Plant Life Management Activities for Long Term Operation in Nuclear Power Plants

Feb. 22, 2011

Ki Sig Kang,
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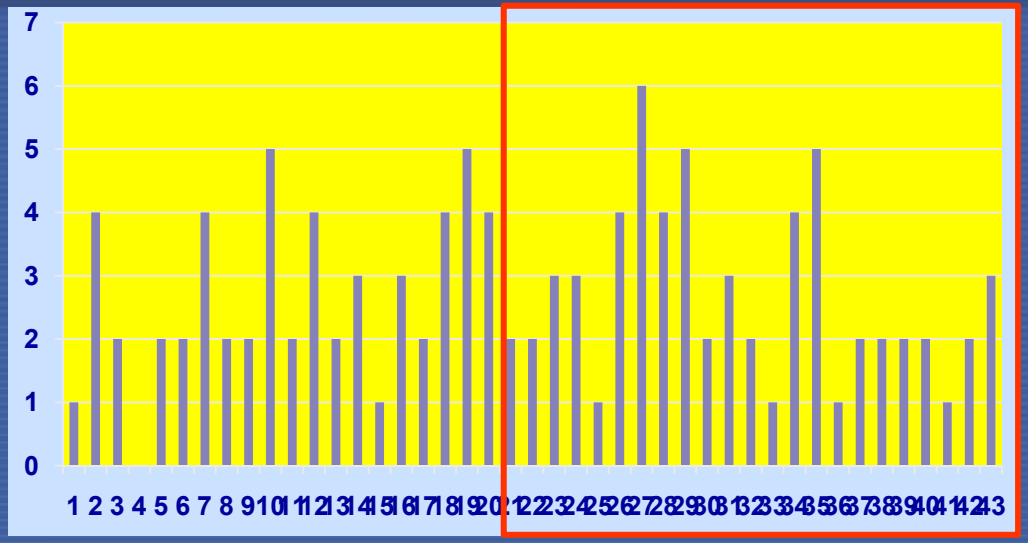
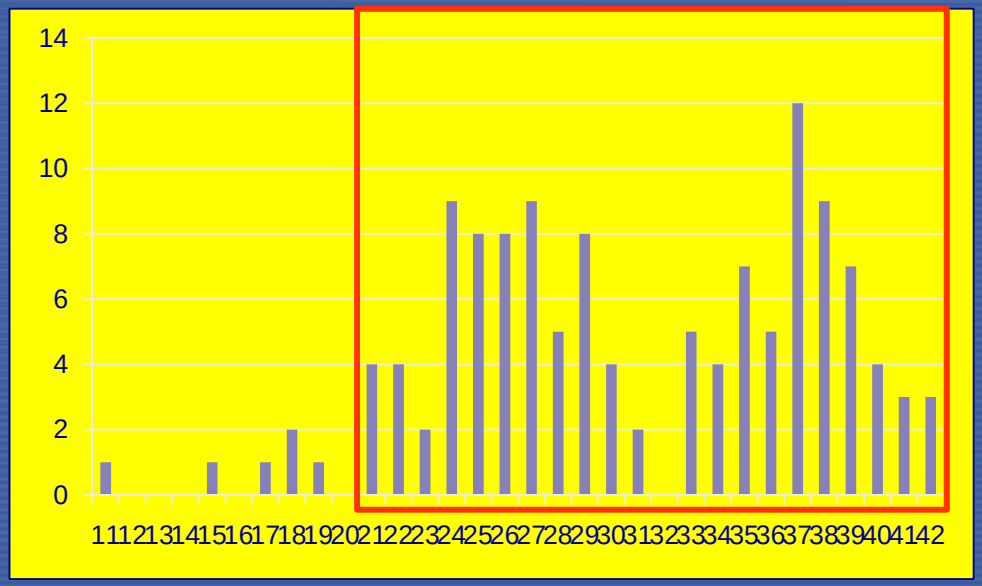
IAEA
International Atomic Energy Agency

America and Pacific Asia Npps



- America : 128 NPPs
- More than 20 years:122 NPPs (95%)

- Asia: 116 NPPs
- More than 20 years : 62 NPPs (53%)



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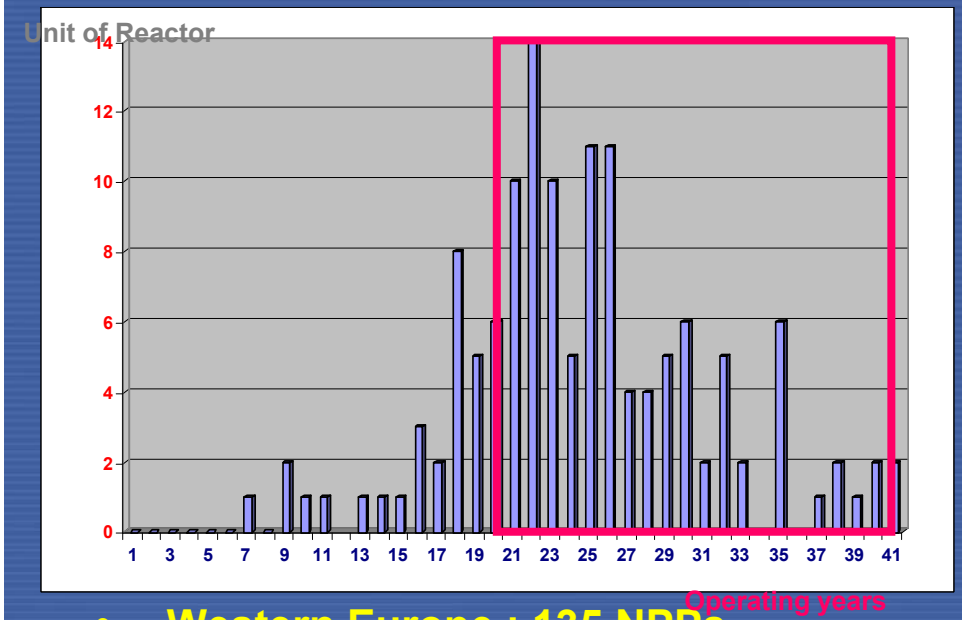
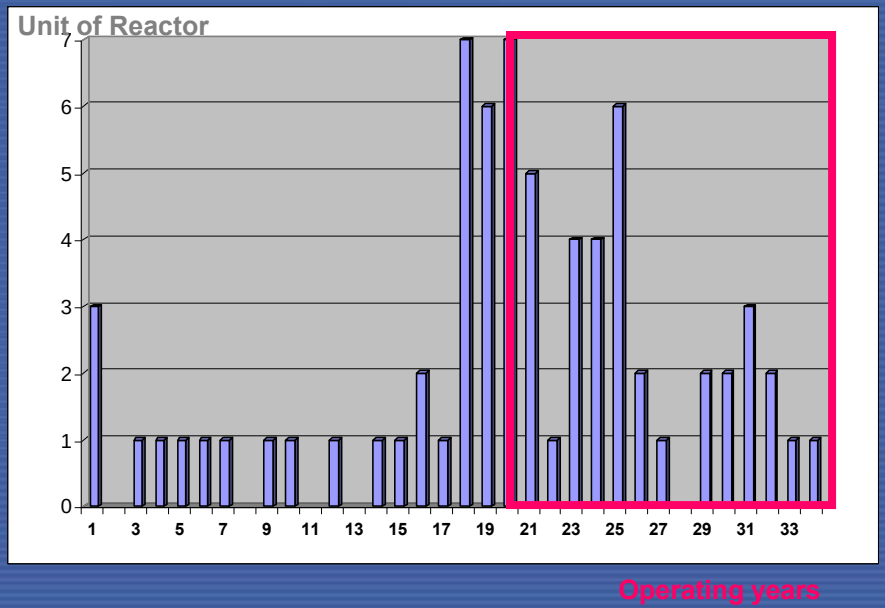
Western and Eastern Europe



