Strål
säkerhets
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Swedish Radiation Safety Authority

Regulation and supervision of aging management in Swedish NPP

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Contents

- Some experiences from Swedish NPP
- Regulation and supervision of aging management in Sweden

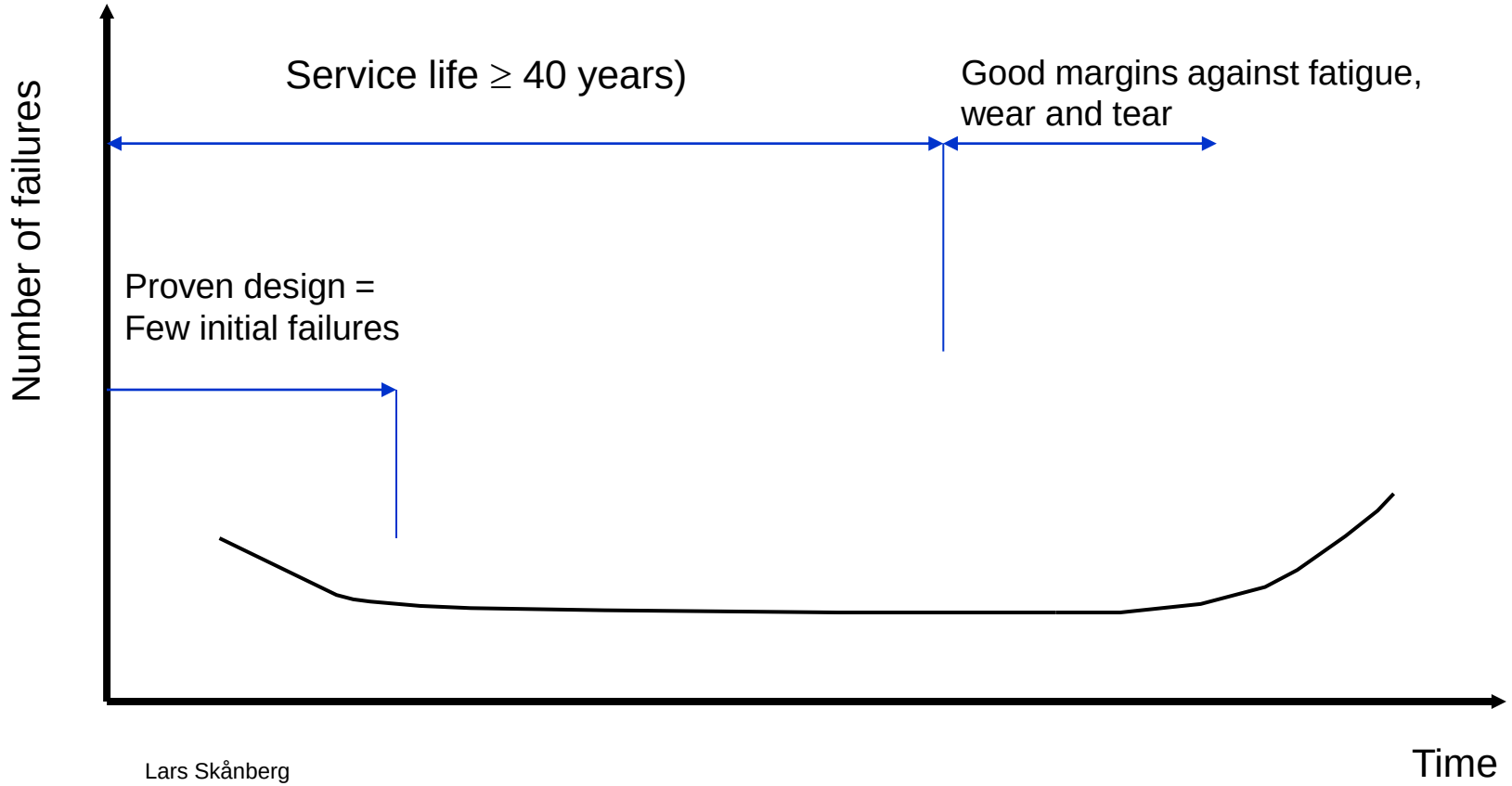
"Ageing" manifests itself in various forms

