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Technical and regulatory aspects of ageing management of pressure-retaining components in German NPPs

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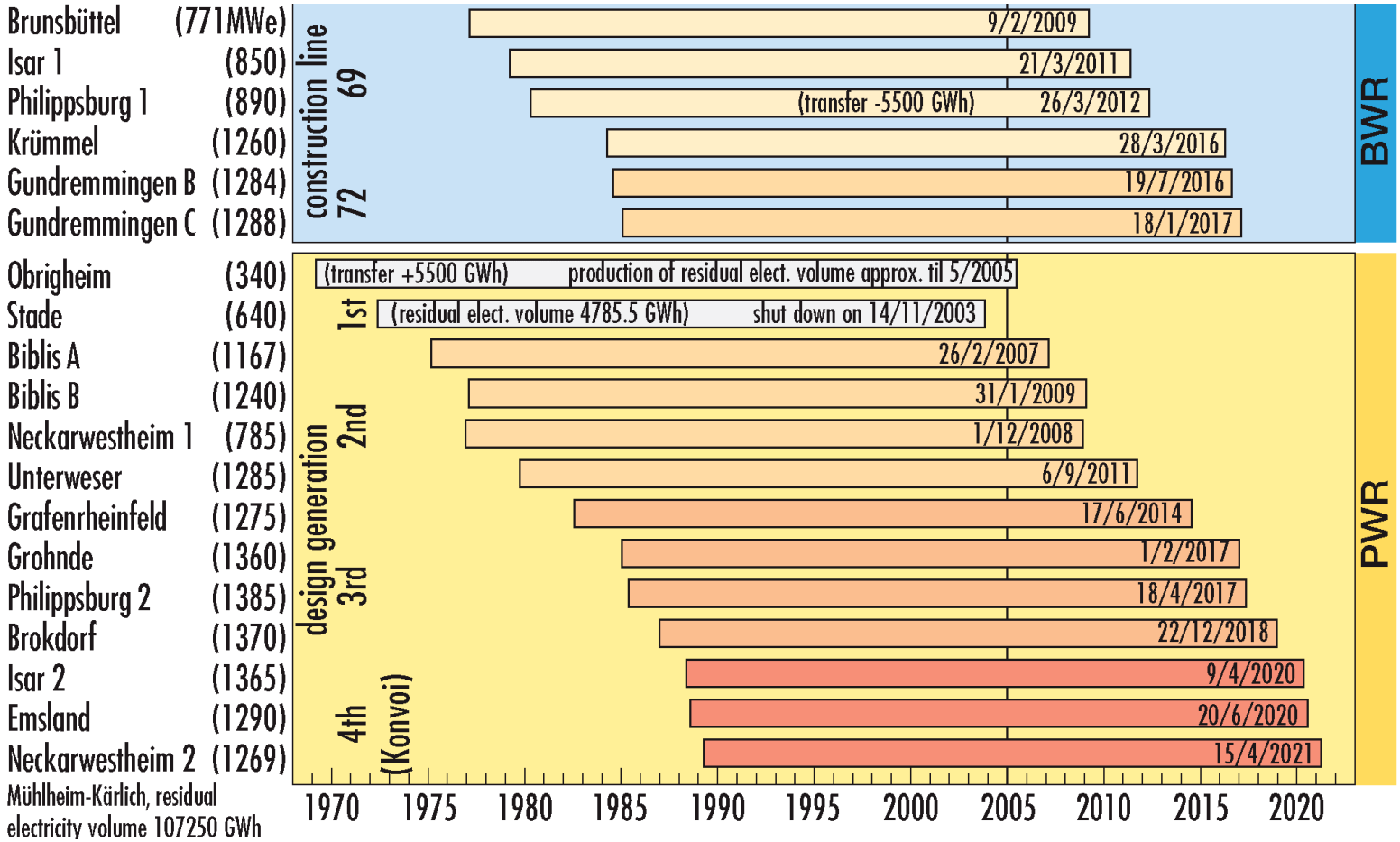
Outline