- Western Europe : 135 NPPs
- More than 20 years : 109 NPPs (80%)

- Eastern Europe : 70 NPPs
- More than 20 years : 47 NPPs (67%)



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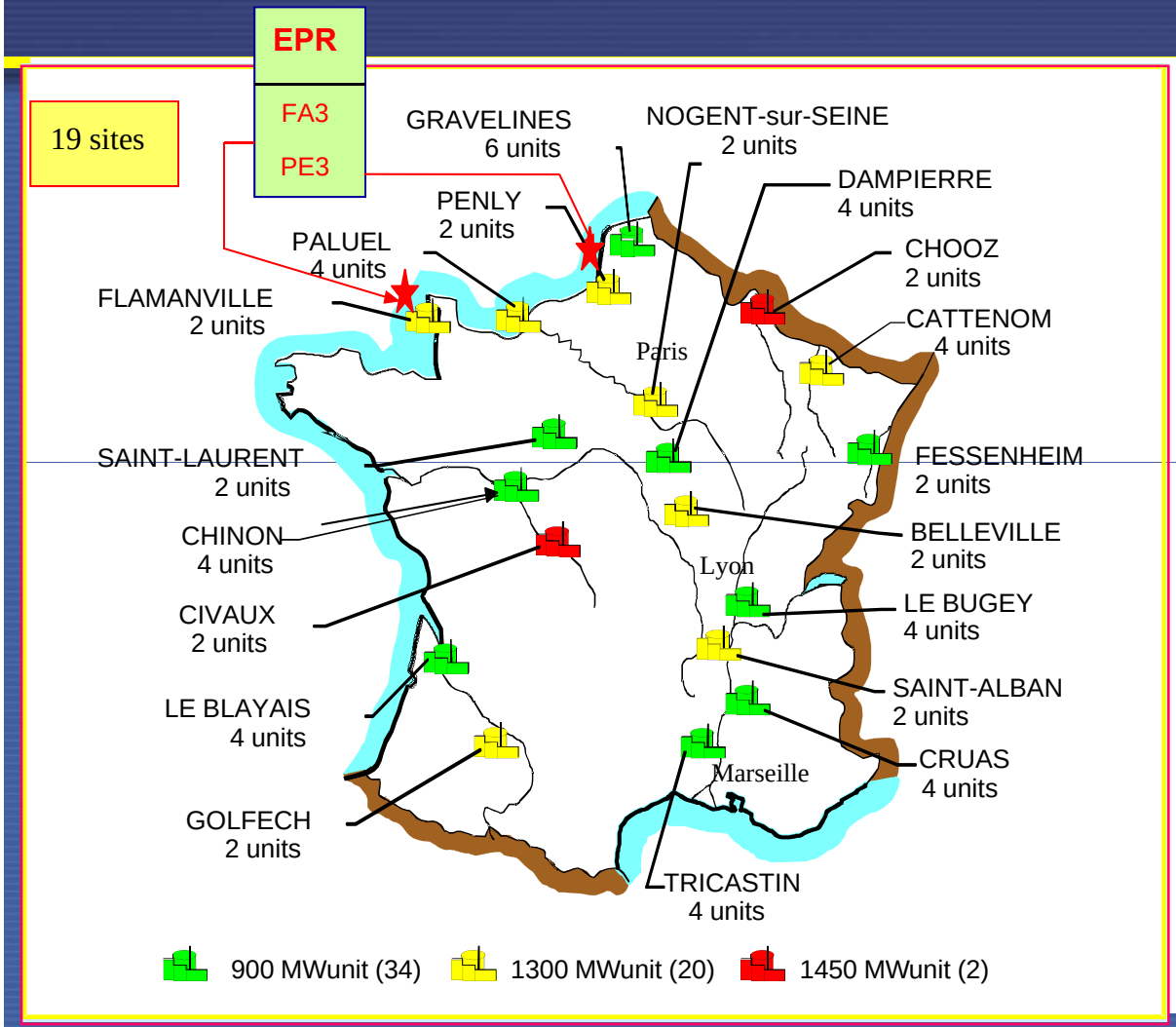
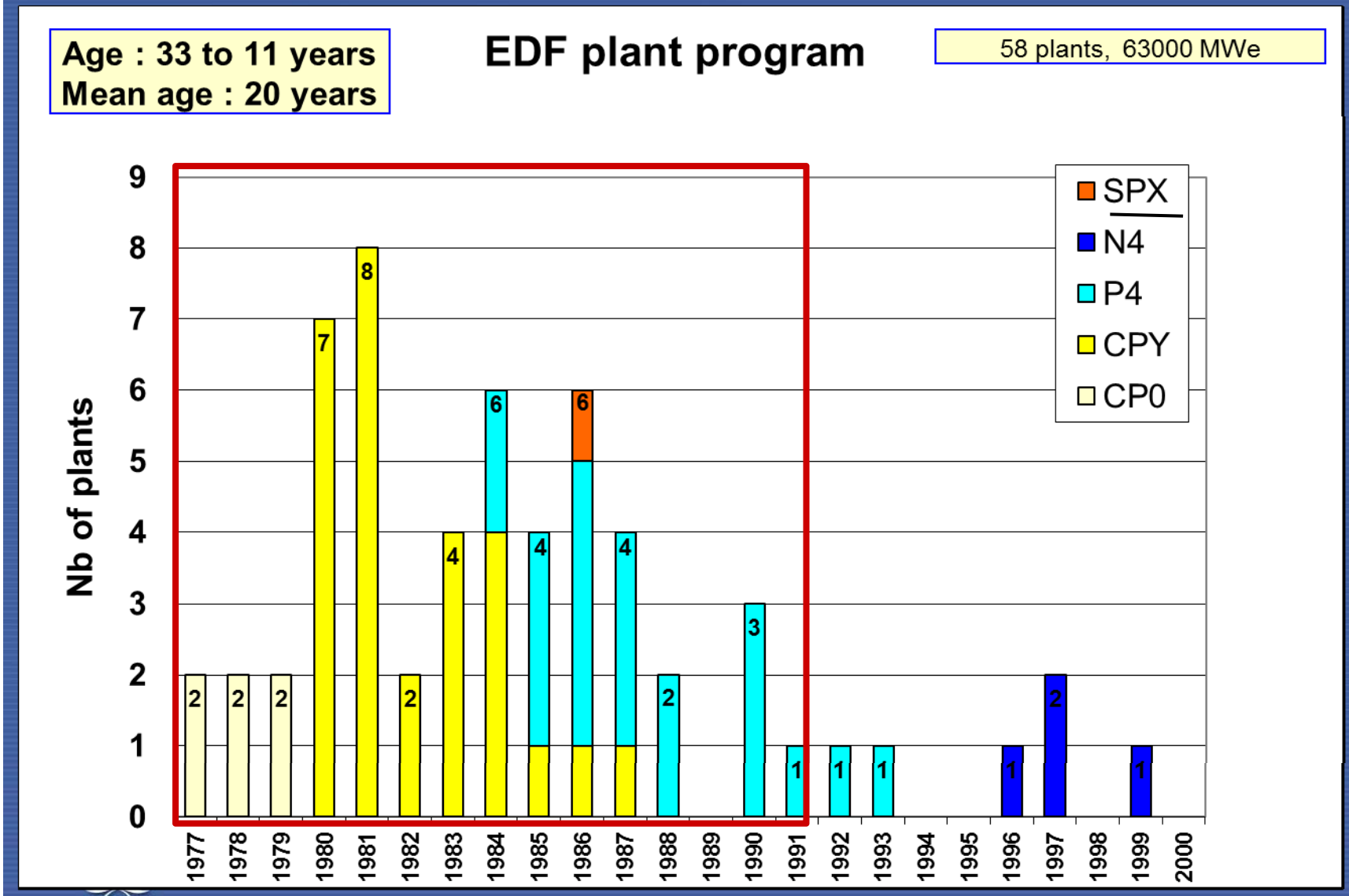
PWR in France



