



Strål
säkerhets
myndigheten

Swedish Radiation Safety Authority

Ageing management in Sweden

Regulatory aspects

IAEA technical meeting

Activities related to International Generic Ageing
Lessons Learned Database

Vienna 18 – 20 May 2009



SSM:s overall regulatory approach

- Regulations with safety goals based on state-of-the art knowledge and technology in all important areas
 - technical, organizational and administrative requirements
- Inspection and supervision
 - with focus on the licensees competence and resources to identify important issues and perform necessary measures
- Investigation and research
 - supporting SSM:s inspection and supervision activities and to keep our expertise up-to-date

Regulative history

- **SSMFS 2008:1** (SKIFS 1998:1, SKIFS 2004:1)
 - SSM:s regulations concerning safety in nuclear facilities
 - Requirement for ageing management programme
 - Requirement to investigate causes of deficiencies in barriers and defense in depth

- **SSMFS 2008:13** (SKIFS 1994:1, SKIFS 2000:2, SKIFS 2005:2)
 - SSM:s regulations concerning mechanical components in nuclear facilities
 - Requirements for ISI and evaluation of degradation

- **SSMFS 2008:17** (SKIFS 2004:2)
 - SSM:s regulations concerning the design and construction of nuclear power plants
 - Requirements for the modernization of plants bringing them up to modern safety standards



What should an ageing management programme do?

- Ensure a long term approach to issues
- Ensure the necessary technical basis for maintaining safety margins throughout the operational life of a plant
 - Natural part of the overall management of the plant
 - Documented in the quality assurance system and part of the underlying safety analysis
 - Includes effective system for experience feedback
 - Includes root cause analysis of degraded structures, systems and components



What should be included in an ageing management programme?

- Physical ageing
 - of structures, systems and components (SSC)
- Technological ageing
 - of instrumentation and control systems
- Ageing of requirements
 - codes & standards are modernized as knowledge improves and this should lead to updates of plant safety analysis reports (SAR)
- Personnel and organizational ageing
 - generation shifts and cultural changes



What is an ageing management programme?

- Coordinates plant efforts in existing programmes such as
 - Maintenance, monitoring, inspection, environmental qualification, chemistry, periodic testing and surveillance programmes
- Covers all components and structures of the plant barriers and its defense in depth



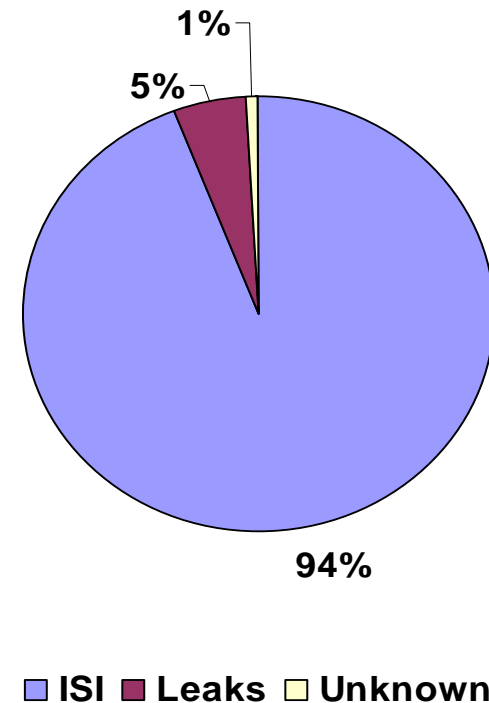
Ageing of materials

- ➔ Continuous deterioration of properties over time caused by operational conditions
 - Results in change of status of component
 - Consequences: degradation of barrier, reduction of redundancy, risk for common cause failure (CCF)
 - Often occurs unnoticed during normal operations
 - Not only metallic materials but also concrete and electrical cables, etc
 - Several degradation mechanisms can be active concurrently



