



MOTIVATED. EXPERIENCED. THINKING AHEAD.

Engineering Services Experience & References

References 2014-2022

SIEMENS

DIEFFENBACHER



**SIEMENS
ENERGY**

kompaflex ag



MAN Energy Solutions



DOMINION

KROHNE



More than 500 different projects, OEM customers, international experience

Application Field Overview

Part Classification

Casted & Forged Parts Casings, Bearing Housings, Wheels, Track Links	Welded Constructions Steel Constructions, Supports	Thin-wall Constructions Production Systems, Burner Lining	Turbine Parts Vaness & Blades, Coating
Rotating Parts Rotor disks, Blades	Kinematic Parts Actuation systems	Pressure Vessels Boilers, Drums	Equipment & Measurement Parts Hydraulic cylinders, Testing Instrumentation

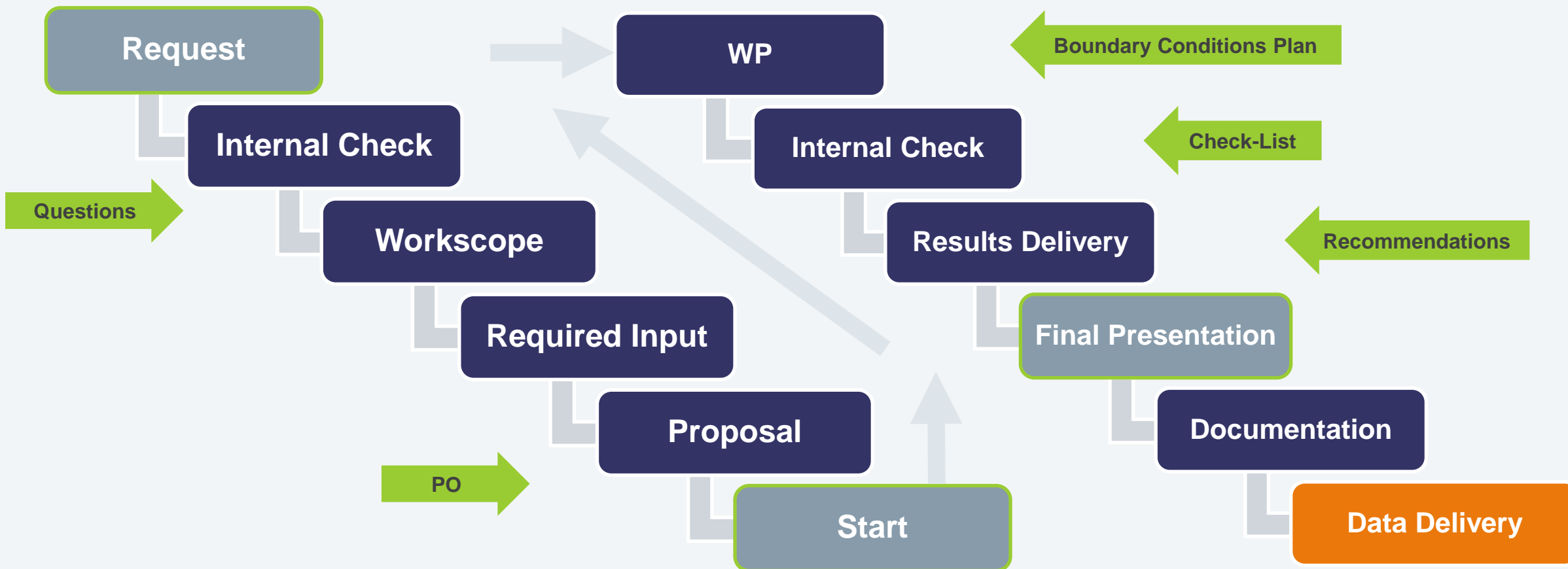
Engineering Service Tools & Guidelines

- ASME CODE
- EUROCODE
- FKM-Guidelines
- IIW-Guidelines
- VDI-2230
- AD 2000
- DIN EN 13445
- EN 1591
- other..



