power Plants Age Pyramide

World 441 Nuclear Power Plants Age Pyramide 2006



EDF 58 Nuclear Power Plants Age Pyramide



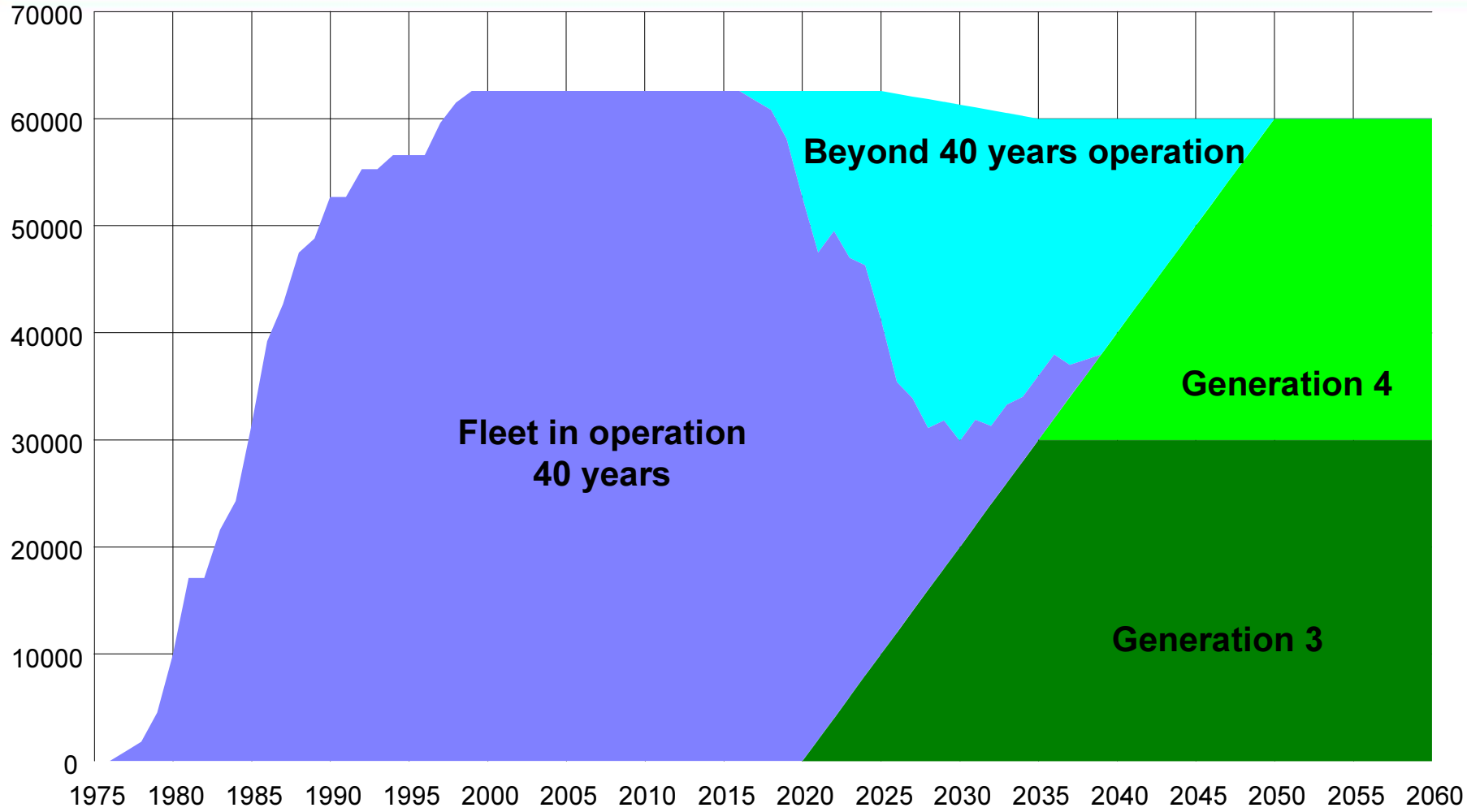
Example : GRAVELINES NPP

FLAMANVILLE

NPP Plant Life Management context in France

- Largely share majority (78,1%) for nuclear generation
  - Average age 3 loops 900 Mwe = 25 years – first 30 years reassessment 2009,
  - First 10 years 4 loops 1500 Mwe = 2009
- Fleet dimension / standardized plants
- To perpetuate nuclear fleet is a major stake :
  - for EDF : safety, competitiveness, sustainability,
  - Beyond : French energy policy / 2005, July 13th Program Law
    - Energy independance, supplying security,
    - Health and environment (greenhouse effect)
- French electricity market total opening
- Structural stresses with regard fossil raw materials
- Evolutionary regulatory environnement
