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Derivation loss of main heat sink frequency considering the operational experience

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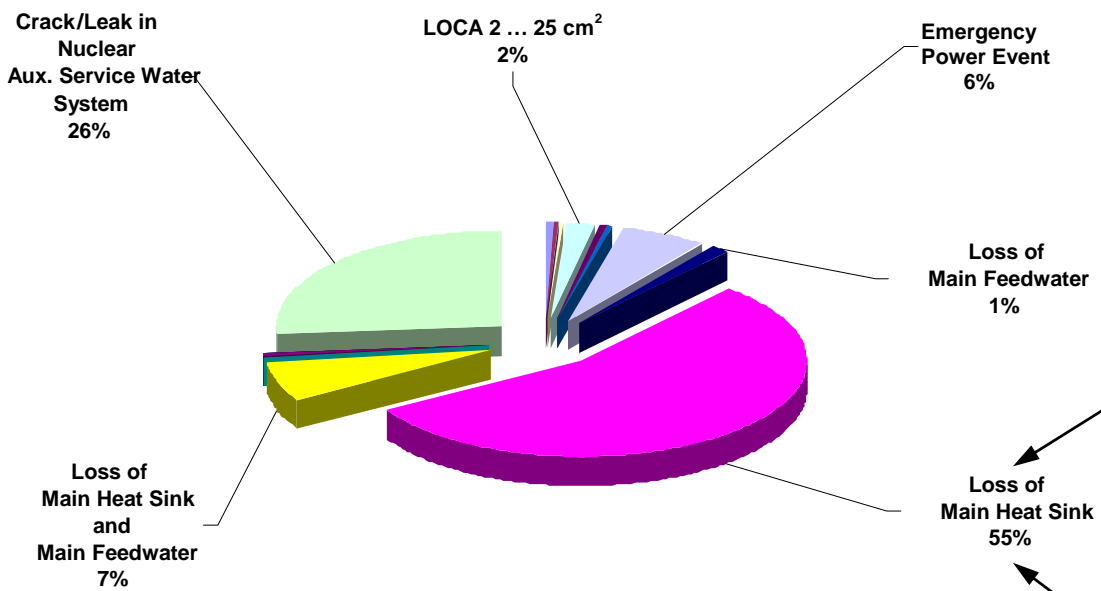
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Structure

- Influence of the event “Loss of Main Heat Sink“ on the current PSA results
- Evaluation of frequencies considering the operational experience
- Results
- Conclusions

Influence of the event “Loss of Main Heat Sink“ on the current PSA results



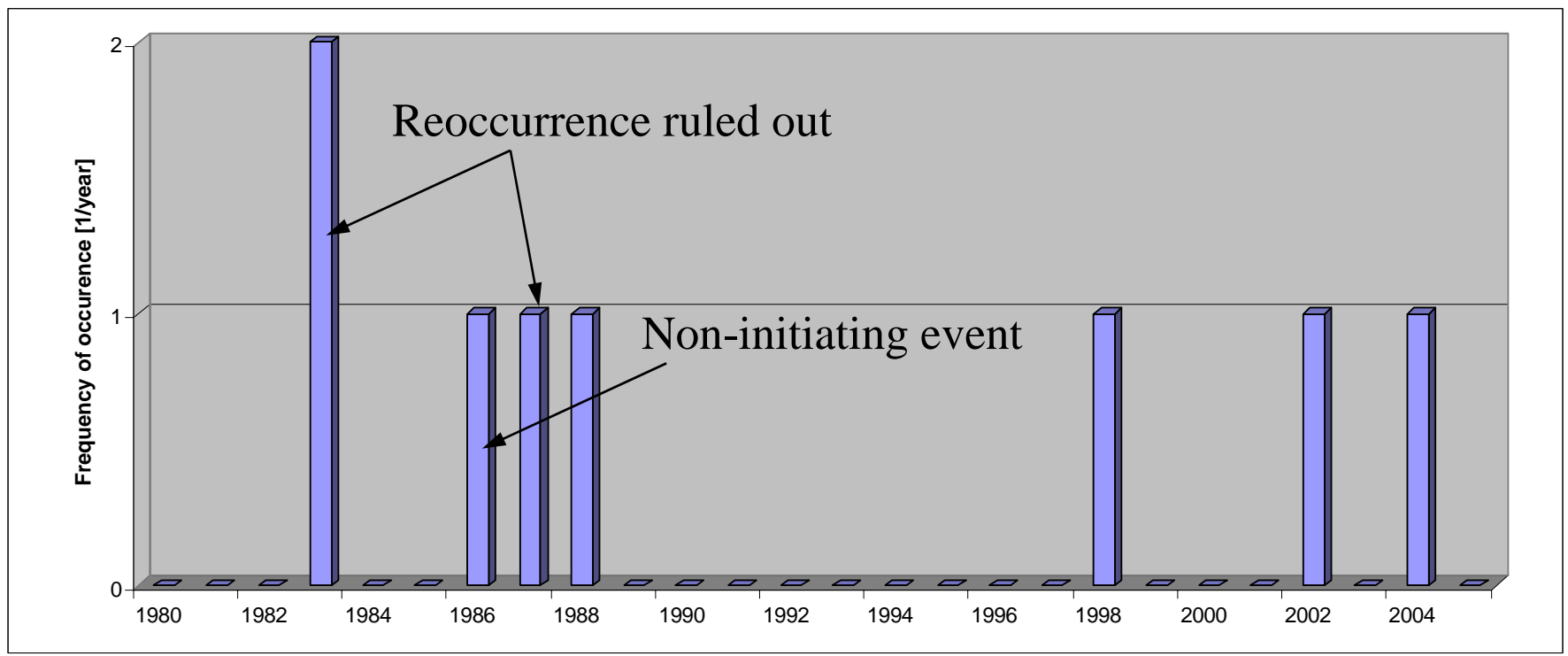
Frequency of the initiating event: 0.31 per year