- 58 PWR reactors in operation on 19 sites, 63 GW
- 3 standardized levels :
  - 900 MW – 3 loops, 34 units, 31 GW
  - 1300 MW – 4 loops, 20 units, 26 GW
  - 1500 MW – 4 loops, 4 units, 6 GW
- 1 EPR under construction
- 1 other EPR decided

Reactor Age of French NPP's



Service life in France Npps

- **Design life : 40 years**
  - Improvement of safety continuously through operation and maintenance
  - 10 years basis through modification of installations
- **Management of physical ageing of the plants (causes / consequences):**
  - Improvement operating performance
  - Dynamic and proactive way

→ **Considering 50 years operation.**

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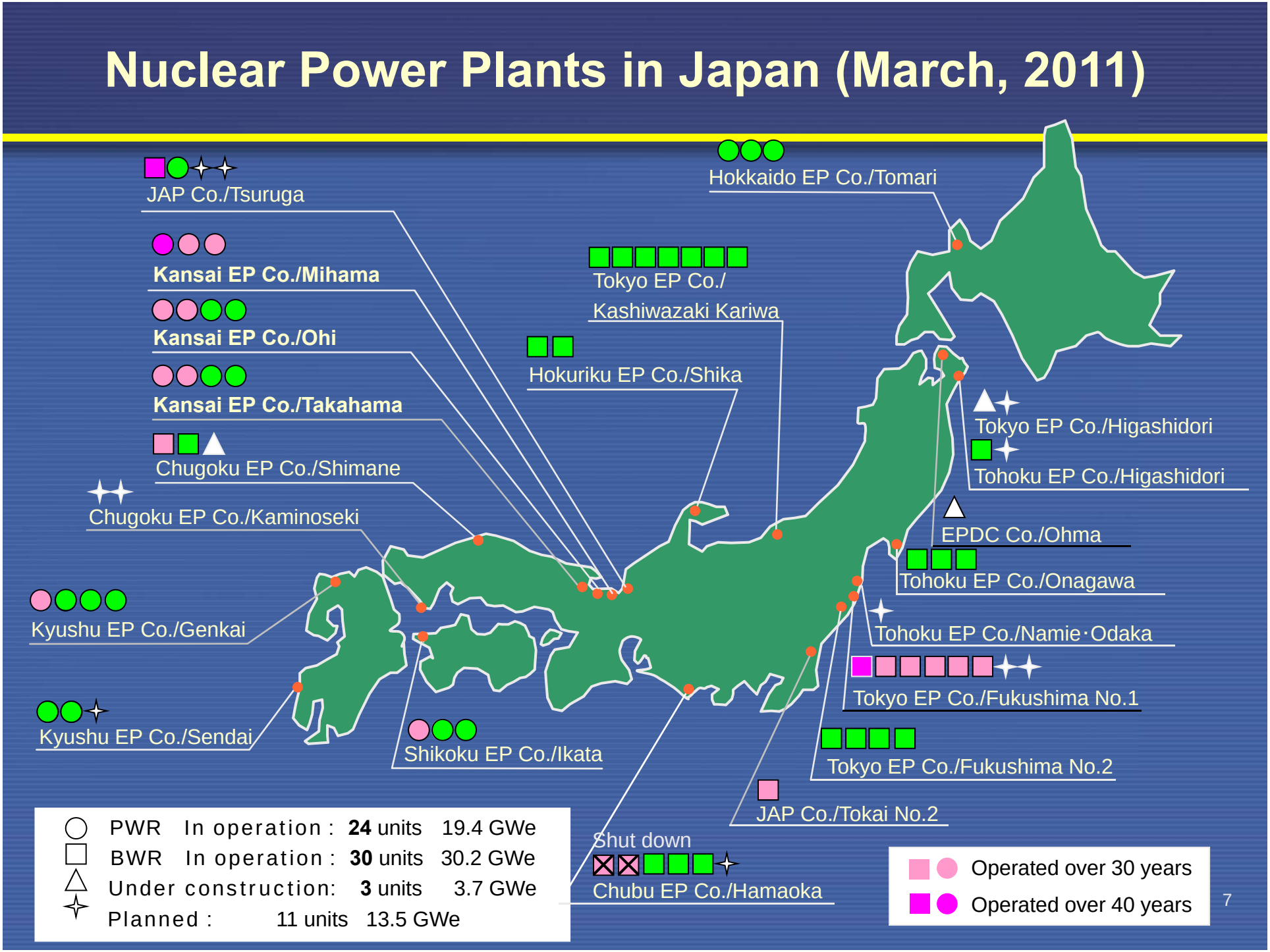
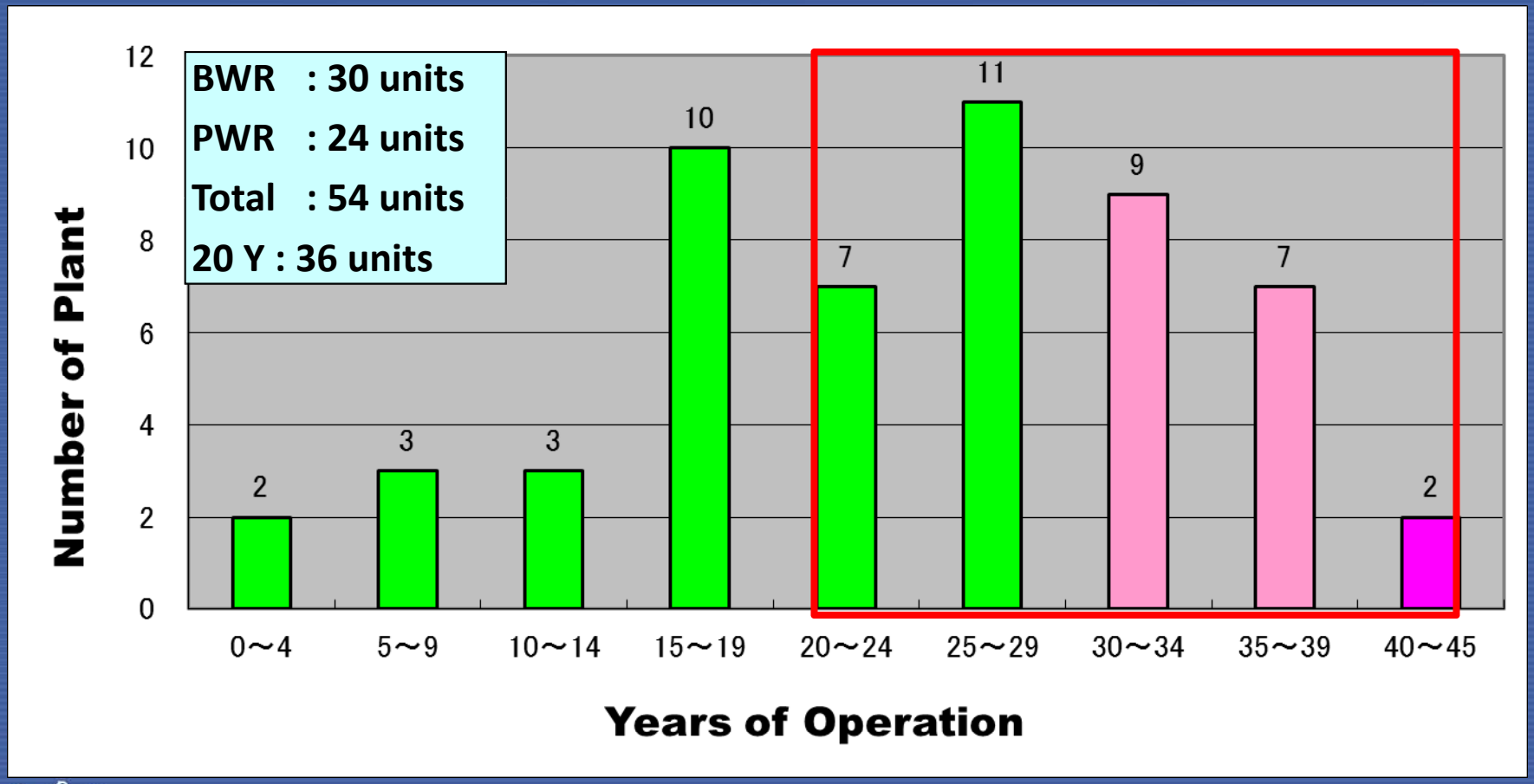
Nuclear Power Plants in Japan (March, 2011)