- physical ageing of components and structures
- technological aging of equipment, equipment becomes obsolete

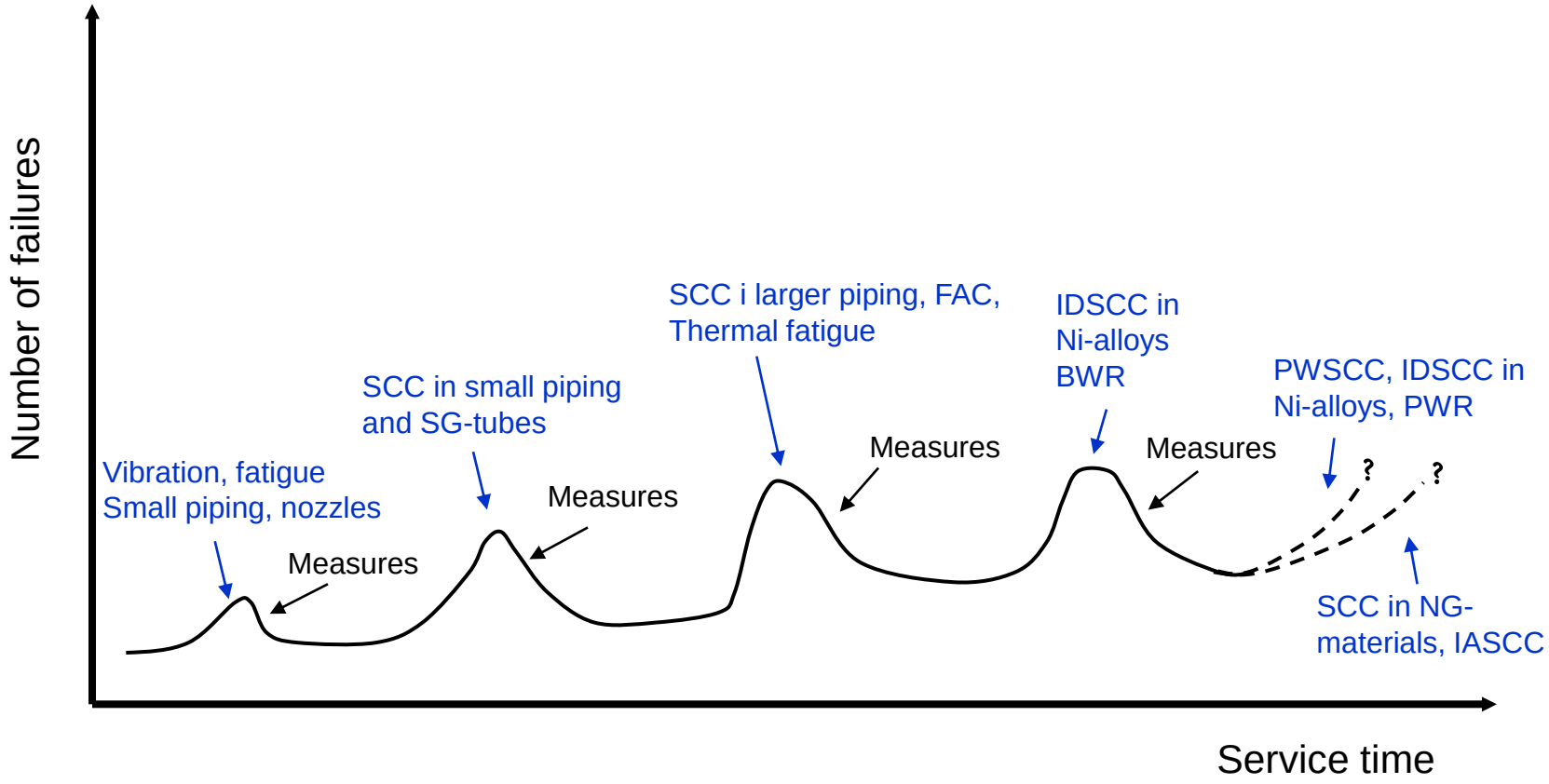
- **but also in ageing of**
  - analytical methods and techniques
  - regulations, guides and standards
  - personnel and organizations