- Service live of German NPPs and approach to ageing management
- GRS knowledge base on pressurised NPP components
- Overall results of the evaluation of operating experience
- Development of tools for quick access to information on ageing-related degradation mechanisms
- Recent regulatory activities on ageing management in Germany
- Concluding remarks

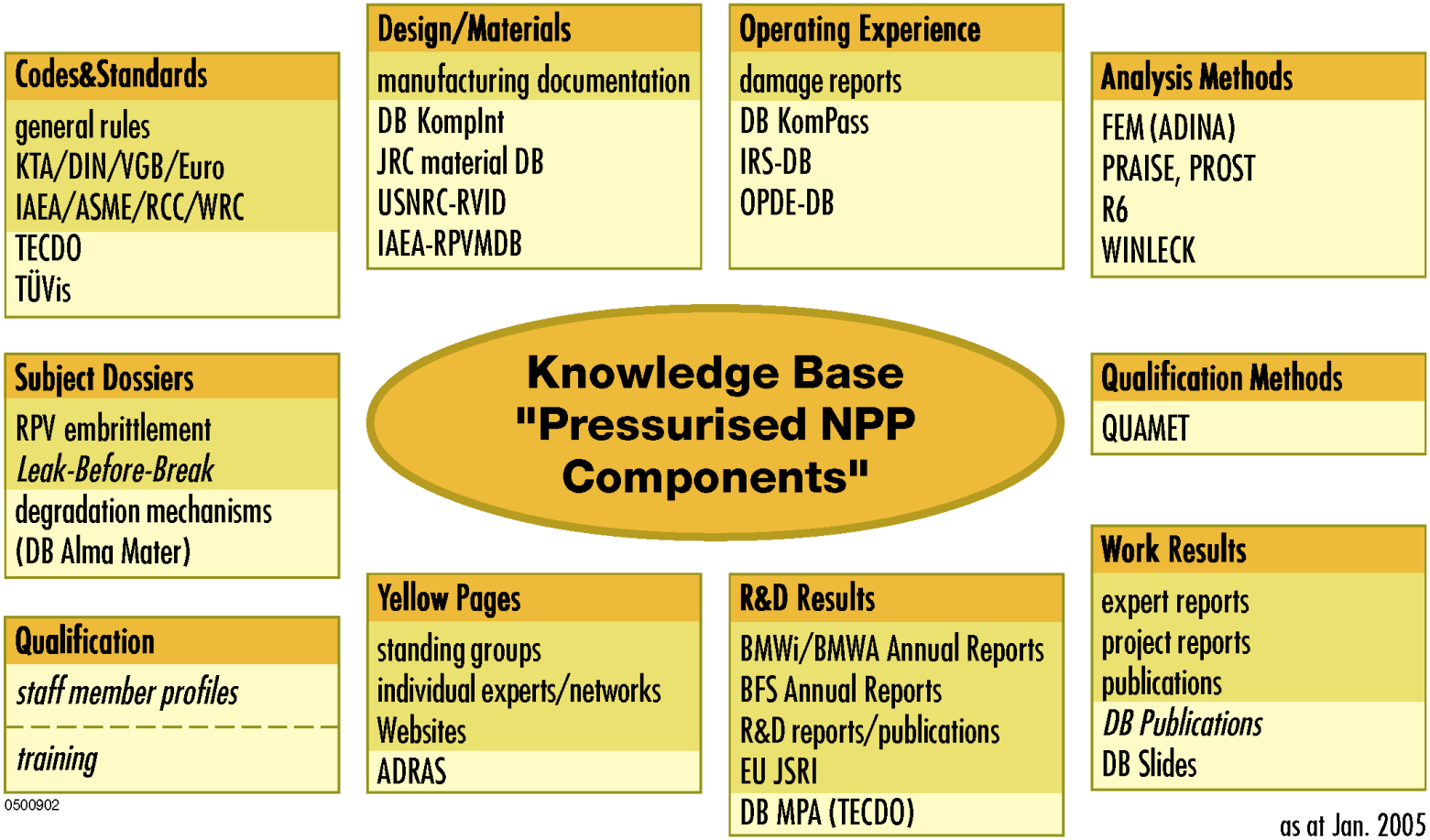
NPPs in Germany – Start of Operation and Service Life