Reactor Age in Japan NPPs

As of Feb, 2011



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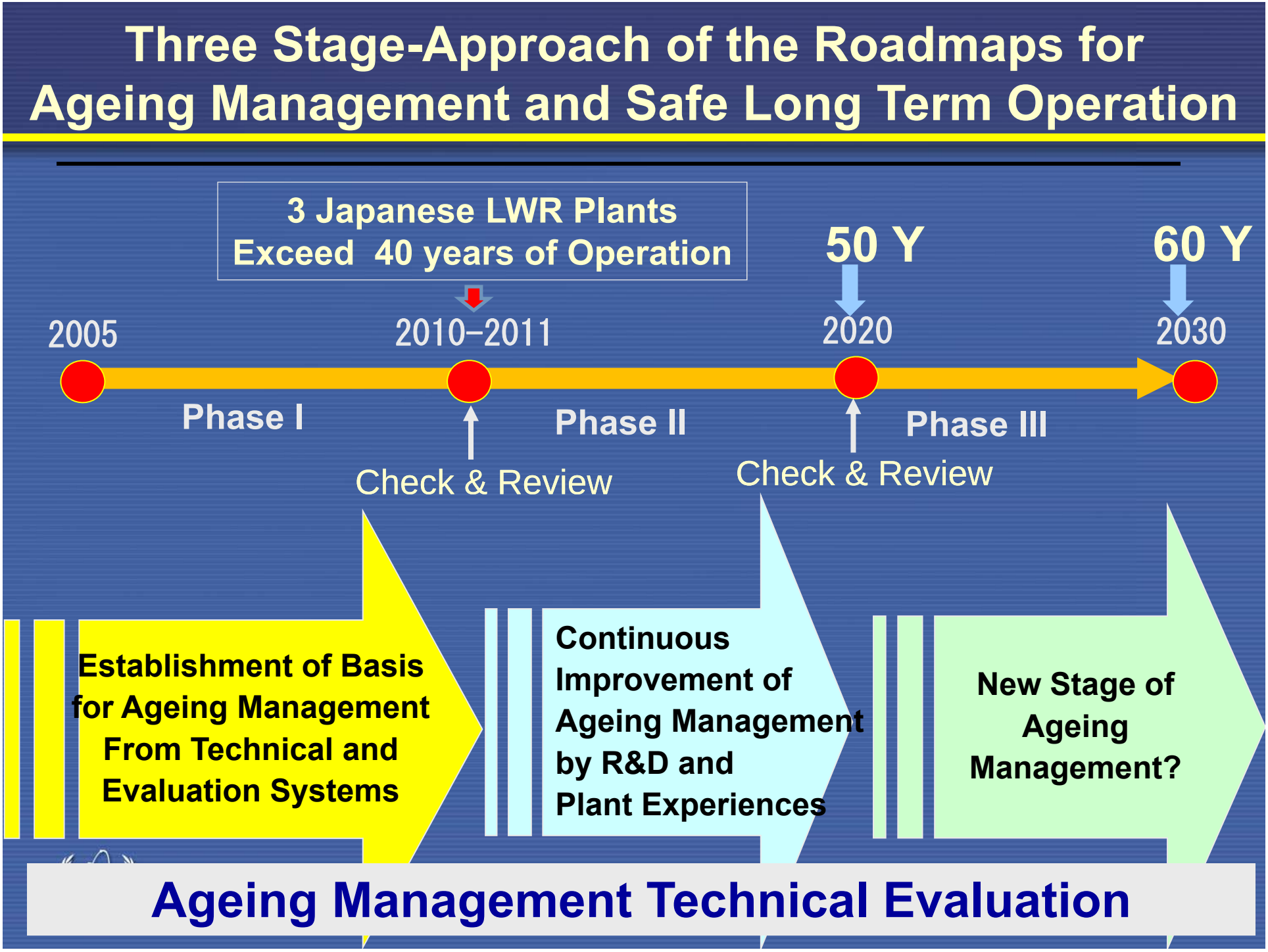
Three Stage-Approach of the Roadmaps for Ageing Management and Safe Long Term Operation