  - 2006, June 13th « Transparency and nuclear Security »,
  - WENRA safety requirements
  - French general technical regulation rewriting (2010)

NPP Plant Lifetime Management / Renewal



Renewal scenario example : 30 years going on with 2000 MWe/year

Key EDF approaches for plant lifetime management (1)

Main questions to deal with :

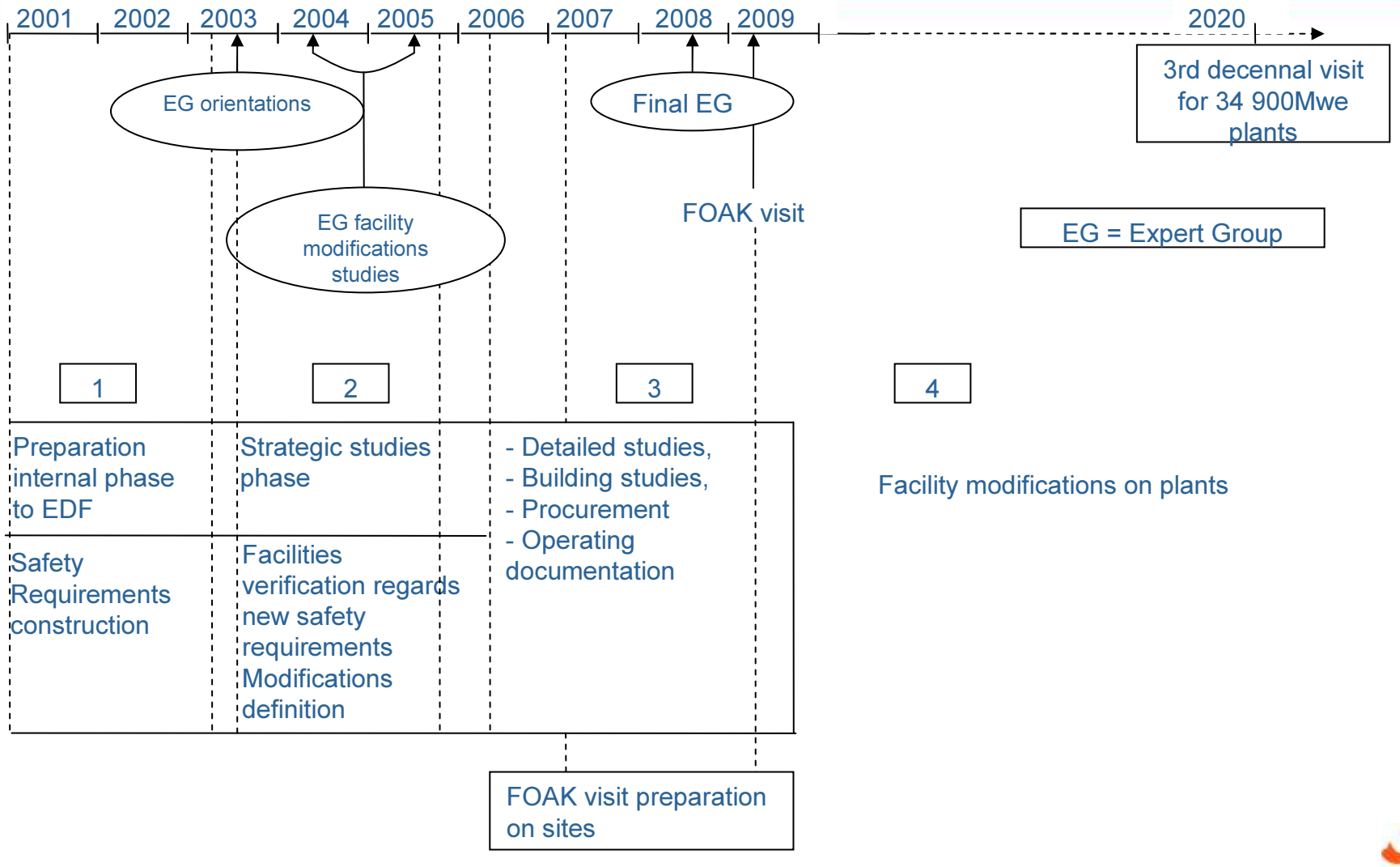
- Safety requirements compliance : operation and facilities,
- Continous safety improvement : operation and facilities,
- Operating performances improvement
  - fuel management / outages schedule and duration,
  - to reduce unplanned unavailability
  - optimized maintenance
- Physical ageing facilities (SSC) management,
- Skills and knowledge management :
  - development and renewal : internal to the company and external ones : vendors, equipments suppliers, service providers
  - knowledge gathering
- Public acceptance