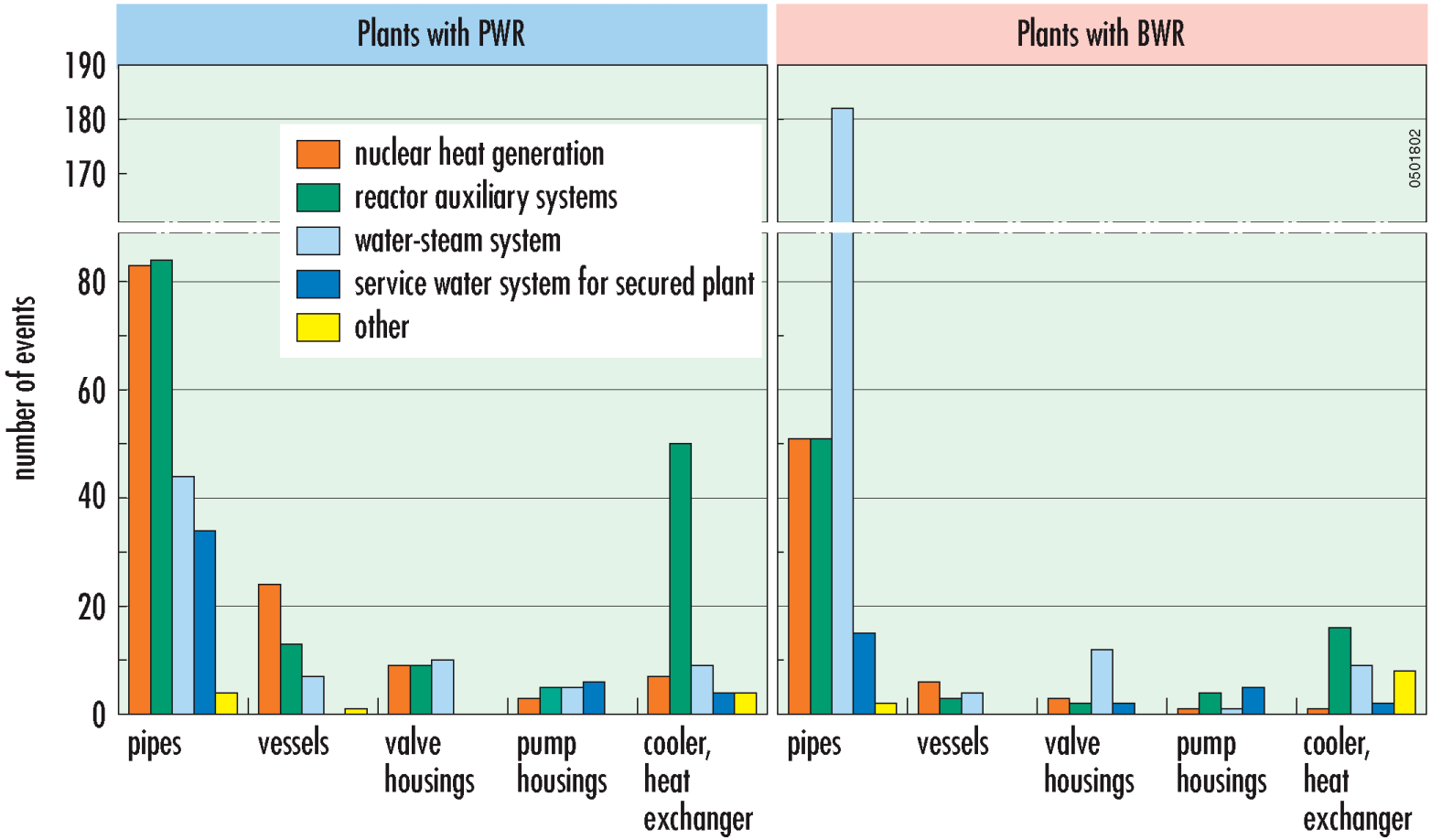
German Approach to Address Ageing Issues

