

The standard DIN EN ISO 16708 in Germany: Is the probabilistic approach mandatory for high-pressure pipelines?

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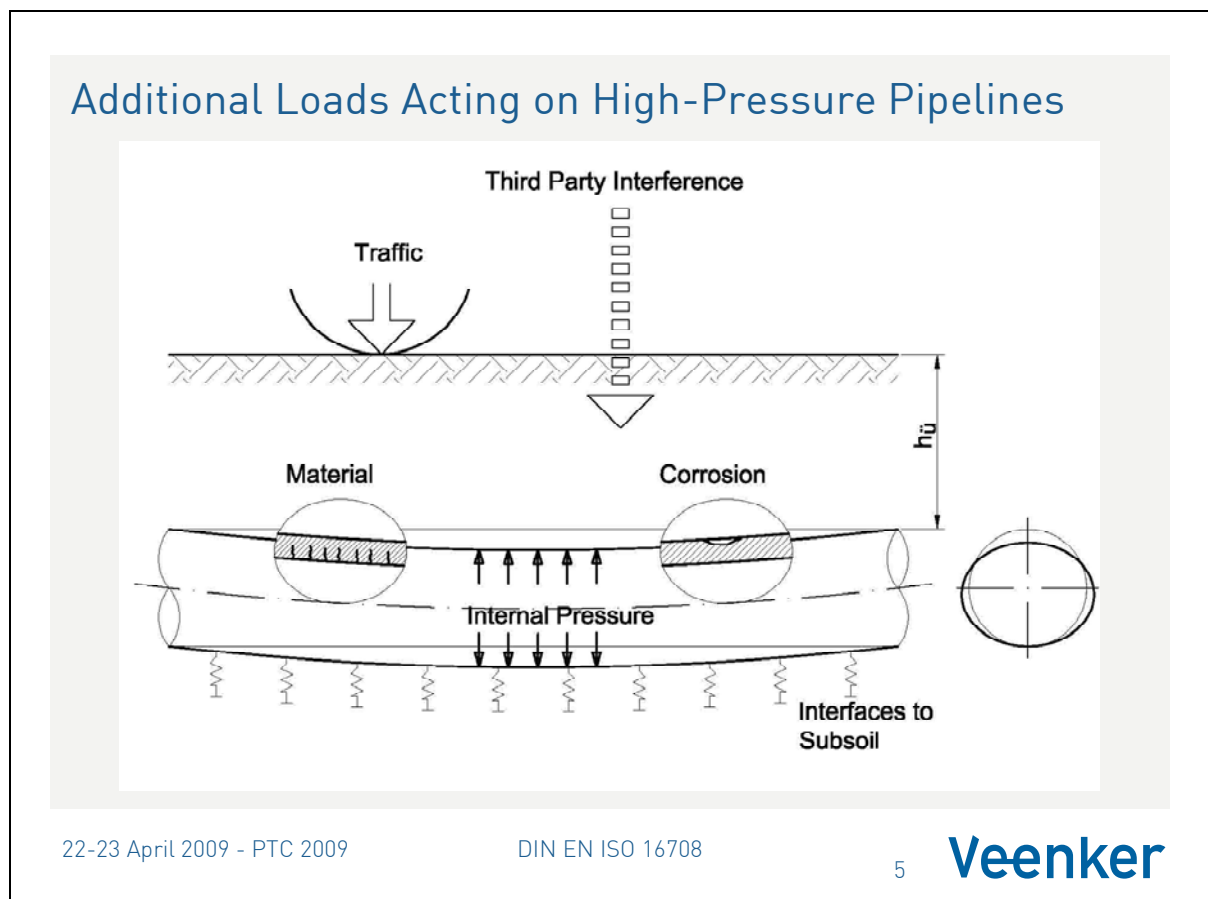
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1 Deterministic Approach vs. Probabilistic Approach

Standards related to the design of structures generally follow the deterministic approach. This approach applies predefined and earlier-calibrated safety factors that are taken from the applicable technical standards and regulations. The advantage of this approach is that with a limited set of formula to be applied quickly, it allows for a sufficiently secure design with regard to regular loads acting on a structure over its regular useful life.