Key EDF approaches for plant lifetime management (2)

Regulatory Frame

- Ten year safety review (regulatory practice and 2006 June 13th law)
  - Compliance analysis (2007 to 2014)
  - Safety reassessment (2003 to 2008)
- Ageing requirements (3rd ten years decennial visit 2009 – 3 loops plants).
  - Generic (fleet) demonstration for ageing control (2008) fit to service, R&D studies and facilities,
  - NSA will make a reactor by reactor decision on operation based on specific file (compliance results, external hazards, skills, ageing surveillance program).

Key EDF approaches for plant lifetime management (3)



Third Ten year safety review planning – 3 loops plants

Key EDF approaches for plant lifetime management (4)

Compliance Analysis

- Design, facility,
- Organisation, documentation,

– **Compliance analysis program,**

  - On each site / plant before ten years visit,

– **Complementary investigations program (CIP)**

  - To check pertinence of hypothesis, on which preventive maintenance is based (ex. : sampling inspection for areas where damage is unlikely).

Key EDF approaches for plant lifetime management (5)

Safety Reassessment (1/2)

- A safety level improvement to take into account :
  - **feed back experience, more recent knowledges,**
  - **additional NSA safety requirements or EDF ones,**
- Main topics
  - **seismic reassessment (new French rule 2001)**
  - **hazards : fire, explosion gas, winds, heat sink, hot temperatures,**
  - **safety injection capacities,**
  - **containment tightness,**
  - **fuel pools drain risk,**
  - **severe accidents management,**
  - **sumps performances.**

Key EDF approaches for plant lifetime management (6)