Physical ageing of components and structures

The “bath tube curve” as principal design base for NPPs



General operating experience so far shows another picture (mechanical components)



Some data from the OECD-NEA OPDE

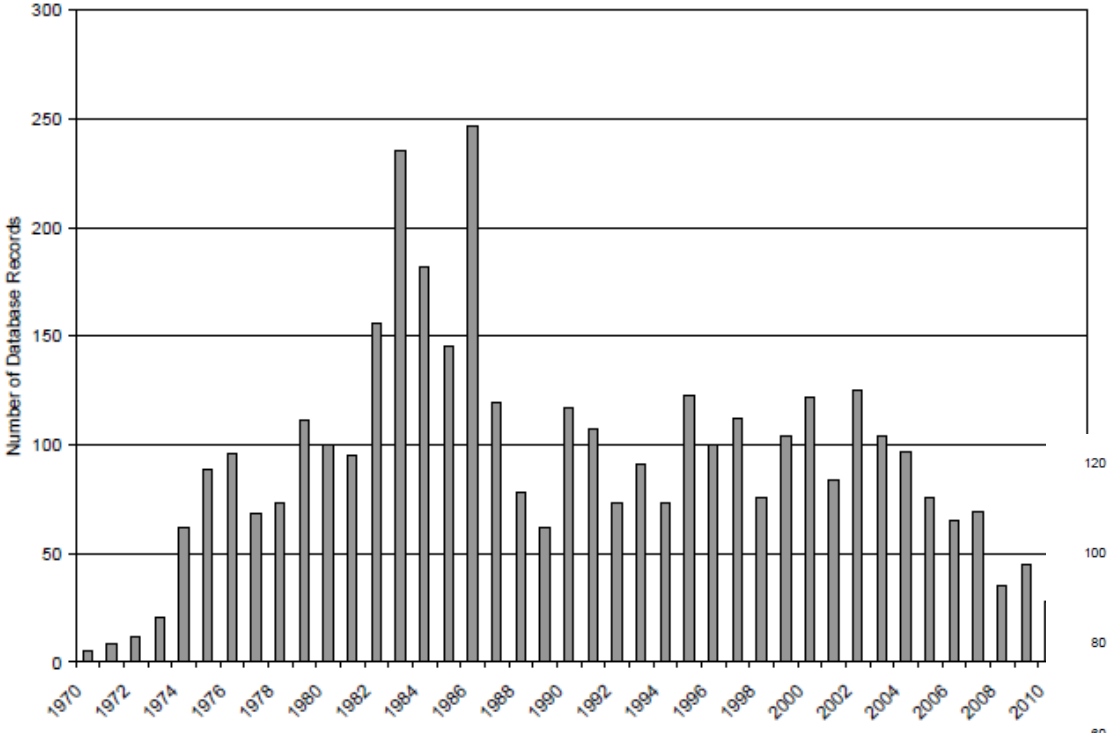


Figure 8: Pipe Degradation & Failure by Calendar Year

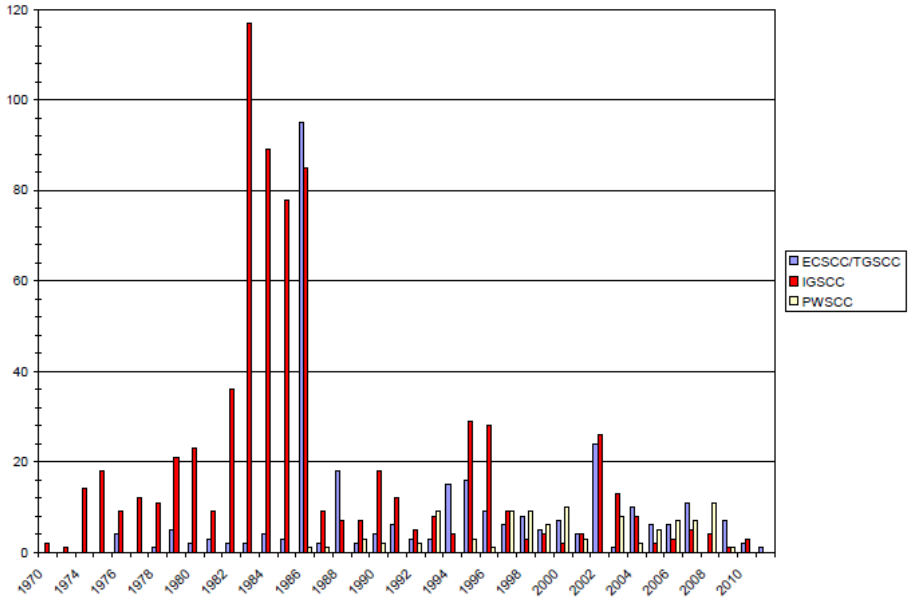
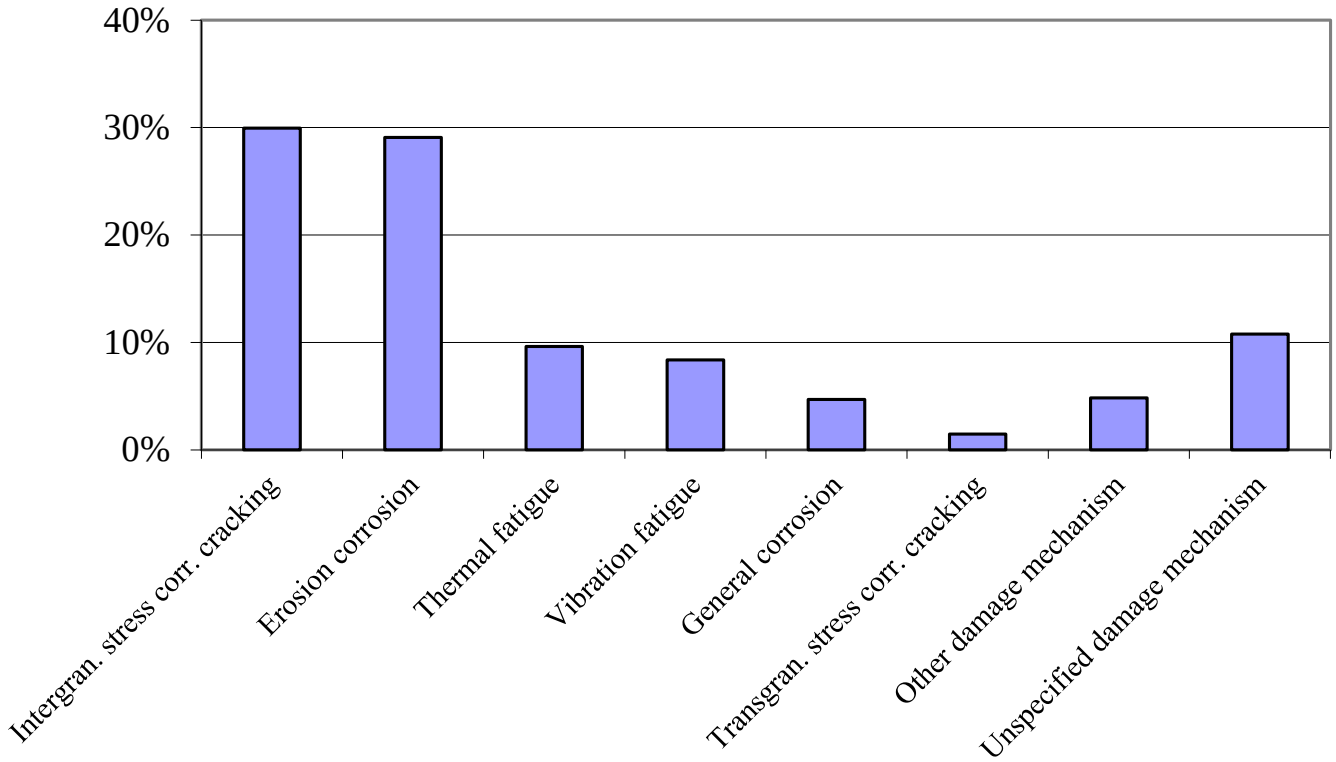