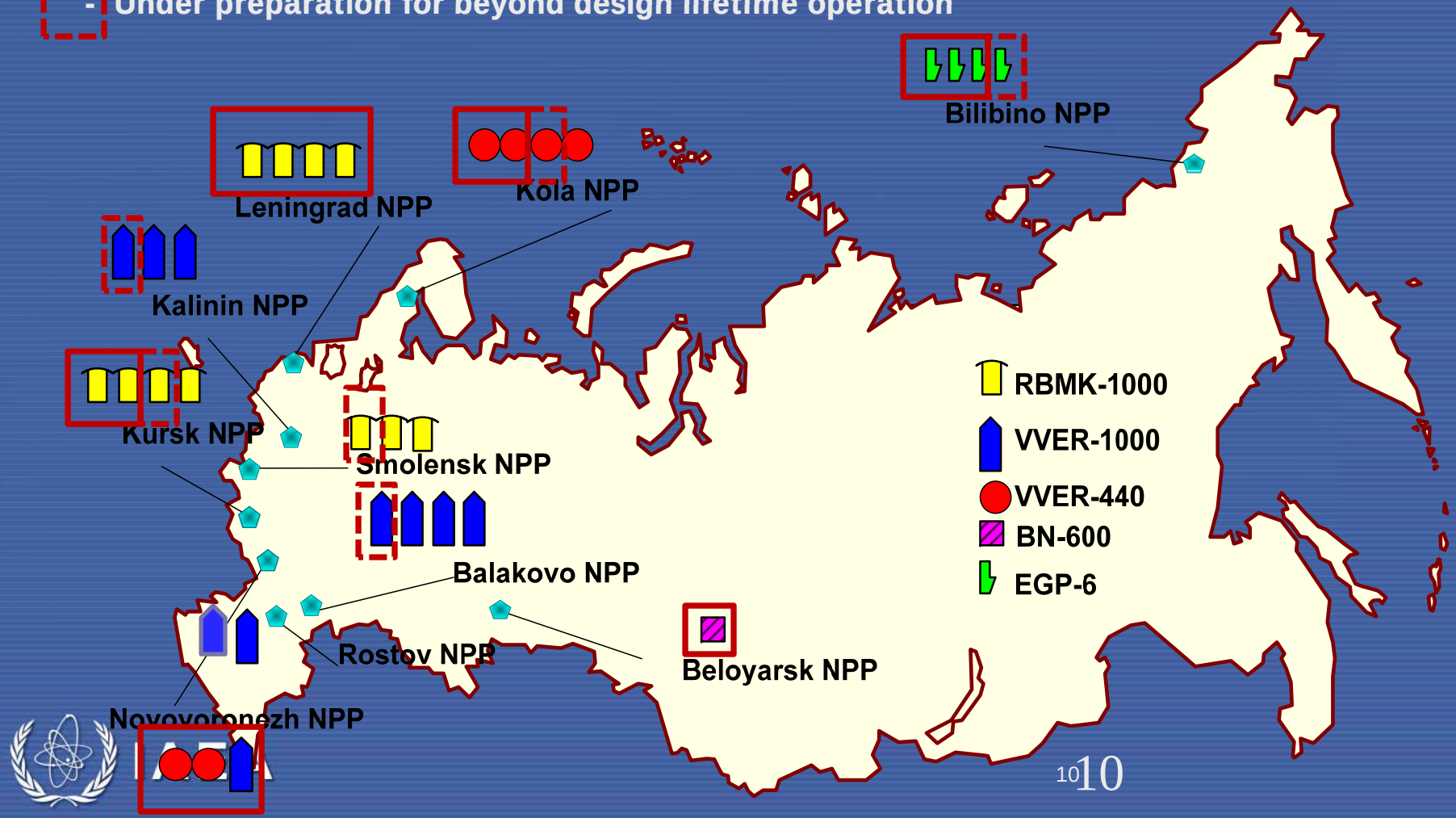
Russian NPPs

10 NPPs, *30* units – *22 242* MW including

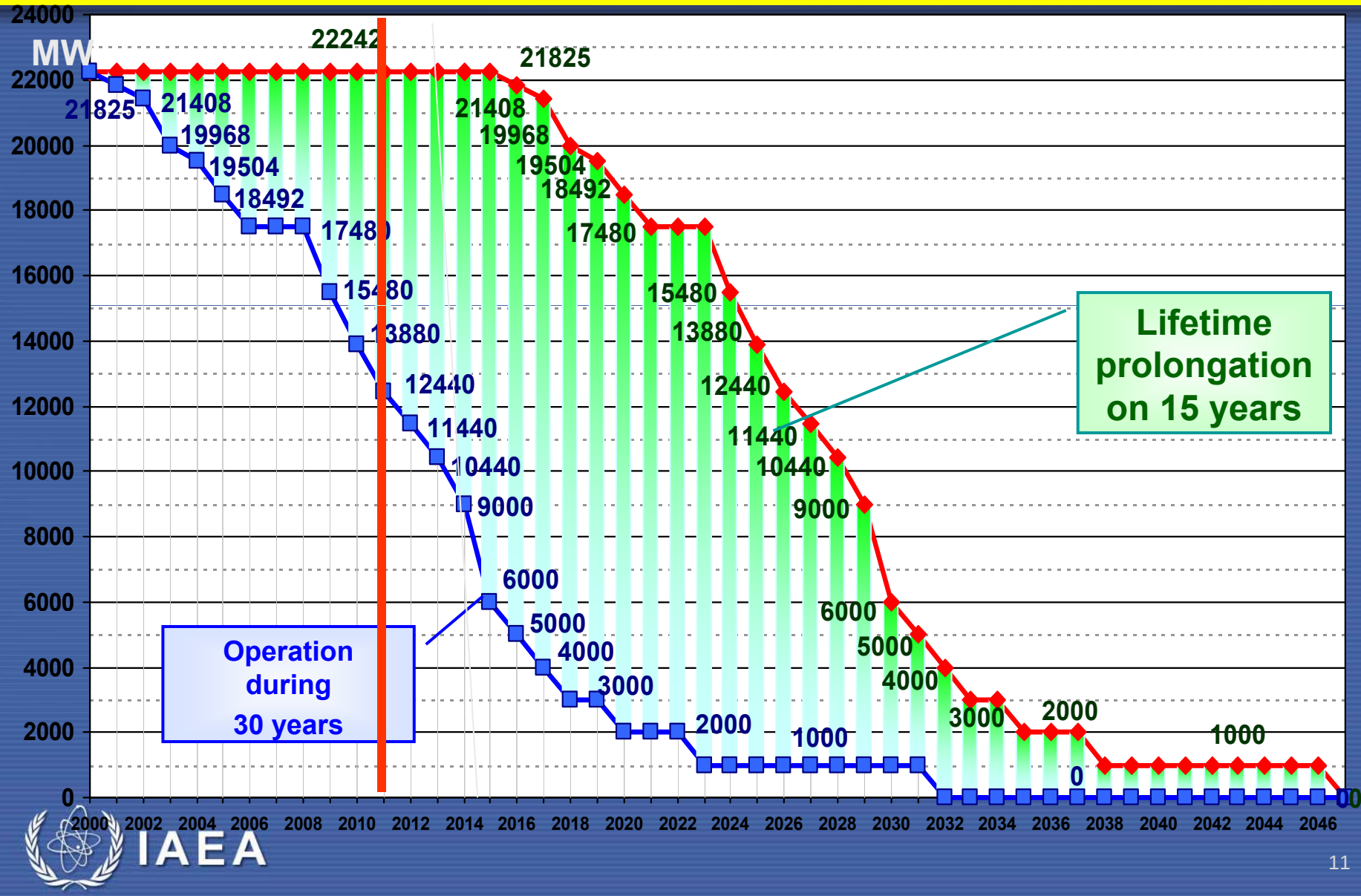
12 units of the 1-st generation - *5 752 MW*

Operated beyond design lifetime

- Under preparation for beyond design lifetime operation



Scenario Of Npps' Power Generation In Russia



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Long Term Operation (LTO) Strategy

1. **RF Nuclear power development programme for the period up to 2010”,** *approved by Government act № 815, 21.07.98*

2. **Strategy of Development of Nuclear Power Industry in the 1st Half of 21 Century**

- **WWER 440- 230: Design life : 25 Y → 15 Y (40Y)**
- **WWER 440- 213 : Design life 25 Y → 25 Y (50Y)**
- **WWER 1000 : Design life 30 Y → 30 Y (60Y)**

→ Considering 60 years operation.

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Czech Republic

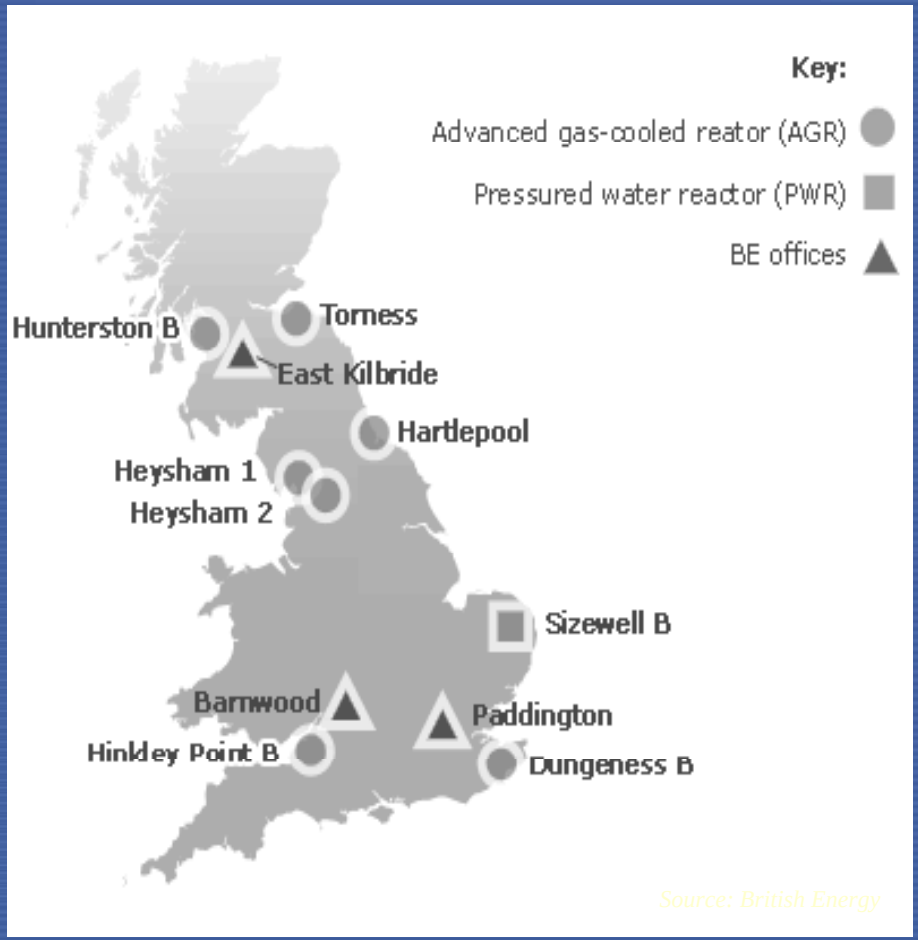
- **4 units of WWER-440/V-213C type in DUKOVANY**
  - **Operation start-up : 1985, 1986, 1986, 1987**
  - **Design lifetime: NPP – 30 years, RPV – 40 years**