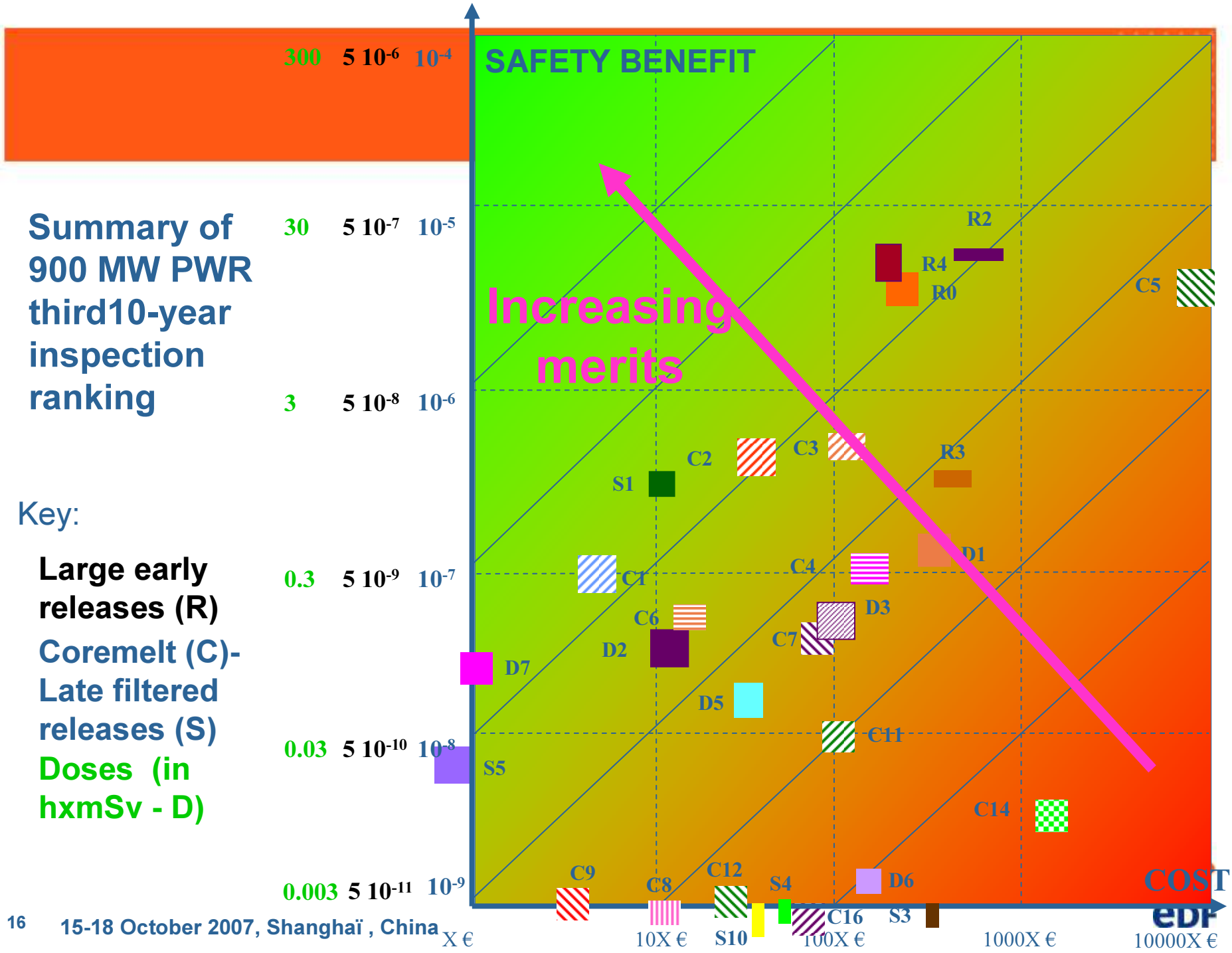
Safety Reassessment (2/2)

- Others

– outage performances : loading / unloading fuel rate, radioprotection optimization,

– IC (part of) renewal by anticipation of obsolescence (RCCA, Turbine, Generator).

Summary of 900 MW PWR third10-year inspection ranking



Key:

Large early releases (R)

Coremelt (C)-Late filtered releases (S)

Doses (in hxmSv - D)

Key EDF approaches for plant lifetime management (8)

Ageing Process Management – Technical and Industrial aspects (1/3)

- Identification, caracterisation of proven or potential degradations : mecanisms/consequences
- Preventive maintenance
  - Systematic : RCM/PSA
  - Condition based : expert tools (Primary Pumps, valves, …), witness equipments
- Feedback events analysis
- Accidental conditions equipments qualification
- Heavy maintenance : important operations once in a plant life time
  - to manage proven degradations on the fleet : RVH, SGR, generators…
  - to prepare future : faisability study tools development, expertises (ex. : RCV nozzle FESSENHEIM removed with SGR).

Key EDF approaches for plant lifetime management (9)