Figure 11: Stress Corrosion Cracking as a Function of Time

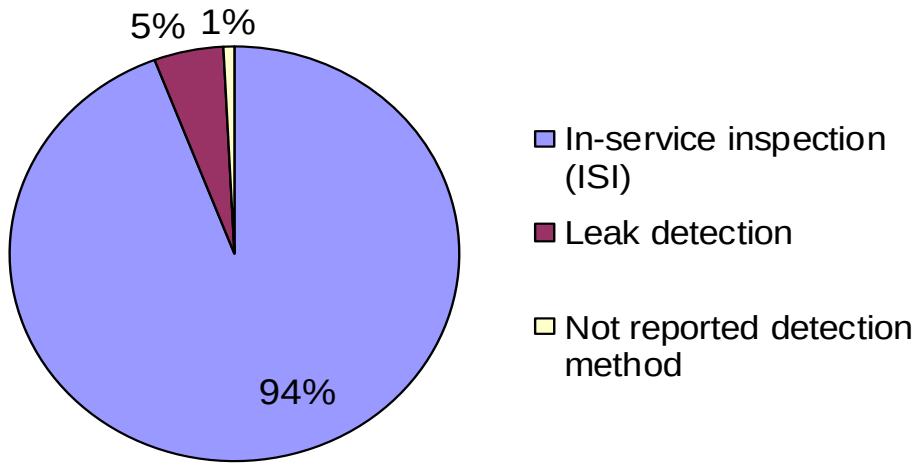
Most frequent degradation mechanisms in Swedish NPPs

(mechanical components)

Component	Degradation mechanism
Piping including elbows and mixing tee	FAC
	IGSCC
	TGSCC
	Corrosion
	Thermal fatigue
	Other fatigue
RPV nozzles and safe ends	IGSCC
	Corrosion
	Thermal fatigue
RPV internals	IGSCC
	IASCC
	Thermal fatigue
Other components	FAC
	Corrosion
	Thermal fatigue
	Other fatigue



Inspection and control have worked well – so far



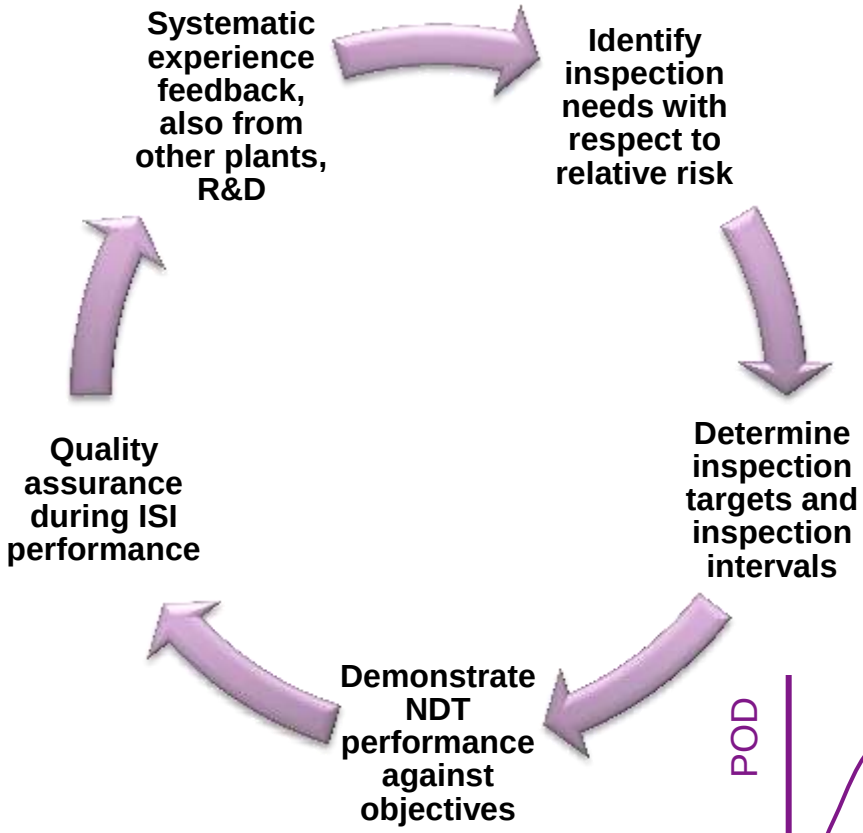
- No major safety consequences
- Most degradation events have been detected by ISI
  - but some misses have been reported
- Detection of degradation have often led to extensive replacement measures
  - to prevent further failures