► **Tools Experience and wide Engineering Spectrum provides Flexibility in Development Support**

Project Management and Workflow



► Proven project workflow – international experience, large OEM customers



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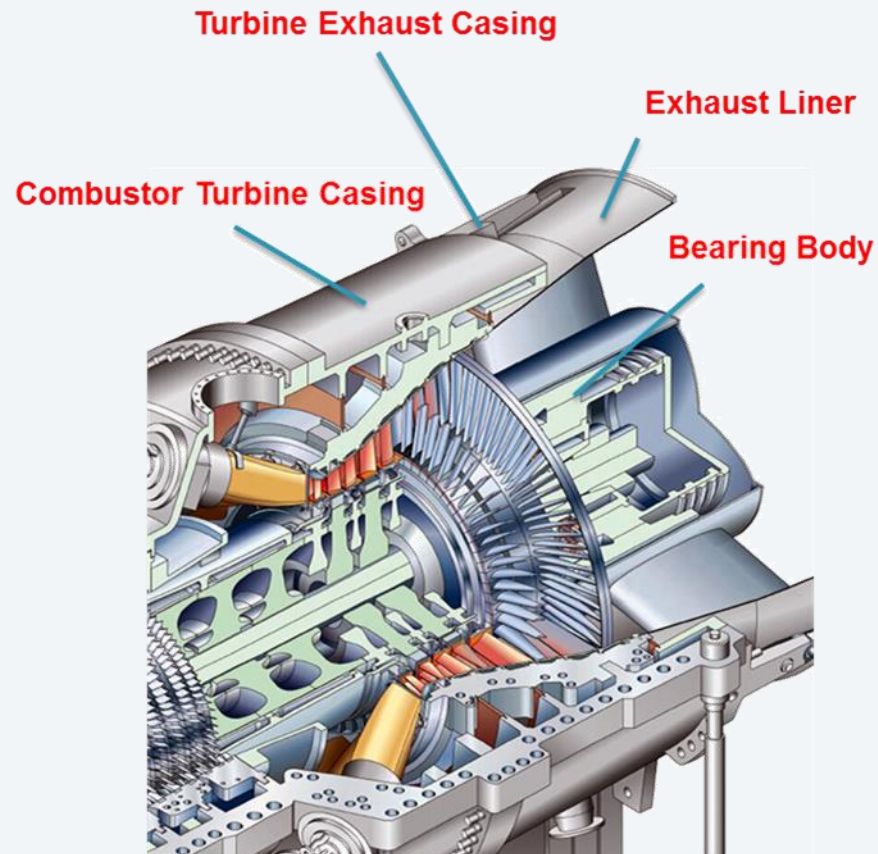


REFERENCE PROJECTS

(some representative examples)

Development of LGT **Casing Exhaust Module**

Full Development Support from Concept to Prototype Test Data Evaluation

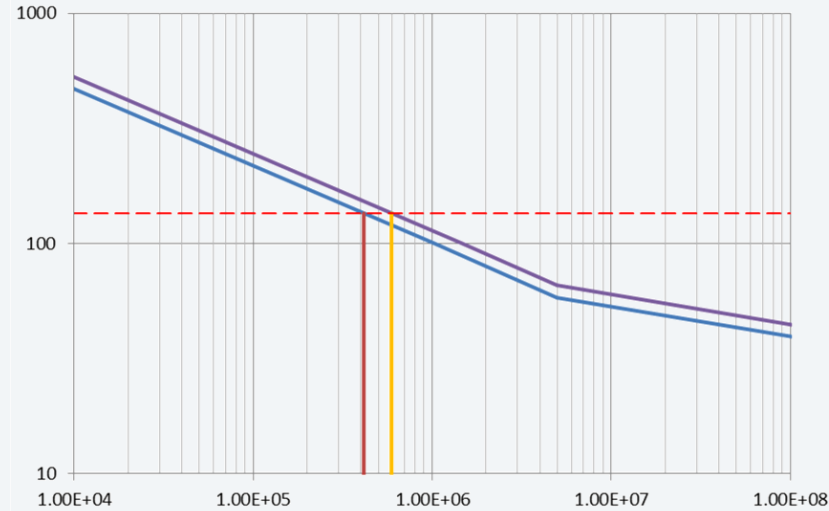
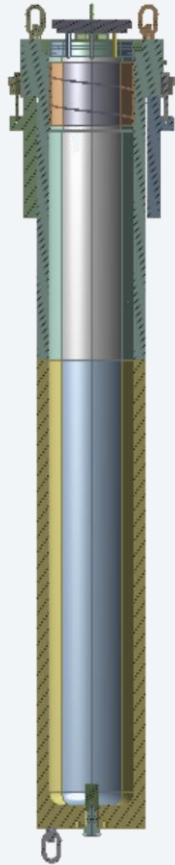