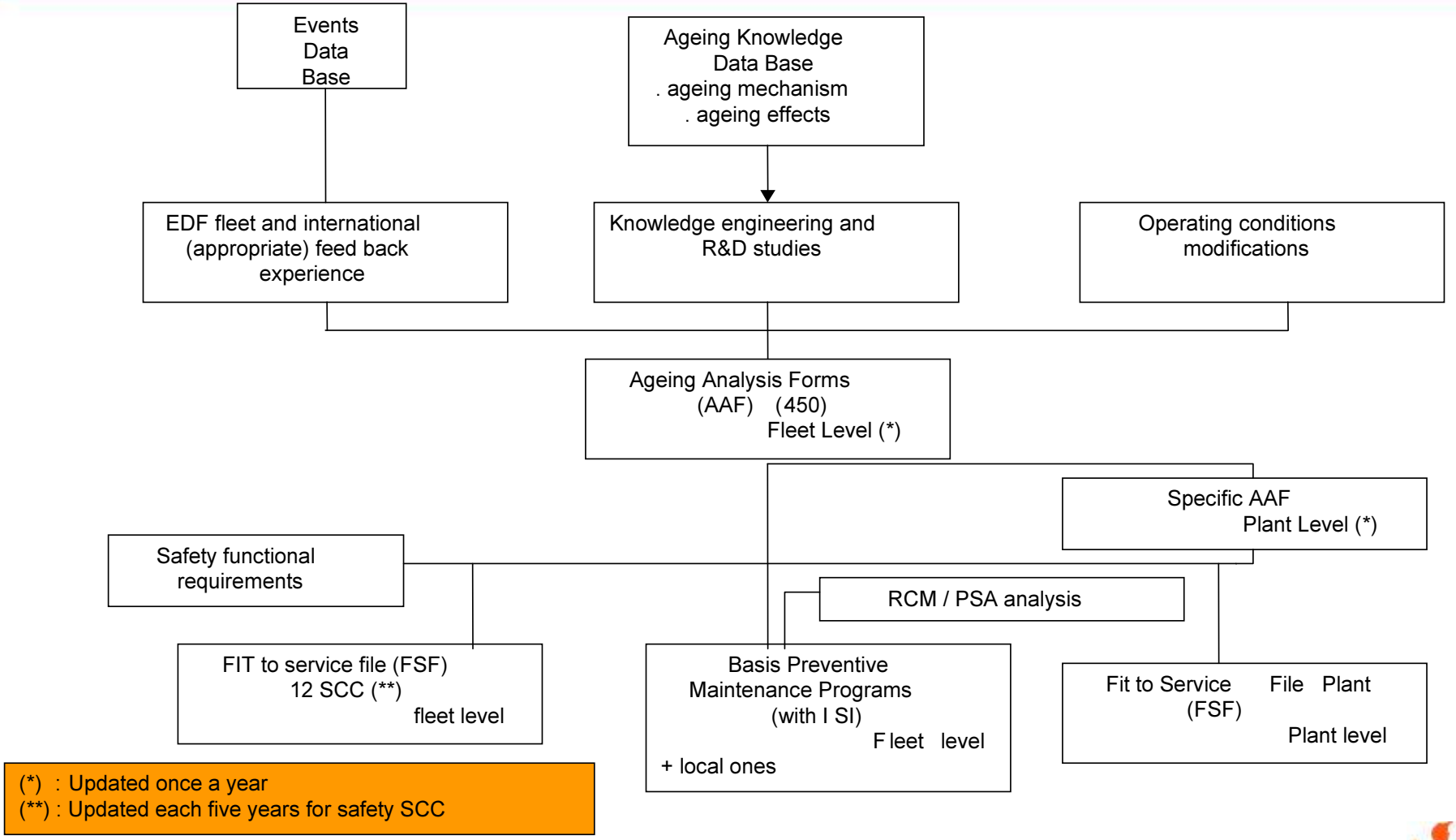
Ageing Process Management – Technical and Industrial aspects (2/3)