- **2 units of WWER-1000/V-320 C type in TEMELIN**
  - **Operation start-up: 2002, 2003**
  - **Design lifetime: NPP – 40 years, RPV – 40 years**

→ Considering 60 years operation.

UK Reactor

- **Magnox (4)**
  - Gas cooled
  - Graphite core
  - Magnox fuel
  - Design life time : 25 Y
- **AGR (14)**
  - Evolution from original Magnox design
  - Design life time : 25 Y
- **PWR (1)**



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UK Reactor

- PLiM/PLEX for LTO considered within the framework of PSRs
- British Energy became part of EDF Energy during second half of 2010

- In Dec. 2010 EDF Energy announced 5-year lifetime extensions to 2 AGR NPPs;
  - Noted PLEX programme could enable 5-year lifetime extensions for remaining AGRs
  - 20-year lifetime extension for Sizewell B PWR

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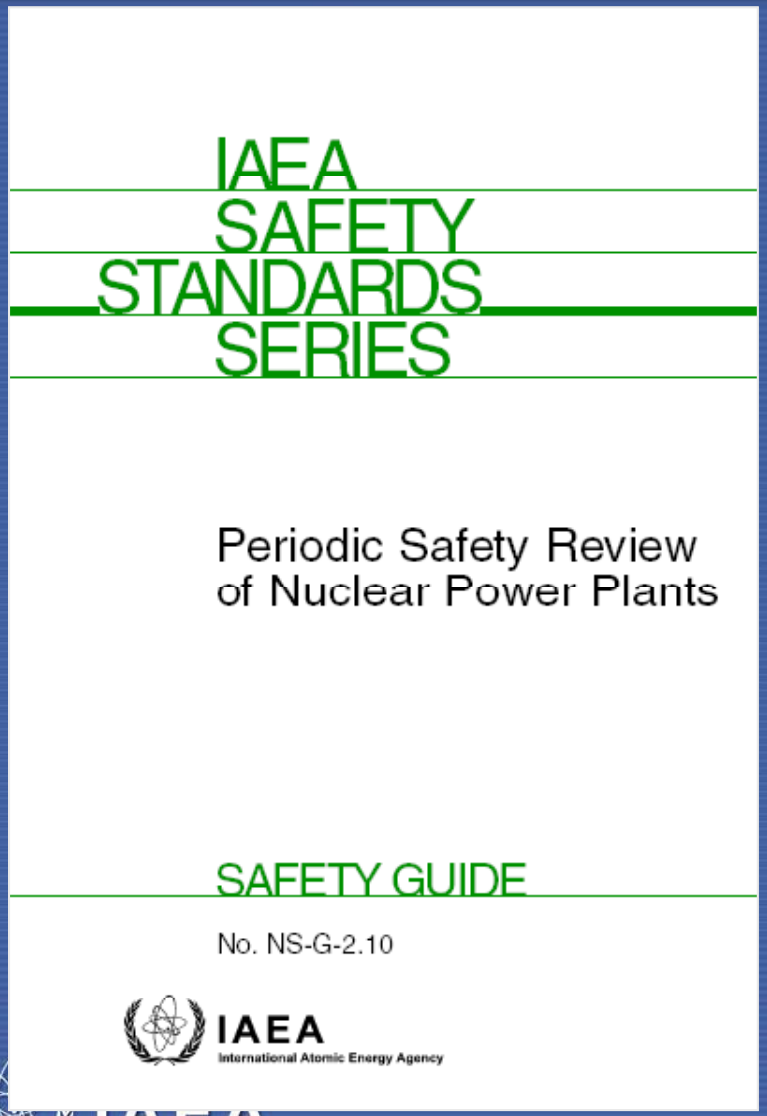
PSR Overall Process and Inputs



Plant

1. Plant design
2. Actual condition of SSCs
3. Equipment Qualification
4. Ageing

Safety Analysis

5. Deterministic Safety Analysis
6. Probabilistic Safety Analysis
7. Hazard Analysis

Performance & Feedback experience

8. Safety performance
9. Use of experience from other NPP

Management

10. Organization and administration
11. Procedures
12. Human factor
13. Emergency planning

Environment

14. Radiological impact and environment

Global Assessment

Intensive PSR (PSR + Ageing Man)

Normal PSR

- Physical condition
- Safety assessment
- Equipment qualification
- Aging effect
- Safety Performance
- Use of operation experience &
- research results
- O&M procedure
- Organization & administration
- Human factors
- Emergency plan
- Environmental effects

+

Additional Req. beyond design life

- Time-limited aging analysis
- Aging management program
- Back-fitting rules
- Newly assessed regulatory requirements at international level
- Radiation environmental effects
- Field inspection

Intensified PSR

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Summary

- **Operating Npps**
  - **Target of life extension : 50~ 60 years**
  - **LB 60 years operation ???**
- **No limitation of operational life :**
  - **10 years safety review based on PSR**
  - **More focused on ageing management technical evaluation**

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IAEA Actviites for Plant Life Management

Feb. 7 2011

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What is the Plant Life Management ?

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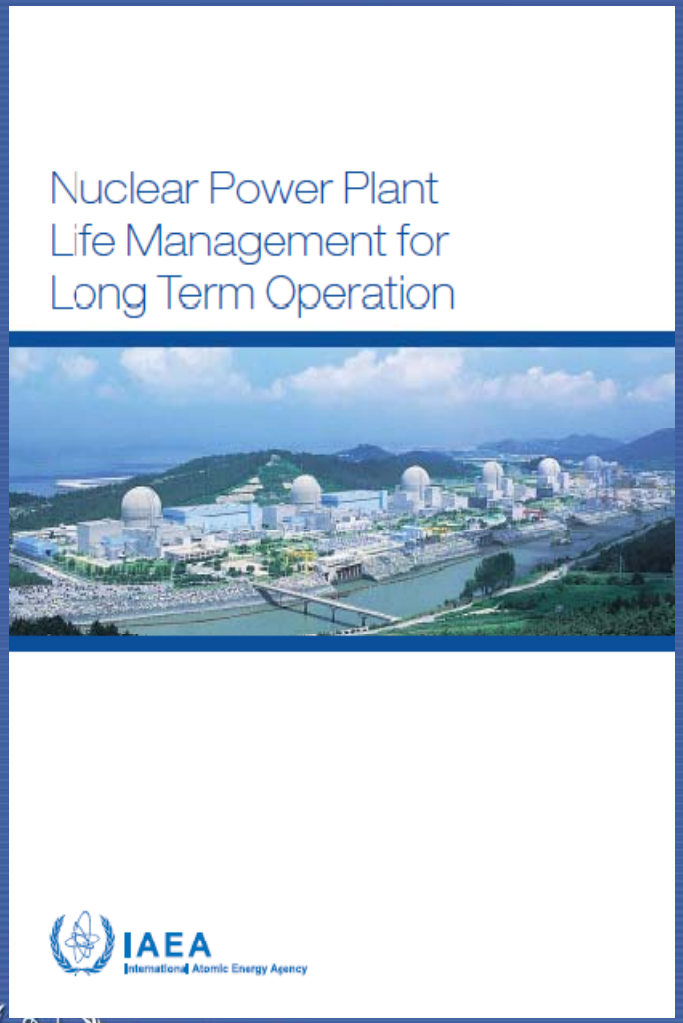
Plant Life Management for Long Term Operation Activities