CONTEXT & OBJECTIVES

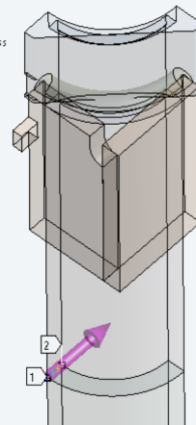
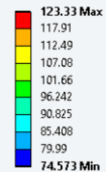
- Preparation of Analysis Plan for Development
- Concept Phase Analyses (feasibility, structural integrity)
- Cast Part Release Supporting Analyses (heat transfer, fatigue, integrity, bolted joints, leakage)
- Fabrication Release Supporting Analyses (fatigue, creep, fracture mechanics)
- Assembly Release Supporting Analyses (deformation, centering)
- Preparation of Instrumentation Plan for Prototype Engine
- Preparation of Review Documentation
- Participation on Reviews
- Assistance in Closing of post-review Action Items
- Post-processing of Prototype Test Data
- Calibration of BC using Test Data
- PLM: SAP, Teamcenter

► **Casing Exhaust Module – Development Support from Concept to Assembly**

Example of Integrity & Fatigue Analysis Dimensioning of a Hydraulic Cylinder



B: 280bar
 Linearized Equivalent Stress
 Type: Linearized Equivalent Stress
 Unit: MPa
 Global Coordinate System
 Time: 1



$$\frac{P_m}{f} = 48.2\%$$

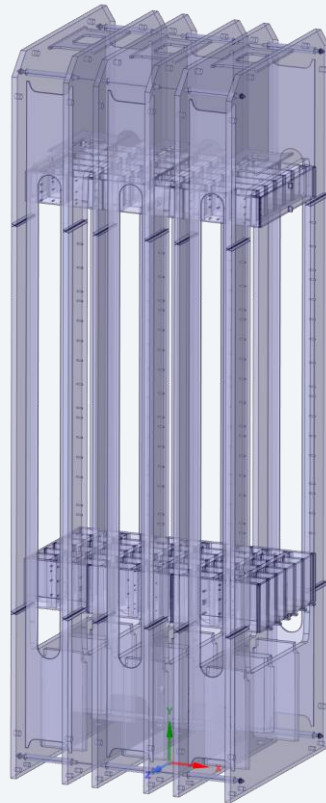
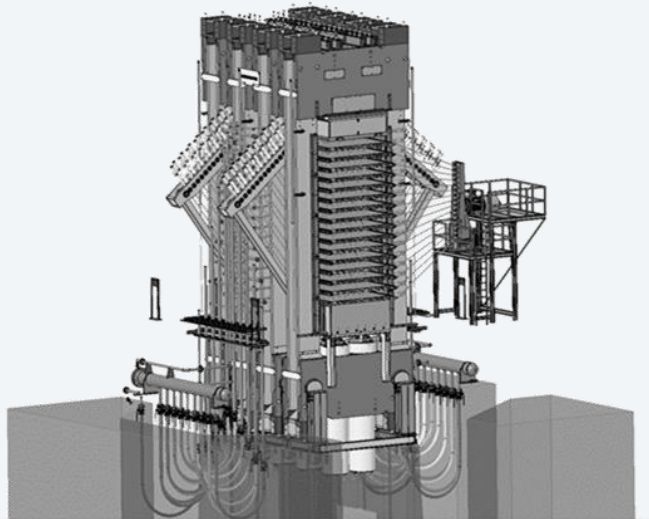
$$\frac{P_m + P_b}{1.5 \cdot f} = 40.1\%$$

CONTEXT & OBJECTIVES

- Multiple projects with Assessments acc. to AD2000, FKM, ASME
- Structural Integrity, Failure Load Cases
- Fatigue Assessment
- Bolted Joints
- Welded Joints
- Deformations, deviations
- Geometry modifications to meet design targets
- TOOLS: ANSYS