SSM has a strong legal basis and binding regulations

- with requirements for aging management in general
  - and for ISI/IST of pressurized components and other safety related structures and components, in particular
- SSM is now reviewing, clarifying and precise both the regulations and general advice about aging management
  - in view of the licensee's planned long-term operation of the Swedish NPPs

The ISI-process

P \ C	1	2	3
I	A	A	B
II	A	B	C
III	B	C	C



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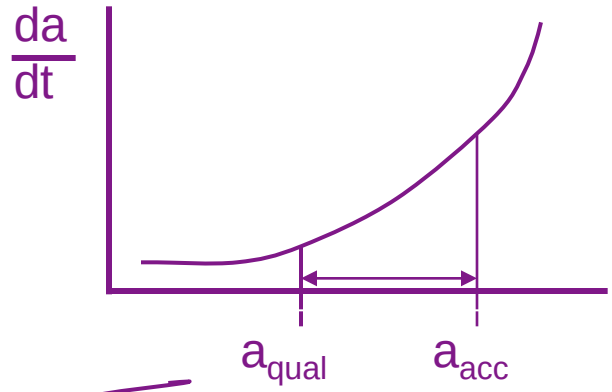
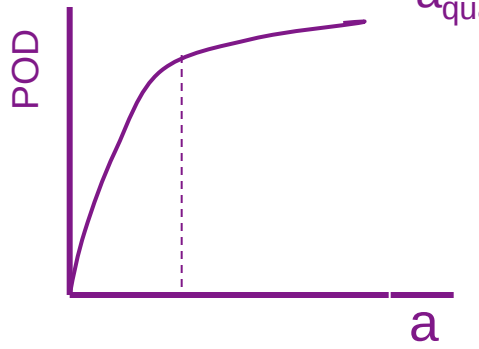




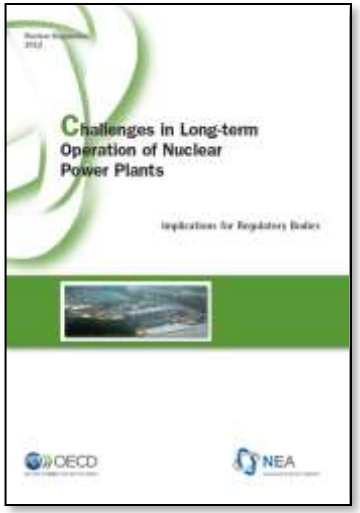
SSM reviews the licensees

- aging management program
  - incl. ISI/IST program, surveillance program, maintenance program

SSM supervise the licensees

- aging management activities
- But, the system also include
  - Independence (accredited) inspection bodies that supervises tests, inspections and review results
  - Independent qualification bodies that qualify personnel and NDT system

Long-term operation, LTO



- presents both licensees and regulatory bodies with new challenges
- Organisations, resources and expertise must be adaptable to manage new safety issues that might arise in connection with LTO
- Thorough knowledge of under which conditions different degradation mechanisms can occur is essential

Research activities and operating experience world wide

  - have led to a situation where substantial knowledge has been accumulated about degradation mechanisms that can affect components and structures in NPPs
- However, degradation history shows clearly that our knowledge base must be continuously updated based on
  - further research, and
  - detailed damage analyses, which often reveal other circumstances than those expected
- Continued international cooperation will be important
  - such as the IAEA IGALL, OECD-NEA OPDE

Conclusions

- Experience shows that effective aging management must continuously be taken into account
  - from the design phase and throughout the planned period of operation
- In regulatory evaluation of potential for LTO focus on aging management is necessary but not sufficient
- Other aspects that must be considered are
  - implemented and need for additional safety improvements
  - application of lessons learned from operating experience
  - adequate licensee staff resources and performance
  - security at the plant