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- Current Status of Nuclear Power
- PLiM Approach
- Periodic Safety Review
- Ageing Management
- SALTO Mission
- RPV Irradiation Embrittlement
- Heavy Comp. Replacement
- Effective In-Service Inspection
- Power Uprates
- Continuous Process Optimization
- Independent Engineering Review of I&C systems
- Power Reactor Information Systems
- Recently Published IAEA Nuclear Energy and TECDOC Series

International Generic Ageing Lessons Learned

EBP IGALL expected programme stages

Scoping Meeting/ Briefing for PMs of the MSs

1st – 2nd Q 2010

Launching of the Programme

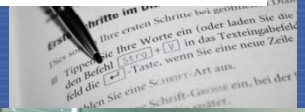
Organization set-up

Steering Group

Working Groups

2nd -3rd Q 2010

Progress of the programme in accordance with time schedule



2011-12

IGALL final report

2nd Q 2013

operators

regulators

vendors

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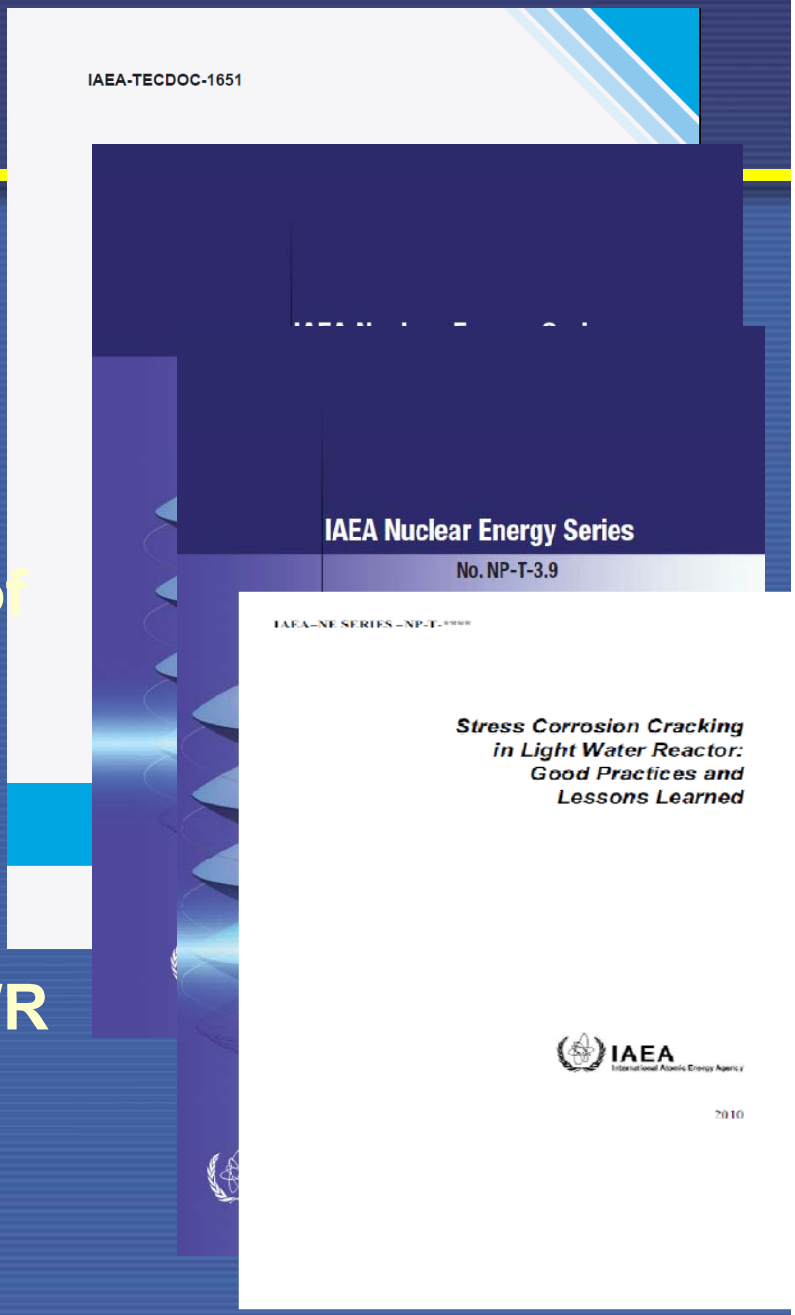
2010 New Publications

- Information Technology for NPP Configuration Management (TECDOC-1661),
- Risk -informed In-service Inspections of Piping Systems of NPPs (NP-T-3.1),
- Power Uprate in nuclear power plants : Guidelines and Experiences(NP-T-3.9)
- Stress corrosion cracking in LWR : Good practices and Lessons Learned



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Current Activities on I & C system programmes

- Impact of modern technology on I&C systems
- Increasing Instrumentation calibration interval through on-line calibration technology
- I&C Aging management
- Large Retrofit Modernization Projects in I&C Systems
- Maintenance and repair procedures of I&C systems
- Performance monitoring of instrumentation, control, and protection systems
- Testing dynamic response and calibration of instrument channels
- Database on I&C modernization projects

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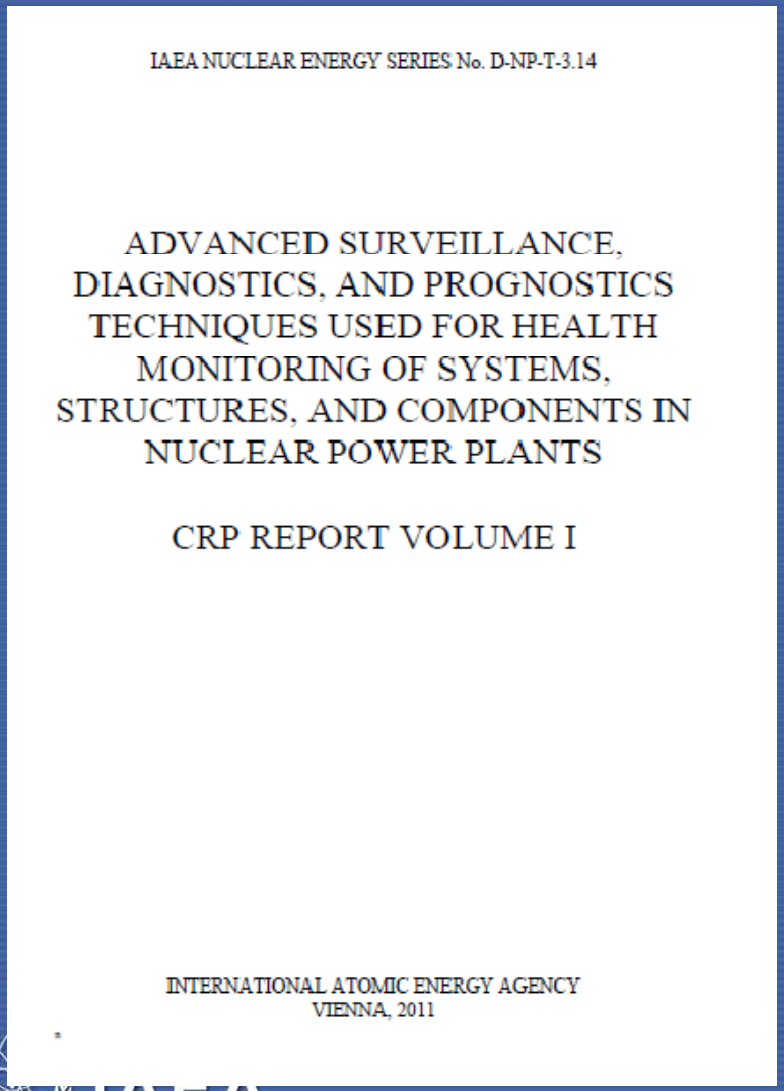
Int. Research Programme SHM