► Dimensioning of hydraulic according to customer targets

Example of Integrity & Fatigue Analysis Dimensioning of a Cycle Press Frame

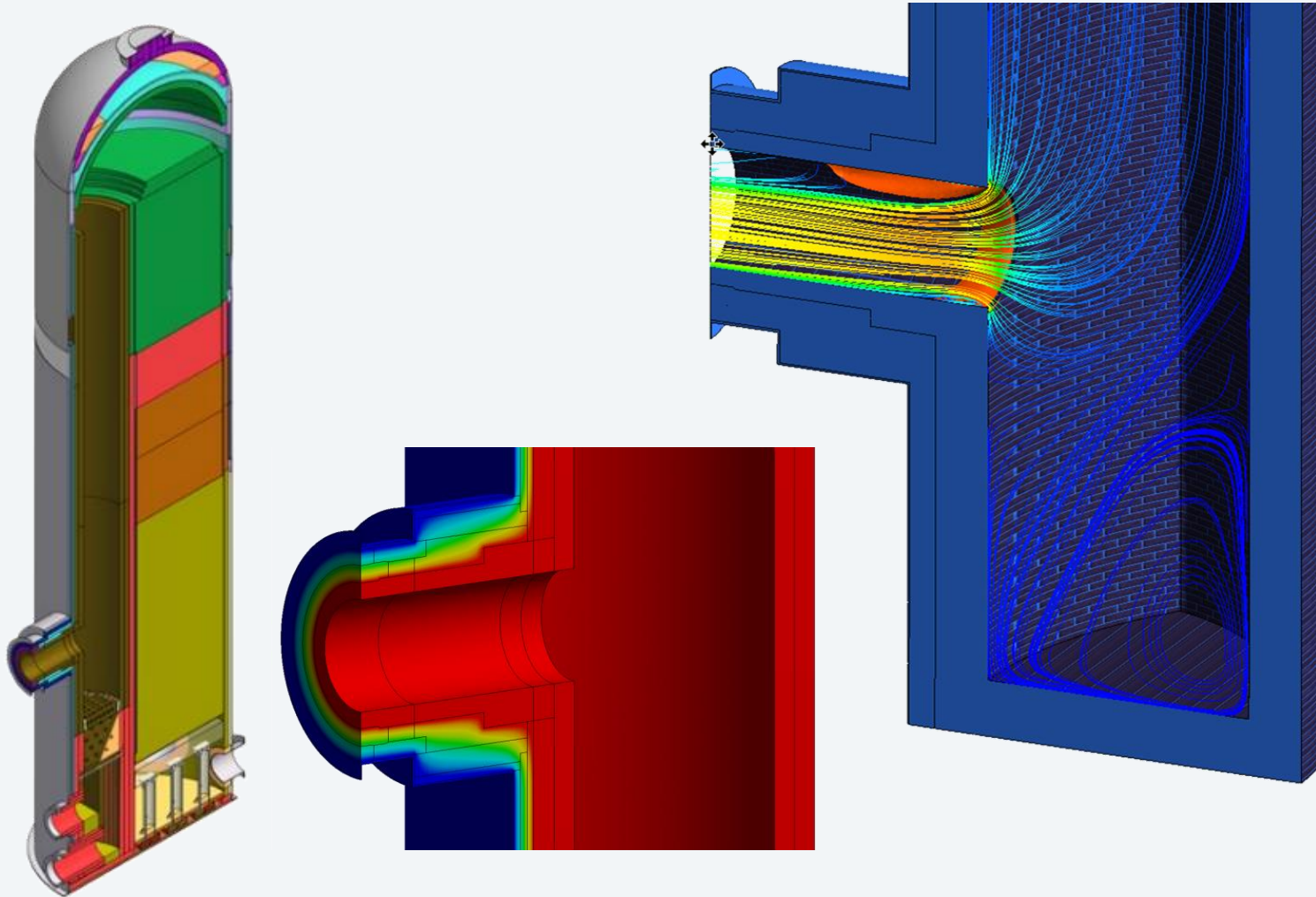


CONTEXT & OBJECTIVES

- Multiple Assessments acc. to FKM Guideline
- Static and Fatigue Assessment
- Base Material
- Bolted Joints
- Welded Joints
- TOOLS: ANSYS