- House keeping investment,
- Obsolescence « products / suppliers » couples

dedicated process in place managed by Top Generation Management

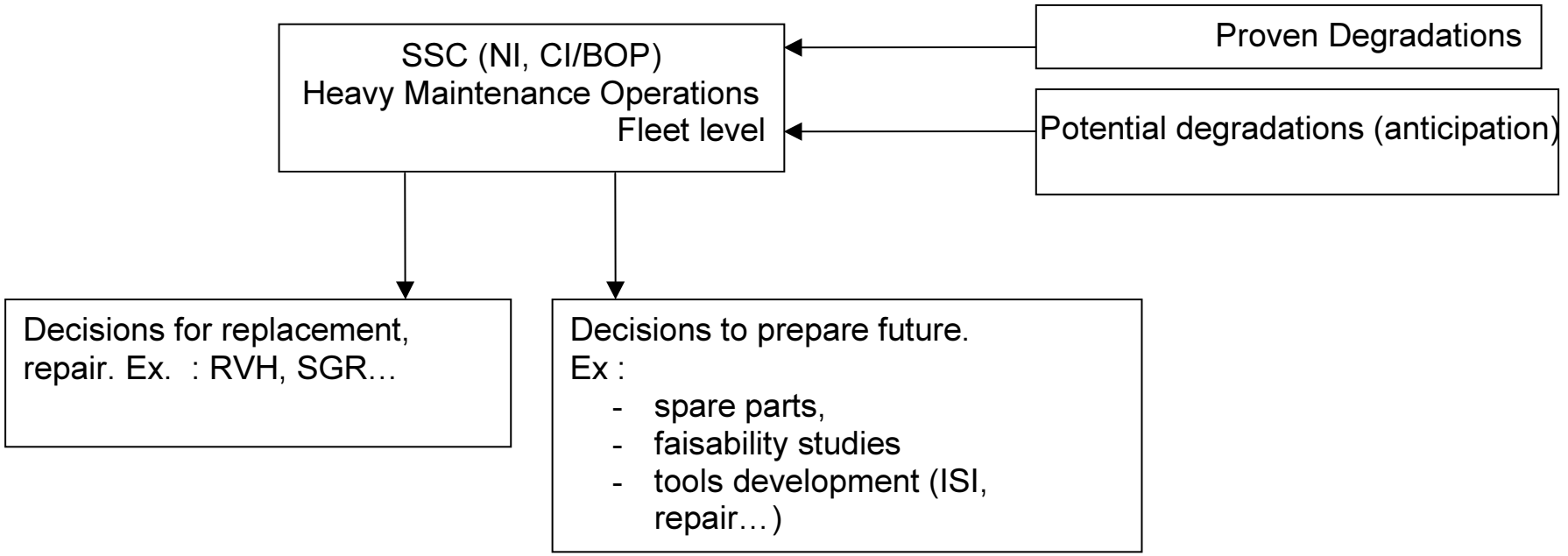
- Problems identified / national level coordination,
- Appropriate strategic stocks (in particular electronic components),
- Internal and equipment suppliers skills and manufacturing tools.

Key EDF approaches for plant lifetime management (10)



Ageing Process Management

Key EDF approaches for plant lifetime management (11)



Nota : Updated each two years

Heavy Maintenance Management process

Key EDF approaches for plant lifetime management (12)

- R&D actions for long term SSC behaviour :

EDF Internal laboratories,

Strong investment inside worldwide activities : EPRI, European Projects…

Participation to Jules Horowitz Research Reactor

Key EDF approaches for plant lifetime management (13)

- Knowledge and skills management – A priority for management plant life

– A challenge = EDF nuclear generation staff : ~25 000 pers, ~ 36 % retiring by 2015,

– To renew and adapt skills to requirements induced by job evolutions,

– To gather sensible information data for life time management.

Key EDF approaches for plant lifetime management (14)

- Main aims

– **Job forecast : to anticipate evolutions, to propose job course,**

– **Skills and jobs management forecast within each business unit, with mid-long term (qualitative and quantitative) view,**

– **Knowledge transfert**

  - job type : shared by numerous technicians inside a working team,
  - Specific type, especially for engineering skills.
  - Job animation on a national level.

– **Sensible skills : fuel, I&C, safety, vessels, civil engineering, architect.**

CONCLUSION

• A fleet lifetime of 40 years is, from EDF point of view, technically achievable, based on :

– continuous safety improvement, every ten years reassessment (PSR), adequate routine and heavy maintenance,

– physical ageing and obsolescence management,

– results for vessels and containments (diagnostic and pronostic).

• EDF has the objective to extend average lifetime of reactors beyond 40 years

– by using the existing potential,

– being compliant with additional safety requirements,

– by strong management of key issues :

- skills renewal and their adaptation to jobs in progress
- Ageing and obsolescence management.