IAEA NUCLEAR ENERGY SERIES No. D-NP-T-3.14

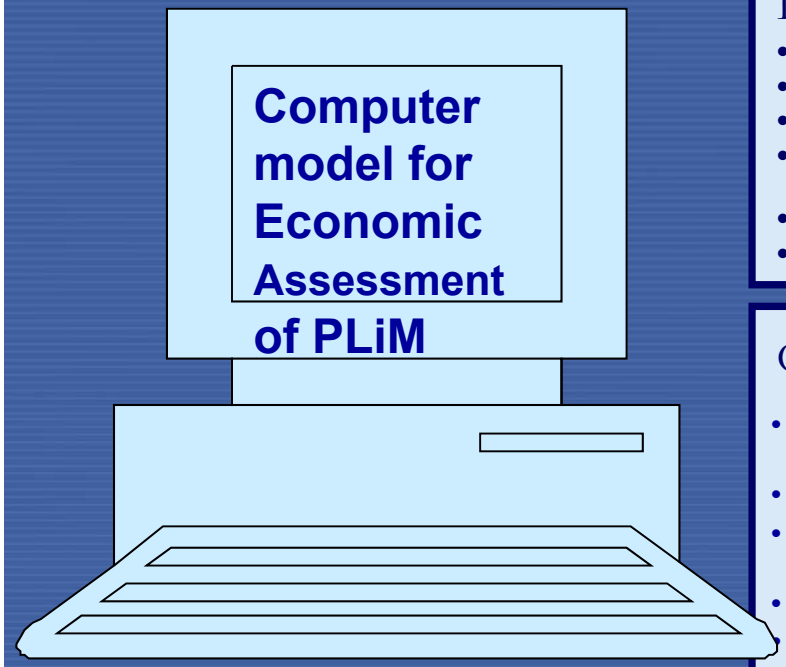
ADVANCED SURVEILLANCE, DIAGNOSTICS, AND PROGNOSTICS TECHNIQUES USED FOR HEALTH MONITORING OF SYSTEMS, STRUCTURES, AND COMPONENTS IN NUCLEAR POWER PLANTS

CRP REPORT VOLUME I

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2011

1. Reactor and Signal Noise Analysis
2. Acoustic and Vibration Monitoring
3. Prognostics and Structural Material Integrity
4. Instrument and Equipment Condition Monitoring and Enabling Technologies

Computer Model for the Economic Assessment of PLiM



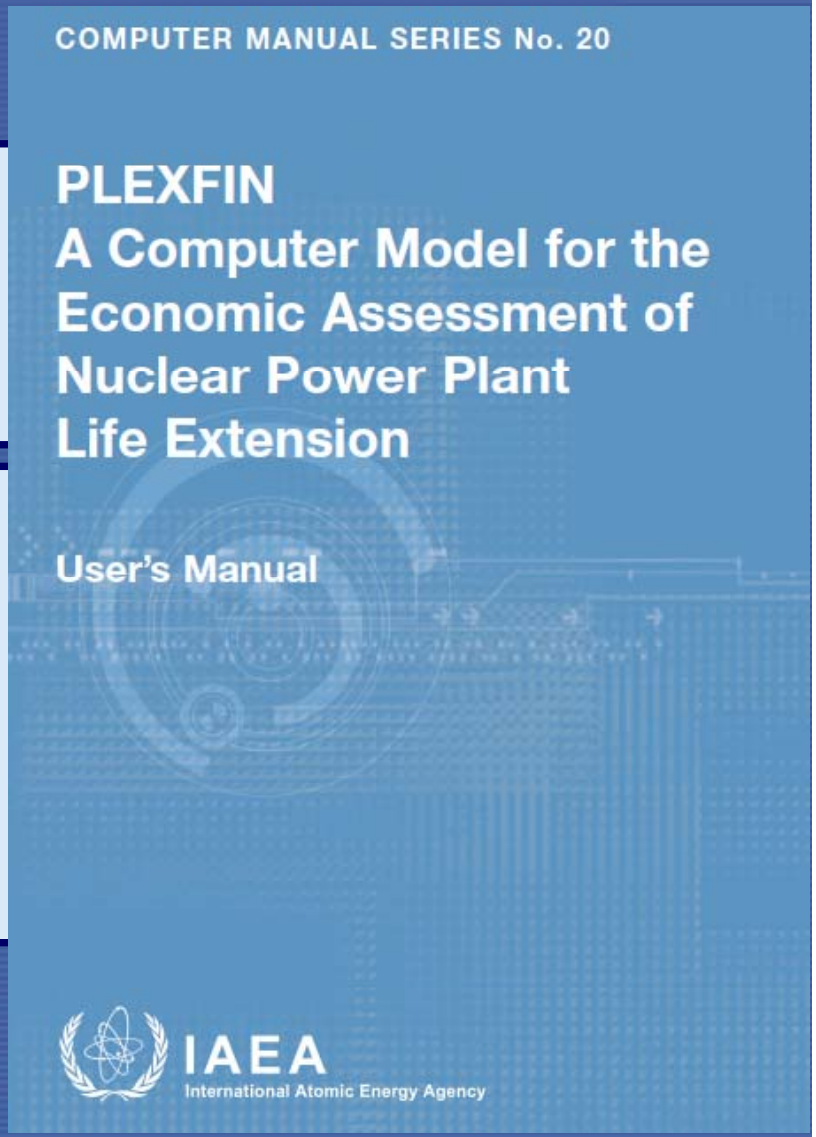
Front End

Input module

- Initialization
- Nuclear Variable Selection
- Alternative Generation
- Scenario Option & Calculation
- Fuel Input
- Taxes Input

Output module

- Performance Projection Report
- Fuel Expense Report
- Economic Performance Report
- Production Cost Repot
- Production Cost Analysis
- MRRD Report



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Reactor Pressure Vessel Knowledge Preservation for RPV in WWER NPPs

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- Non-electronic publishing in the past
- Collection & Storage (scanning + OCR)
- Limited dissemination possibilities
- Retirement and Generation Gap

Reactor P

Developing E-learning Modules (10)

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PLiM- SALTO TC Programme

Support to establish PLiM Programme under TC project

- **Argentina : PLiM programme for Embalse NPP**
- **China : Ageing management of Critical Components**
- **Hungary : License Renewal of Paks Nuclear Power Plant Operation**
- **Mexico : Life Management programme for Laguna Verde NPPs**
- **Ukraine : Action Plans for Nuclear Power Plant Lifetime Management**
- **Pakistan : Development of Capabilities in Automatic UT and Material Corrosion testing for Assessment of Structural Integrity**

Review missions (SALTO peer review services) implemented:

- **South Ukraine NPP (Mar. 2007, Ukraine)**
- **Kori 1 NPP – LTO Peer review (Republic of Korea – July 2007)**
- **Dukovany NPP – LTO Peer review (Czech republic 3Q 2008)**
- **Paks NPP SALTO Peer review (Hungary – Sept. 2008)**
- **Borssele NPP SALTO Peer review (Netherlands)**

Third International Conference on NPP Life Management for Long Term Operation

14-18 May 2012, Salt Lake City Utah, USA

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