► Assessment of press frame according to customer targets

Example of CFD & Heat Transfer Hot Blast Stove



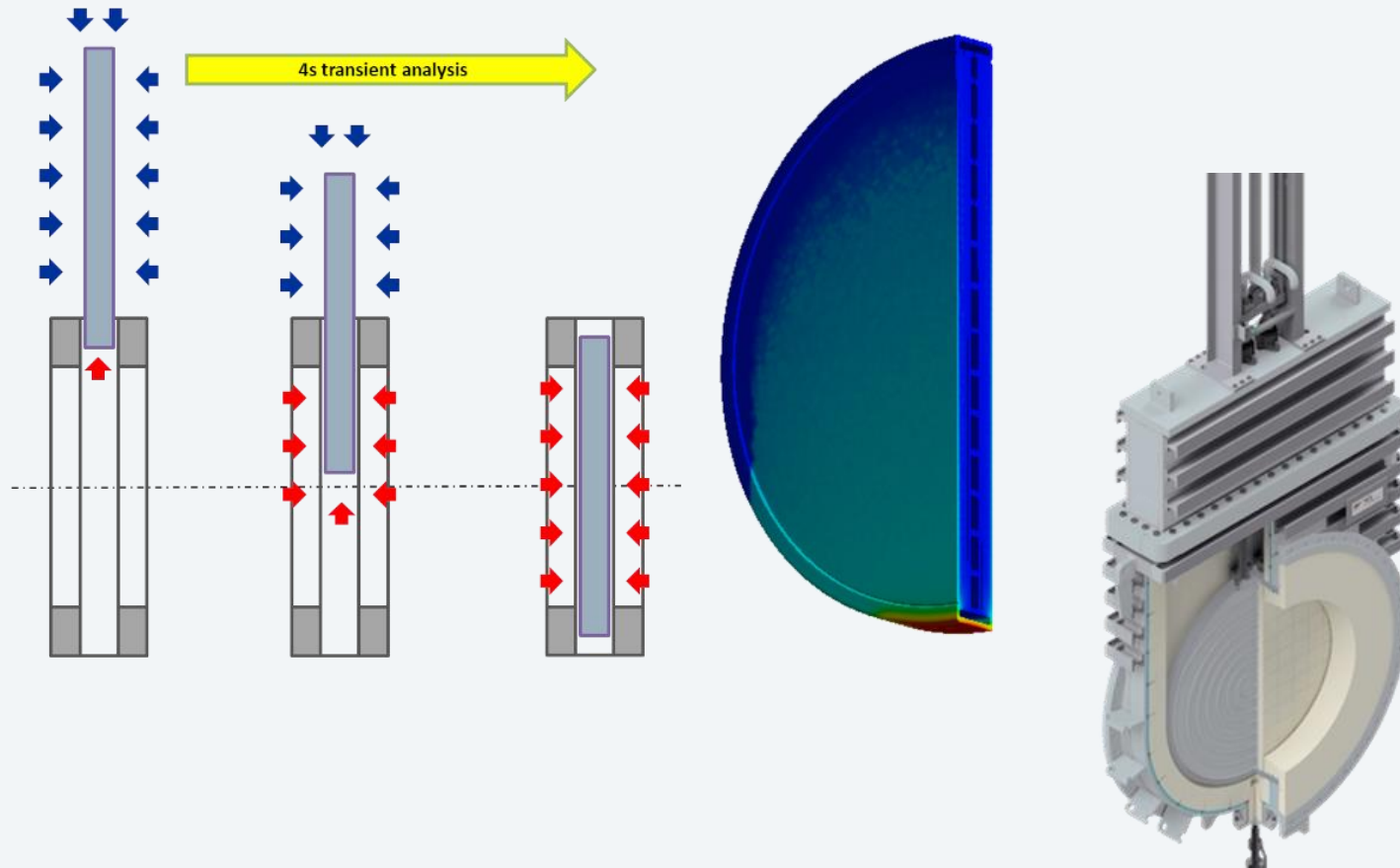
CONTEXT & OBJECTIVES

- Conjugate Heat Transfer Analysis
- Unsteady CFD
- Flow separation
- Optimization of outlet channel
- TOOLS: ANSYS CFX, Ansys WB