High contribution of the CCF probability for steam relief valves

Influence of the event “Loss of Main Heat Sink“ on the current PSA results (Cont.)

- Frequency of the loss of main heat sink was determined from operational experience
- Eight events were taken into account over a period of 26 years
- Marginal condition:
 - Two events resulted in concrete technical measures which will prevent future occurrence of similar events
 - One event was strictly speaking not an initiating event because safety systems weren't needed to cope with the transient

Influence of the event ‘Loss of Main Heat Sink’ on the current PSA results (Cont.)

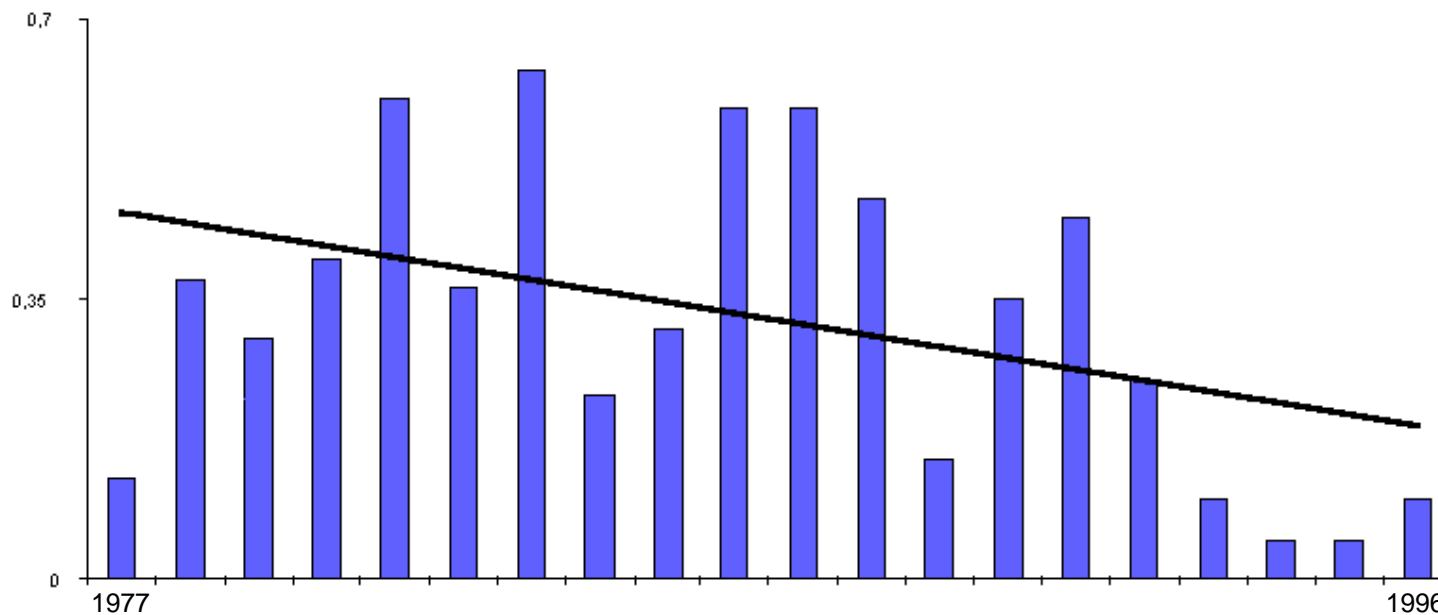


Evaluation of frequencies considering the operational experience