Metallic components

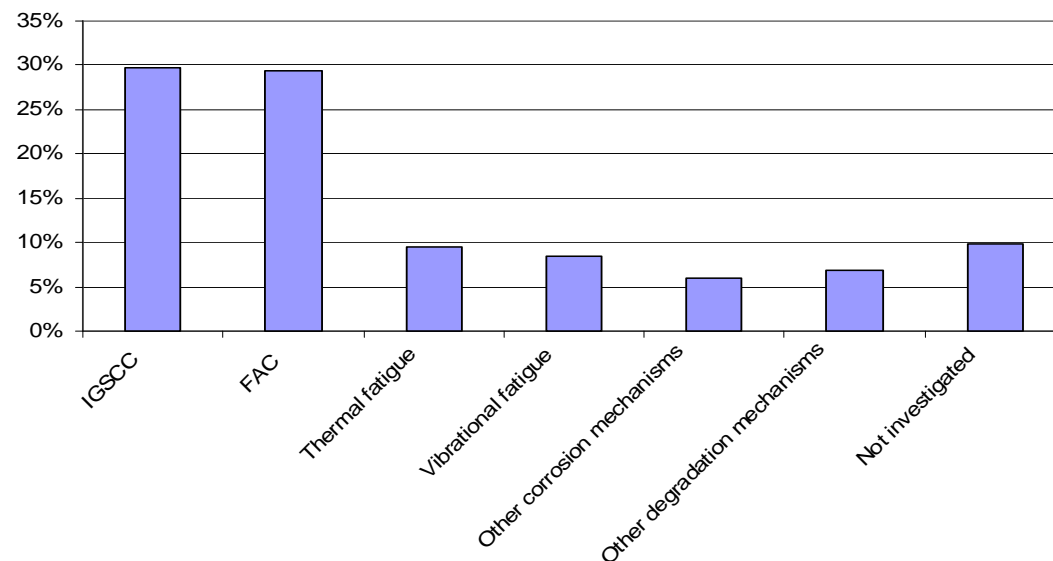
- ➔ Risk informed in-service inspection programmes effective in detecting degradation in a timely manner
- ➔ Their effectiveness needs to be followed and assessed on a regular basis





Regulatory tool: STRYK

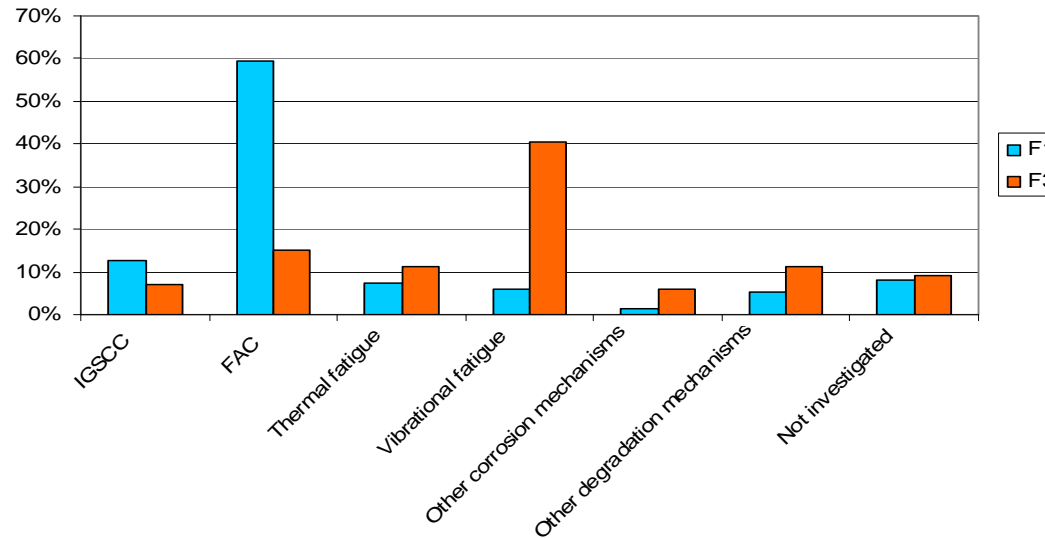
- SSM:s database of degradation in mechanical components is unique and covers all events in all plants from 1972 to 2008. It is updated annually.