- Continuous evaluation of operating experience to identify changes in the reliability of SSCs
- Extended plant monitoring to enhance the understanding of system behaviour and load conditions of the components
- Evaluation of safety margins for lower bound conditions by experimental / analytical R&D programmes
- Generic studies to identify areas of limited knowledge and potential future problems
- Early replacement of components potentially sensitive to degradation to enlarge safety margins
- Enforcing technical requirements in codes and standards to avoid repetition of non-optimised technical solutions

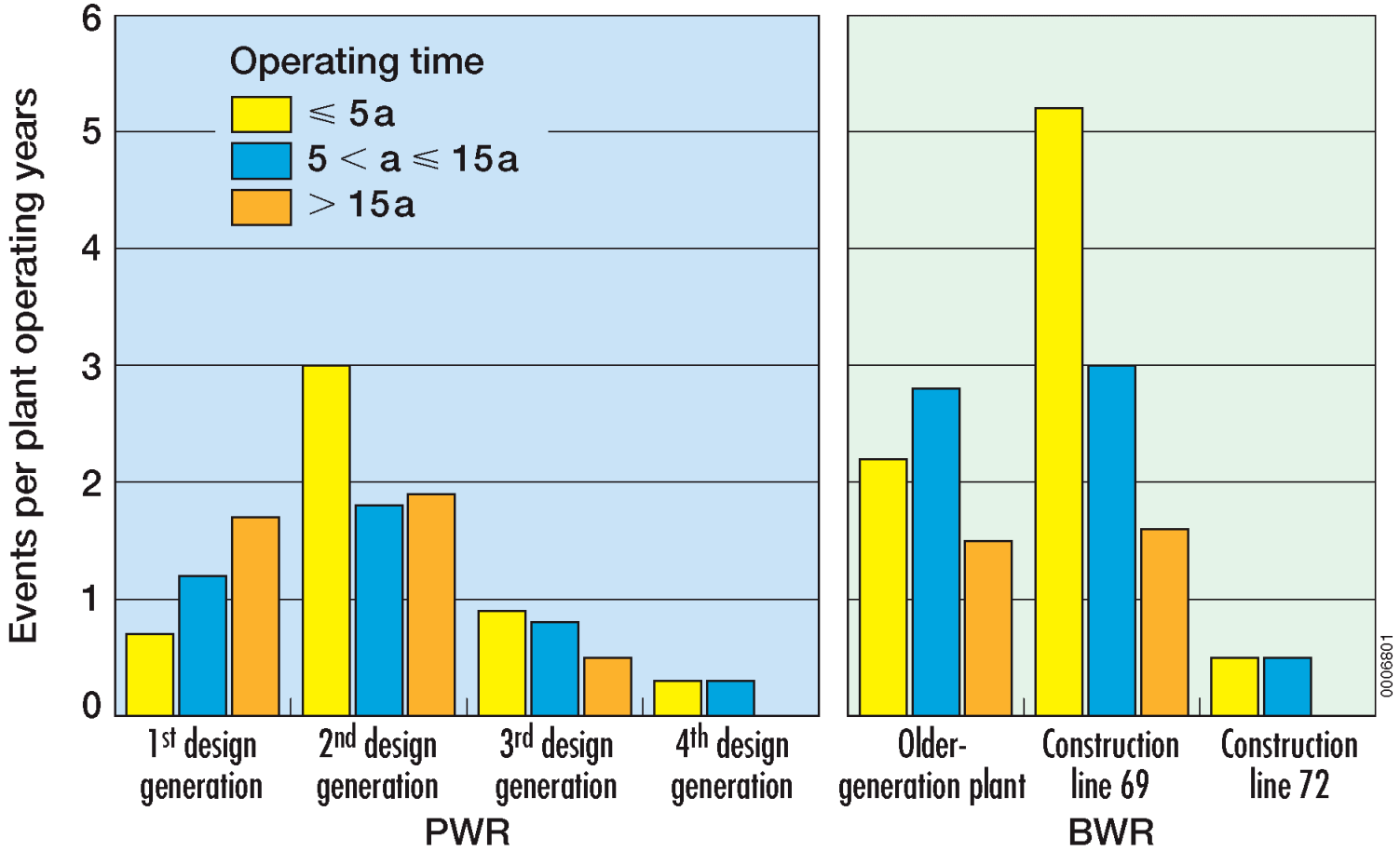
Survey on GRS Knowledge Base



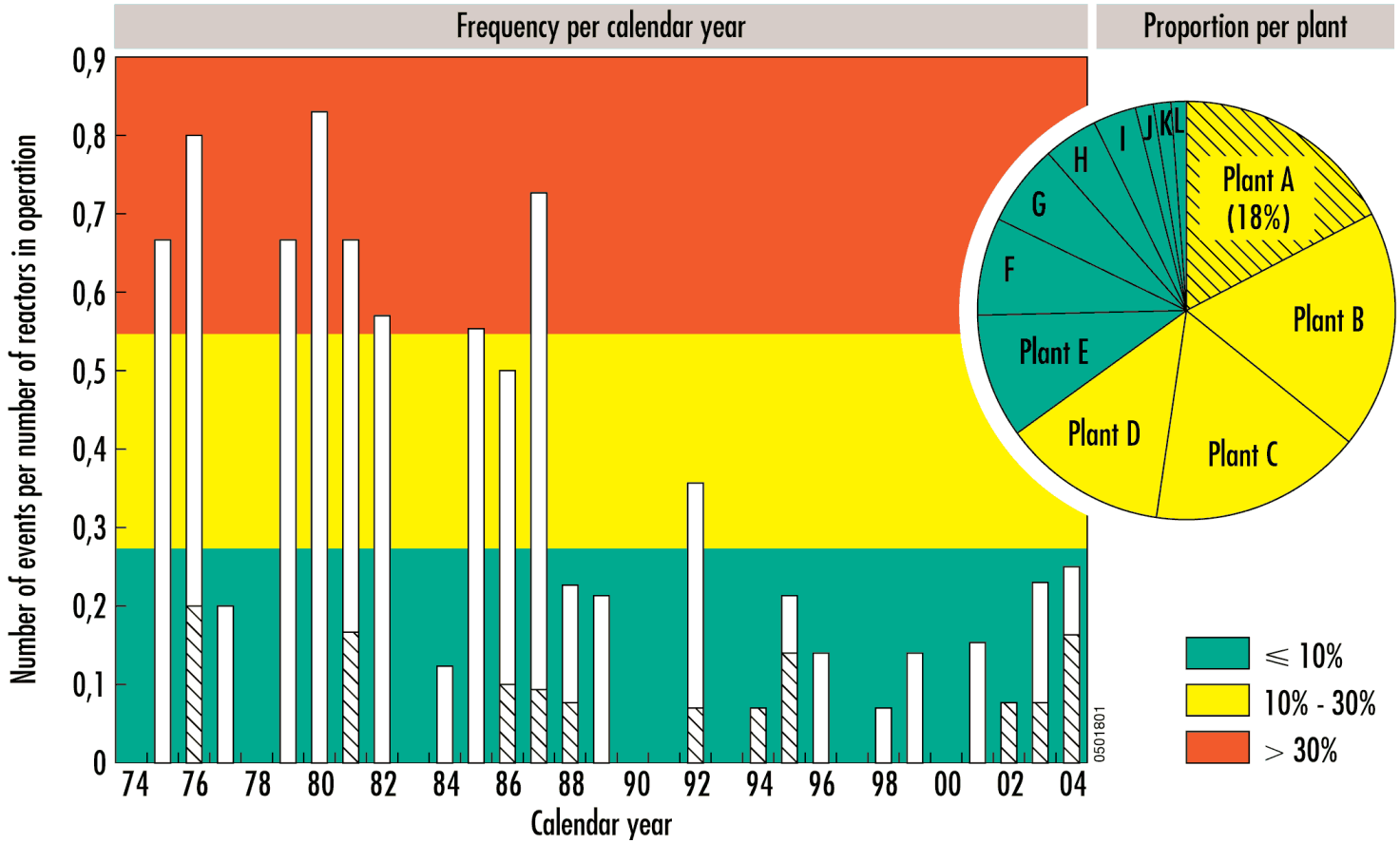
DB KomPass – Recorded Reportable Events at Pressurised Components in German LWR Plants (1974 to 2004)