- Two different points of view:
 - Only considering events with the possibility of recurrence and the necessity of safety systems to cope with the transient according to PSA analysts
 - ☛ 5 events in 26 years
 - All events should be counted according to consultants of the state regulator
 - ☛ Creation of a list of all known possible events
 - ☛ Comprehensive statement on the frequency of occurrence
 - ☛ 8 events in 26 years

Evaluation of frequencies considering the operational experience (Cont.)

- Evident reduction in the frequency of occurrences for all German NPP:
 - Continuous further development of the plants
 - Lessons learned from safety studies

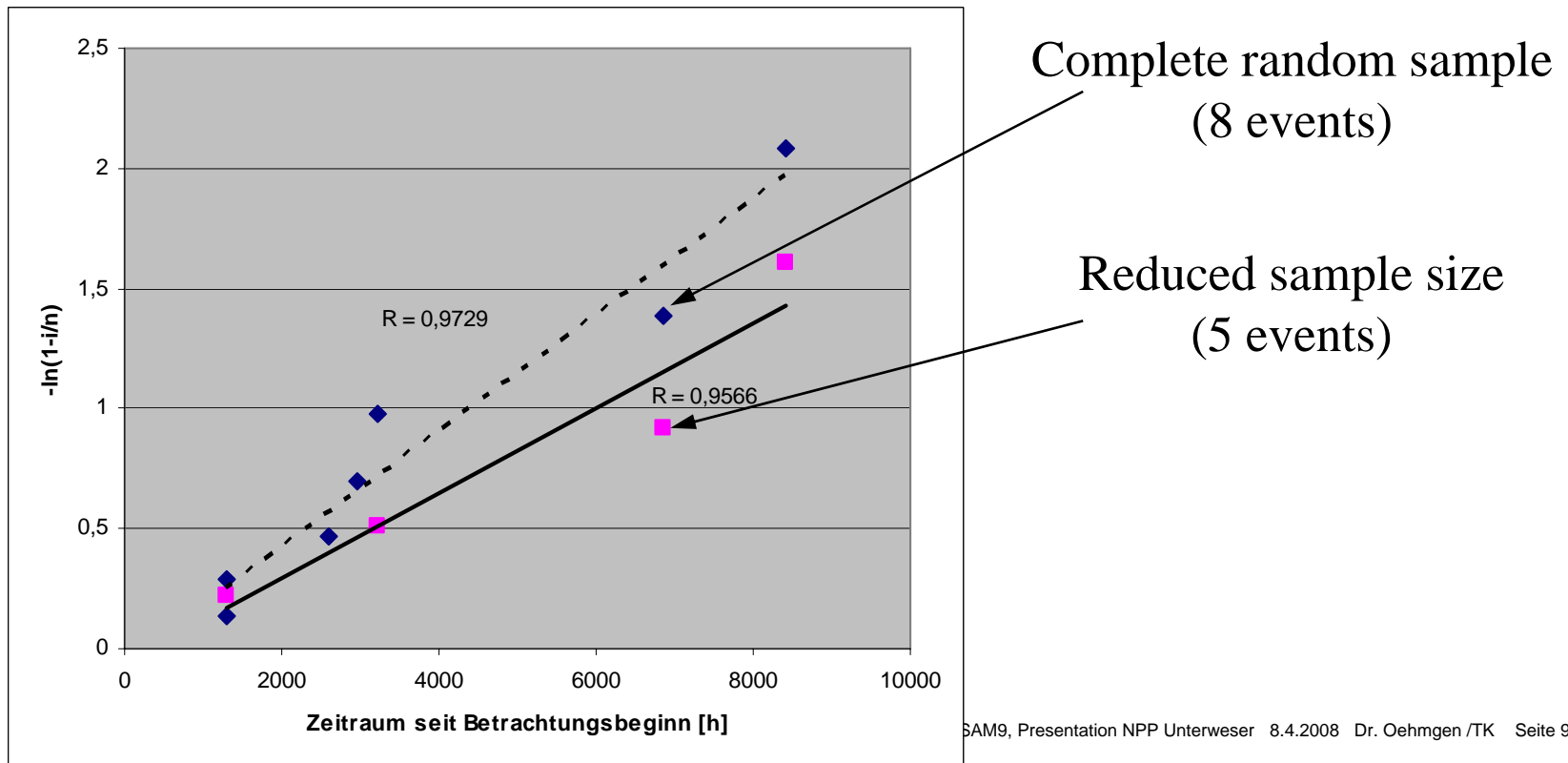


Evaluation of frequencies considering the operational experience (Cont.)