► CFD and Heat Transfer Analyses (CHT) – Optimization of Outlet Channel

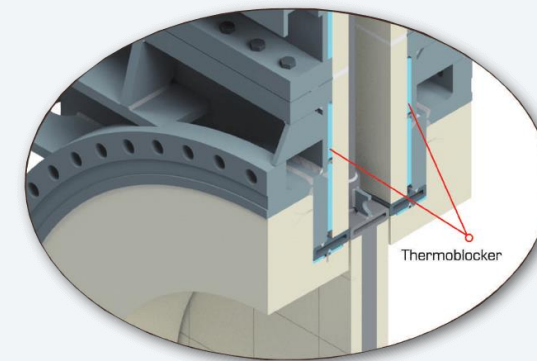
Example of Heat Transfer Analysis

Failure Analysis for Hot Blast Valve of Blast Furnace



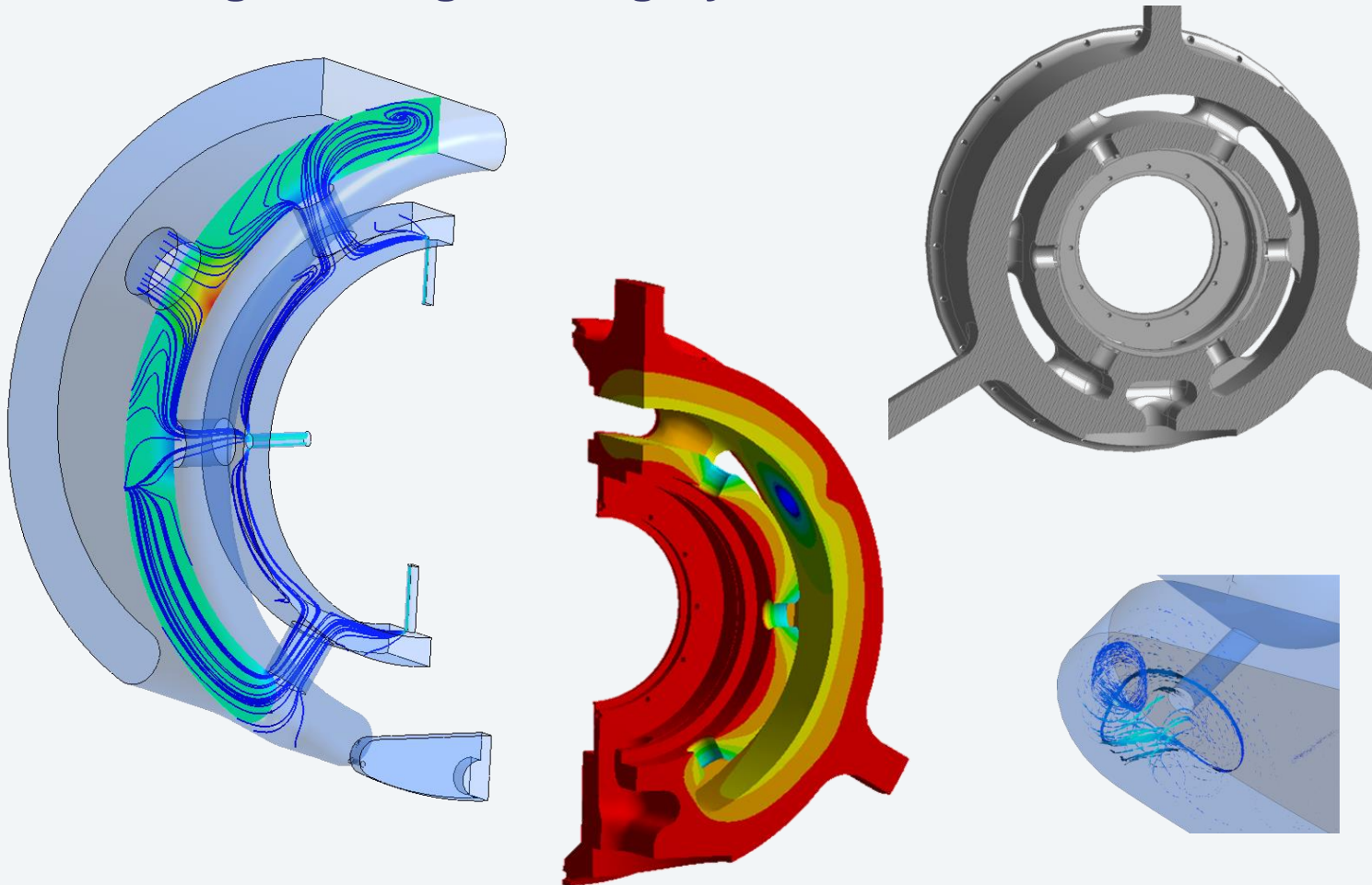
CONTEXT & OBJECTIVES

- Steady-state and transient heat transfer-Analyses
- Simulation of closing process
- Simulation of disposition in cooling channel
- LCF Life Estimate
- Simulation of Cooling Failure



