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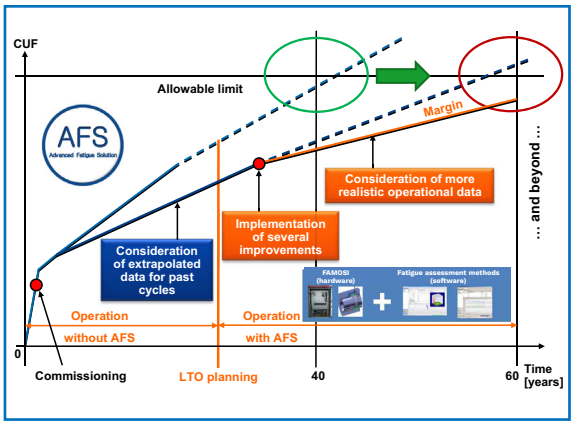
Advanced Fatigue Solution - AFS

The combination of the high-accuracy local load monitoring system FAtigue MOnitoring System-i with progressive fatigue-assessment methods and the utmost level of expertise extends the operational lifetime of components.

Challenge

The safety of nuclear power plants must be ensured for all kind of loads. It is indispensable to monitor and control degradation effects that could compromise safety and availability of the plant. Cyclic thermo-mechanical loads can induce fatigue effects and hence increase the aging of equipment. Fatigue is one of the main aging mechanisms that might lead to unexpected events during operation, such as equipment damage, leakages, and forced outages. A fatigue management program is necessary for licensing or long-term operation (LTO) of reactors, and it must comply with more and more stringent authority and design-code requirements, such as new fatigue curves, consideration of Environmentally Assisted Fatigue, stratification effects, and load-follow operation.



CUF evaluation – LTO with AFS

Solution

The modular Advanced Fatigue Solution (AFS) combines progressive fatigue assessment methods, the utmost level of expertise, and the high-accuracy local load monitoring system, **FA**tigue **MO**nitoring **S**ystem-i, to fulfil the latest design-code requirements, operator's safety management, and regulatory needs.

Based on process data and measured local thermal loads, the fatigue assessment methods adheres to the principle "as much as necessary; as few as possible". Application of local load monitoring systems like **FA**tigue **MO**nitoring **S**ystem-i makes use of realistic thermal input data for the fatigue assessment since the data is obtained directly at or nearby fatigue/stress relevant locations.

Progressive fatigue assessment methods tailored to customer requirements are available:

- The Simplified Fatigue Estimation (SFE) provides for a basic decision about fatigue relevance.
- The Fast Fatigue Evaluation (FFE) module streamlines the direct and widely automated process from temperature measurement to design code conforming cumulative usage factors (CUFs).
- The Detailed Fatigue Calculation (DFC) implements high-end elastoplastic fatigue and ratcheting assessment methods.

AFS provides for accurately calculating the CUF and for resolving fatigue issues with utmost efficiency. Thus, AFS supports the identification of possible degradation mechanisms for systems, structures, and components (SSCs) important to safety and availability.

Customer benefits

- Extends the operational lifetime of components by increasingly realistic computation of CUF
- Effectively supports LTO projects
- Saves costs through component lifetime extension (fewer replacements) and through increased component availability
- Optimizes operating modes that are unfavorable regarding component fatigue
- Reduces the number of in-service inspections and maintenance

Your performance
is **our** everyday **commitment**

Technical information

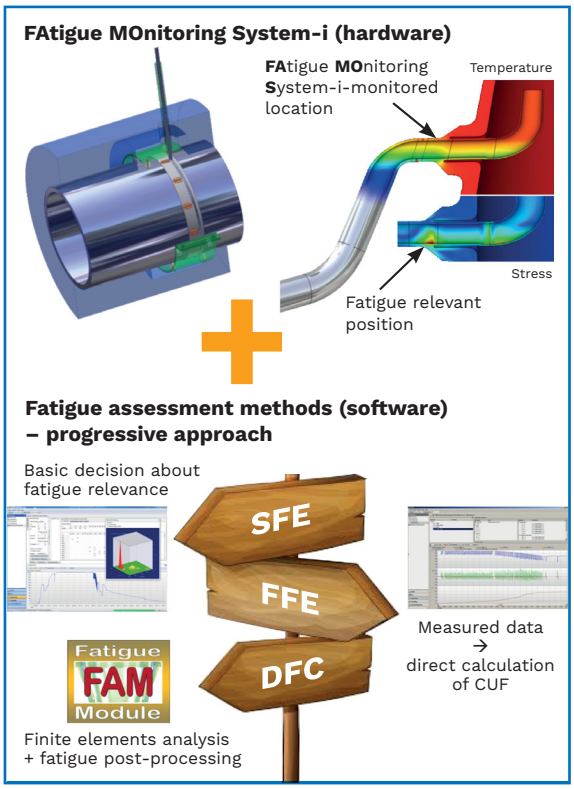
The modular AFS combines progressive fatigue assessment methods and the high-accuracy local load monitoring system, **FA**tigue **MO**nitoring **S**ystem-i.

To obtain precise results, qualified measurement sections are provided in a plant-specific setup. The modular, decentralized **FA**tigue **MO**nitoring **S**ystem-i provides data acquisition, processing, storage, and visualization for all fatigue relevant data.

Based on process data and measured local thermal loads, the resulting CUF is calculated using a toolbox of progressive fatigue assessment methods:

- **SFE** or simple design code procedures provides for a basic decision about fatigue relevance.
- **FFE** streamlines the process from data acquisition to CUFs. It is based on the elementary transients (Green's function) approach, and uses the transient local six components stress tensor for fatigue evaluation.
- **DFC** implements finite elements analysis based on evaluated load data and specified transients with fatigue and ratcheting post-processing. Design codes or specific advanced fatigue assessment procedures are used. The DFC may include elasto-plastic material behavior based on advanced constitutive material models (Chaboche, Ohno & Wang) for the fatigue and ratcheting check.

AFS is based on excellence, proven expertise, years of experience in fatigue analysis, and active participation in the development of related codes and standards (ASME, RCC-M, EN, DIN, KTA, ...).



AFS combines progressive fatigue assessment methods and local load monitoring system **FA**tigue **MO**nitoring **S**ystem-i

Key figures

45 **FA**tigue **MO**nitoring **S**ystem-i systems and related AFS fatigue assessment sold

12 non-OEM plants

35 years of fatigue experience and expertise

OEM: original equipment manufacturer

References

Eastern Europe and Russia
- Ukraine (VVER)
- Russia (VVER)
- Bulgaria (VVER)
- Slovkia (VVER)

Asia
- China (PWR)

Western Europe
- Finland (PWR)
- France (PWR)
- Belgium (PWR)
- Netherlands (PWR)
- Spain (PWR)
- Switzerland (PWR)
- Germany (PWR)

South America
- Brasil (PWR)
- Argentina (PHWR)

PWR: pressurized water reactor VVER: water-water power reactor PHWR: pressurized heavy water reactor

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