Evaluation of relevant degradation mechanisms is plant specific

➤ Comparison of Forsmark 1 with Forsmark 3





Regulatory requirements in Sweden

- Inspection techniques qualified for the specific degradation mechanisms mandatory
- Qualitative or quantitative risk based inspection programmes required for more than a decade
- Surveillance programmes not currently designed for the planned long term operation of some plants, so must be revised
 - Innovative measures (material characterization and reconstitution) may be necessary, but many tested specimens already disposed of as waste

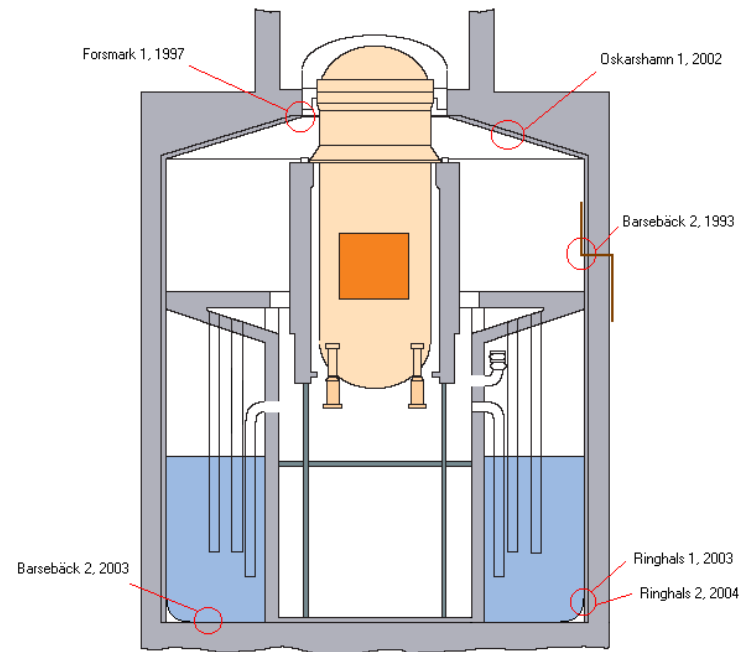


Containment

- Containment structure
 - Reinforced and pre-stressed concrete
 - Tendons protected against corrosion by grease or cement
 - Two concentric concrete shells with a steel liner for leak tightness
- Requirements for containment
 - To maintain leak tightness
 - No plastic deformation of reinforcement steel
 - No crack formation in concrete
- Some observations
 - Loss of pre-stressing force less than calculated
 - Significant liner damage, such as holes
 - Effect of irradiation less than predicted



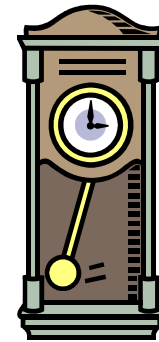
Degradation problems in Swedish containments



Ringhals 2, 2004

Other components

- Qualification of equipment
- Replacement when faulty
- Preventative maintenance programmes using statistical approach
- Use of same approach as for metallic components being considered



Personnel and organizations



Long term considerations

- The effect of operational changes or modernisation needs to be assessed with respect to ageing management programmes, e.g.
- Fatigue
 - Cumulative usage factor assessment to ensure that it has not and will not exceed 1 during the period of long term operation and at the higher thermal effect
 - Should the effects of the environment be included?
- FAC
- Irradiation embrittlement



Long term considerations (cont.)

- Design basis review in accordance with current codes and standards
- Design loadings under normal and upset conditions taking into account changes in operational conditions/procedures (such as power uprates)
- Keep the safety analysis report updated



Did you get what you ordered?

- ➔ Global pressure on manufacturers can result in components being made by organisations not used to the demands of the nuclear industry
 - Unexpected material problems with undocumented properties
 - Difficulties in quality assurance

Regulatory supervision

- Swedish utilities have ambitious ageing management programmes based on IAEA NS-G-2.12
- SSM uses a combination of inspection and document reviews to assess programmes
 - Overall maintenance programmes and methodology
 - Specific maintenance – electrical components
 - Principles for control group assignment – metallic components
- Periodic safety reporting should cover the programmes including future needs

Concluding remarks

- A well balanced ageing management programme has economic advantages since the necessary measures can be taken in a planned and timely manner, limiting surprises, avoiding unplanned and costly loss of production
- International experience will often provide advance warnings
 - Essential to participate in international exchange of experience
- SSM will continue active involvement in national and international research effort to improve basic knowledge about ageing issues



Final word

- Ageing management does not only apply to components that are approaching their theoretical or design life
- It applies to all components!