- Learning effects from failures and events confirmed by study
- Continuous improvement of plant safety
- Hypothesis stating that the frequency of events has remained pretty much constant despite safety improvements is hereby disproved

Evaluation of frequencies considering the operational experience (Cont.)

- Use of a graphic Goodness-of-Fit test to determine whether a Poisson process exists



Evaluation of frequencies considering the operational experience (Cont.)

- Three calculation cases:
 - Current (8 events in 26 years)
 - Reduced sample size (5 events in 26 years)
 - Empirical Bayes estimation with pre-information from a comparable plant
- Frequency of “Loss of Main Heat Sink“ events for newer German plants of about 0.04 per year
 - ☛ Limited comparison
- Technically comparable plant is Biblis-B
 - ☛ Two losses of main heat sink in the timeframe 1988 to 1996

Results

Variant	Frequency [per year]	Error Factor
Counting all 8 events that have occurred during the 26 years of operation	0.31	3.5
Counting 5 events that have occurred during the 26 years of operation	0.19	5
Bayes' evaluation of the operating time since 1980 with pre-information from another plant (1988 to 1996)	0.16	2.8

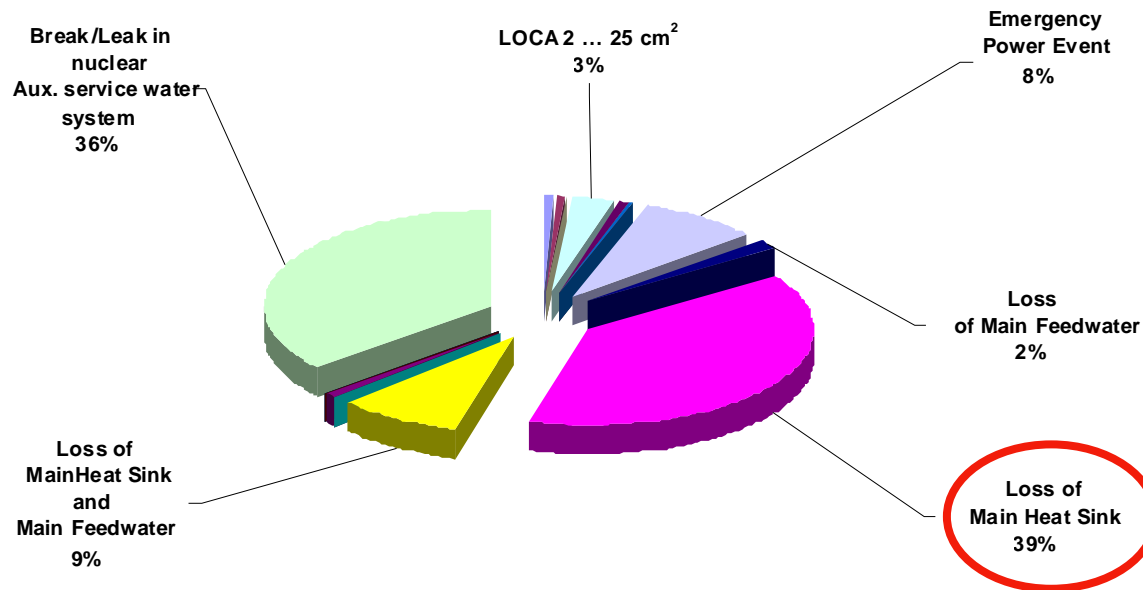
- Empirical Bayes (EB) determined frequency is half the value currently used in PSA
- Lowest error factor resulted from Bayes' evaluation due to the most operating experience
- Case two roughly corresponds to the value from the EB estimation

Conclusions

- Original statement of the PSA experts was correct not to count three of the events.
- EB estimation provides a somewhat lower result with the lowest level of uncertainty.
- The future level of the Maximum Likelihood Estimate will approach that of the of the EB value if aforementioned three events are not considered
- Frequency of occurrence of 0.16 per year with an error factor of 2.8 should be used in the PSA

Conclusions (Cont.)

- Core damage frequency of the plant is reduced by about 25%!



- Compromises of sensitive input parameters distort the results and diminish the significance of the analysis!