Reportable Events Affecting Pressurised Components of German LWRs



Reportable Events Involving Piping in German PWR Plants due to Fatigue



Summary of the Results from Operating Experience

- In the past the pressurised components used in German NPPs have yielded experience with different ageing-related degradation mechanisms such as
  - mechanical and thermal fatigue;
  - IGSCC, TGSCC, SICC, FAC.
- The overall number of events due to ageing-related degradation is low, in particular for the plants of the 3rd and 4th PWR design generation and BWR construction line 72.
- Up to now, no significant increase of ageing-related events with operating time has been recognisable.

Development of the DB-System ALMA MATER

- **Objective**
  quick access to the available information on **degradation mechanisms** relevant to pressurised NPP components

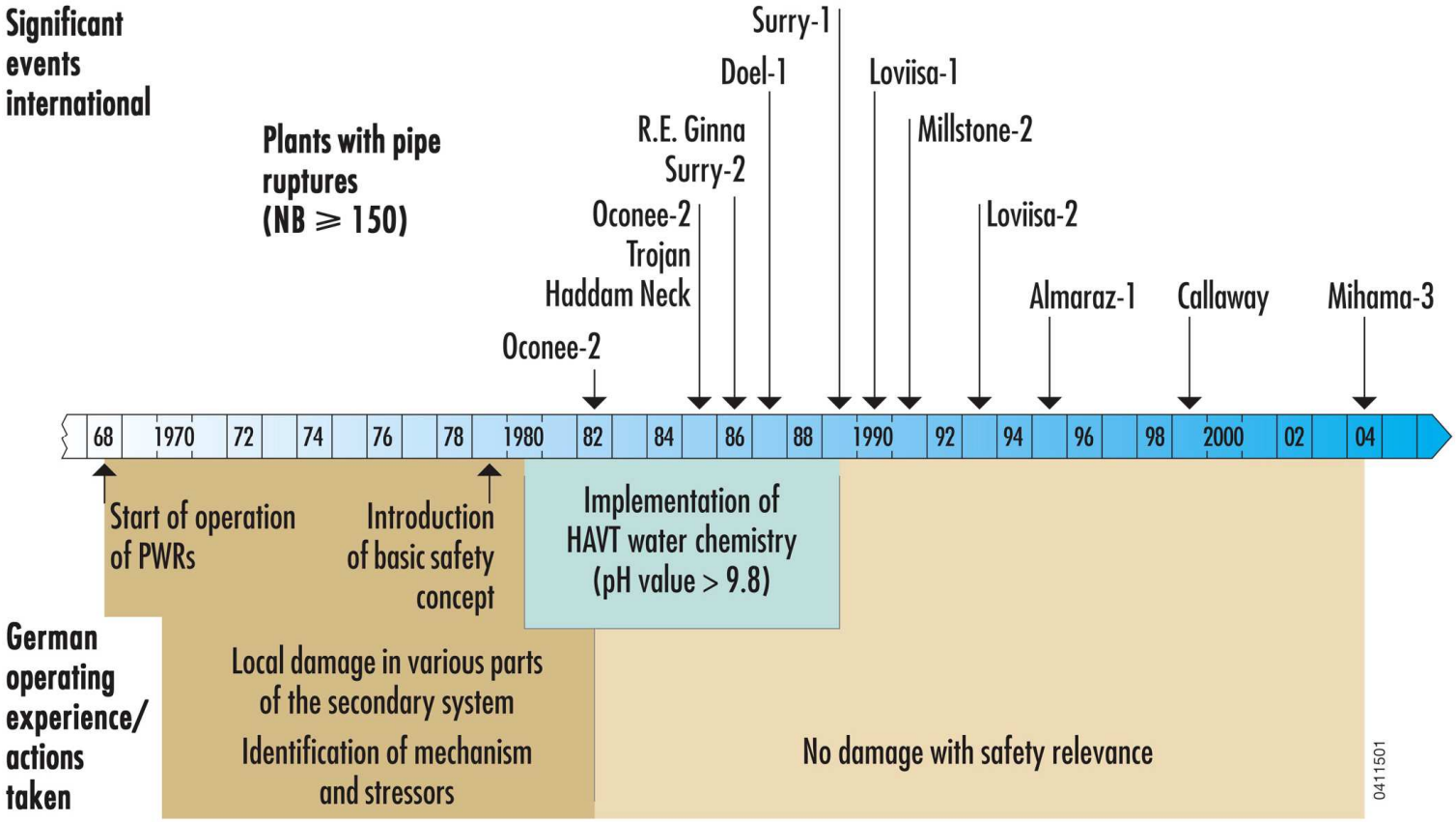
- **Structure**
  → selection of a degradation mechanism via a survey diagram
  - **Initial statement** (definition, boundary conditions, damage symptoms)
  - **Operating experience** including “time bar” and statistics
  - **State of knowledge** in science and technology
  - Relevant sections of **codes and standards**
  - **Yellow pages**