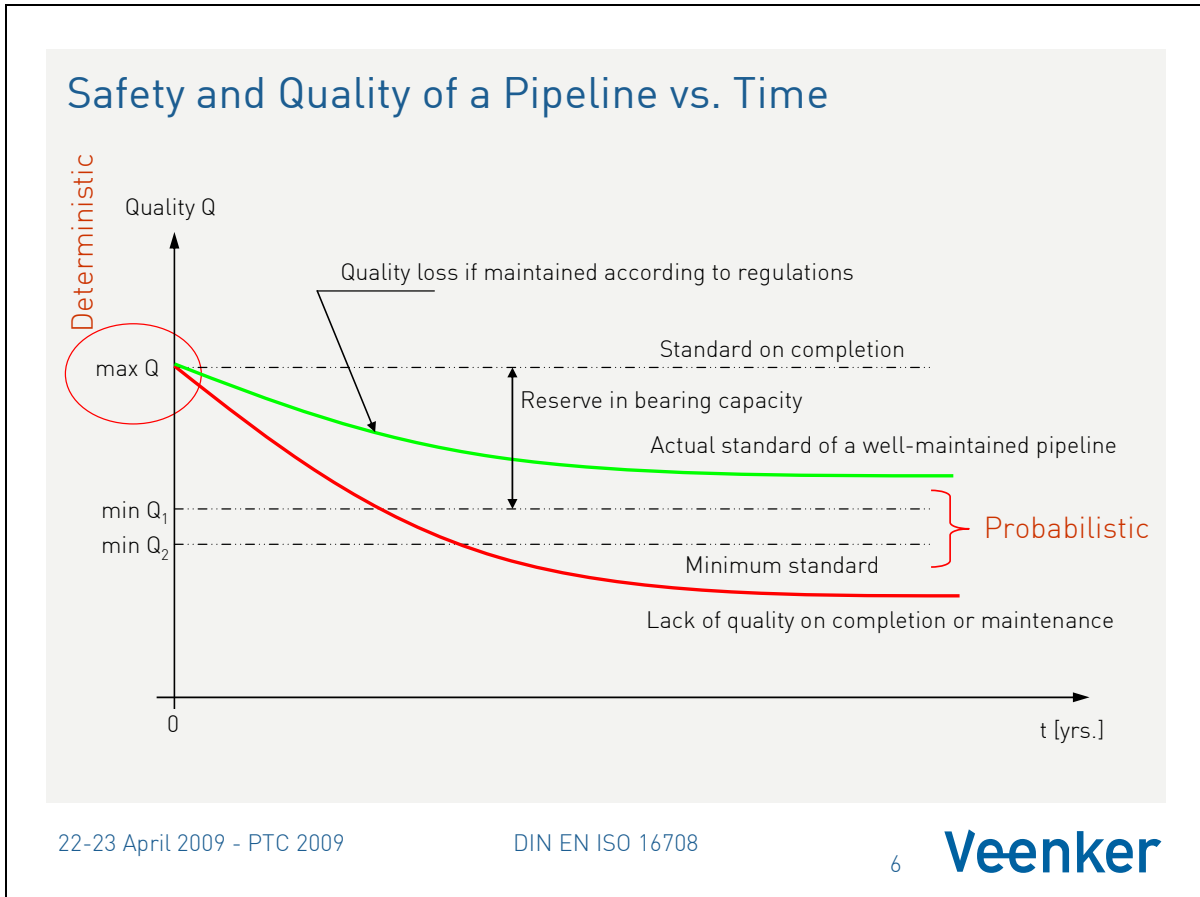
The loads acting on a pipeline as well as the boundary conditions often change over the several decades of the useful life of a pipeline. Reasons are for example ageing material, significant corrosion, and additional loads not accounted for in the initial design (Figure 1).