- **Navigation**
  browser-based using the MS Internet Explorer

Survey Diagram in the ALMA MATER DB-System

Damage mechanism		Materials susceptible	Components affected
Embrittle-ment	neutron-activated	C and low-alloy steels	RPV belt line
	thermal-activated	Cast duplex SS, C steels	piping, housings
Corrosion	IGSCC	SS	BWR piping, internals
		Nickel-base alloys	SG tubes, nozzles
	TGSCC, SICC, FAC, BAC, MIC	…	…
Fatigue	mechanical, thermal	…	…
Syner-gisms	corrosion fatigue	C and low-alloy steels	piping, nozzles
	IASCC	SS, Nickel-base alloys	core internals

Operating experience with FAC in PWRs



Recent RSK Recommendation on “Management of Ageing Processes at NPPs” (July 2004)

- Prepared on behalf of the BMU
- Describes principles on the procedures regarding the management of ageing processes at NPPs
- Considers in detail all safety-relevant ageing processes
  - ageing of SSCs (mechanical, electrical / I&C components, structures, ...)
  - ageing of integrated operation management systems and documentation
  - non-physical ageing of concepts and technology
  - maintaining specialist competence
- Contains requirements of an ageing management system to be applied during the remaining lifetimes of German NPPs

Concluding Remarks

- The results of the investigations performed by GRS provide a technical basis for the evaluation of ageing behaviour of pressure-retaining components in German NPPs that can be used in the licensing and supervisory procedure.

- So far, the limited number of ageing-related incidents and the corresponding trends confirm the conservativeness of the safety concept chosen for the design as well as the sufficiency of the remedial actions and the ageing management system applied.

- The current knowledge of damage mechanisms and the predictive capa-bilities are limited. Further plant- and component-specific investigations are required as well as procedures to maintain a sufficient level of awareness.

- In future, German licensees need to address ageing management of NPPs on a more comprehensive and detailed level and have to submit periodical plant-specific reports on it, following a corresponding RSK recommendation.