Figure 1: Additional Loads



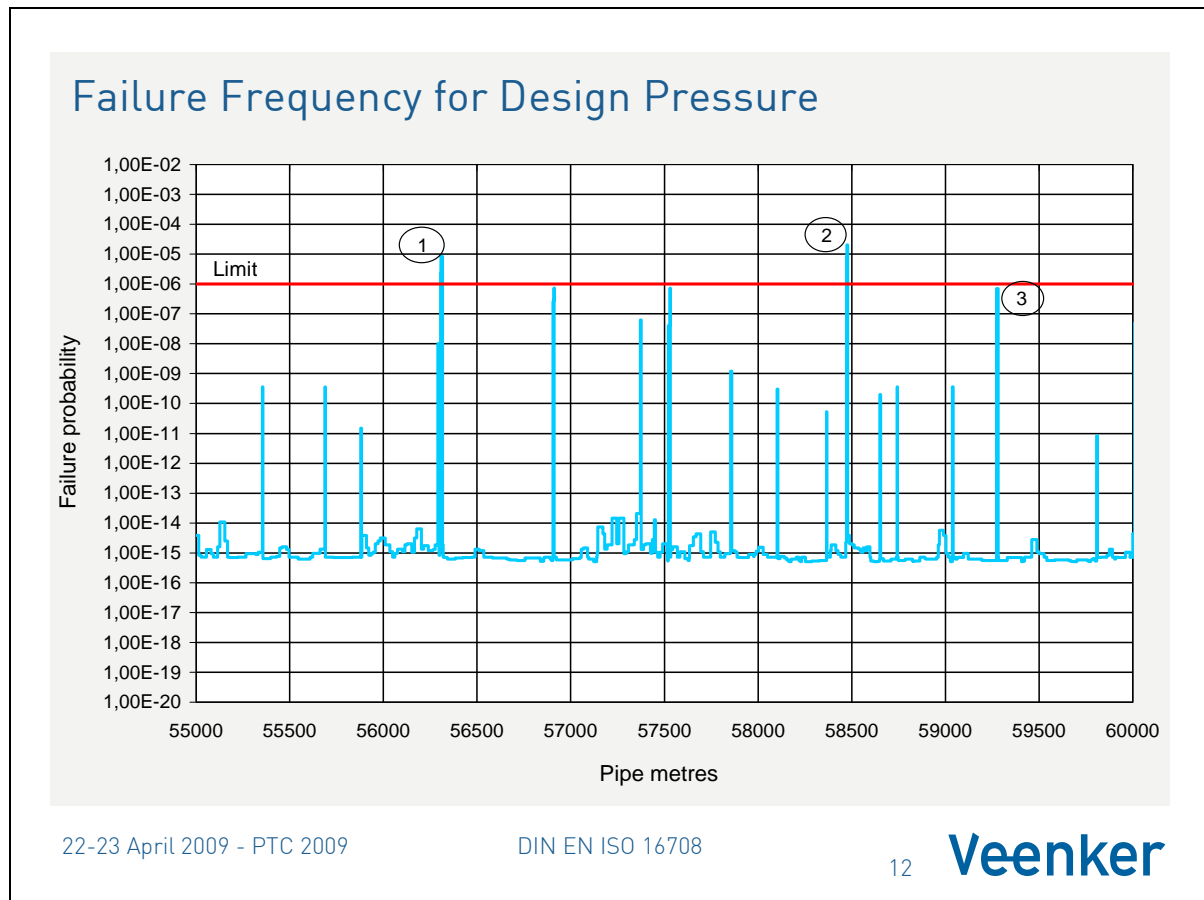
The deterministic approach can only be applied to satisfy the safety and quality requirements at the time of construction as the reserve in load bearing capacity included in the safety factors of the deterministic approach is not quantified within this approach. Therefore the probabilistic approach has to be applied to determine whether a structure subjected to additional loads and quality loss is still sufficiently safe at any given point in time within its useful life (Figure 2).

Figure 2: Safety and Quality of a Pipeline vs. Time



Within the probabilistic approach the failure frequency is determined for each single point of a pipeline and accounting separately for all actual loads and boundary conditions (Figure 3). It has been introduced some 20 years ago into the design and assessment of structures. Compared to the deterministic approach, the calculation of the failure frequency is a complex process that, however, can be carried out safely. A problem has long been the setting of widely accepted limits for the failure frequency.

Figure 3: Failure Frequency



2 DIN EN ISO 16708

The ISO has worked on the probabilistic approach for many years and the standard ISO 16708: „Petroleum and natural gas industries – Pipeline transportation systems – Reliability based limit state methods“ was modified frequently in its draft status over a long period of time. In 2006 it has been adopted as DIN EN ISO 16708 as a national standard in Germany.

The scope of DIN EN ISO 16708 allows for the deterministic and the probabilistic approach to be applied in parallel as they both satisfy the safety requirements. DIN EN ISO 16708 not only gives recommendations and specifies the framework and principles for the application of the probabilistic approach. It also gives specific values for the target safety levels (failure frequency) to be used.

DIN EN ISO 16708 is applicable to a wide range of fluids from non-flammable to toxic fluids. It can be applied to rigid metallic pipelines onshore and offshore. The determination of the applicable target safety level accounts not only for the type of fluid but also for the location category, i.e. the failure consequences.

3 Conclusion

The normative definition of the probabilistic approach along with applicable limits for the failure frequency is highly welcome and the standard DIN EN ISO 16708 has a high level of acceptance among authorities, experts and specialist engineers.

However, even after the introduction of DIN EN ISO 16708 in Germany the probabilistic approach is not mandatory as DIN EN ISO 16708 explicitly allows for the deterministic approach and the probabilistic approach to be used in parallel.

In everyday engineering, the deterministic approach is still widely used in the design and construction of structures to allow for a safe and simple process and for legal certainty whereas the probabilistic approach is applied for complex issues regarding additional loads, quality loss or economical analyses.

The probabilistic approach should be regarded as a chance rather than an obligation as it allows proving the safety of a high-pressure pipeline even if the deterministic approach can no longer be applied.