► Hot Blast Valve - supporting crack findings cause analysis

Example of CFD & Heat Transfer Bearing Housing Cooling System



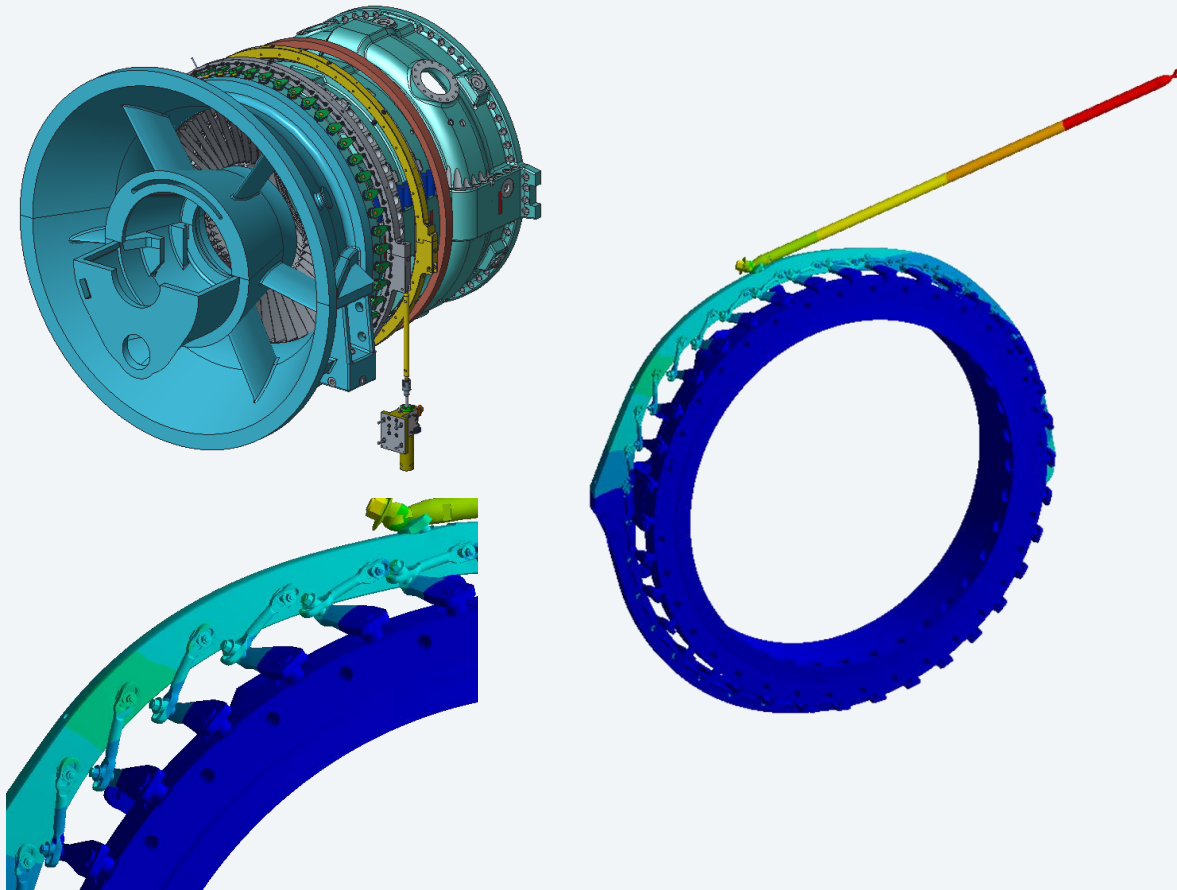
CONTEXT & OBJECTIVES

- CFD Analysis of Bearing Housing
- Oil heating-up
- Structural Analysis of Bearing Housing
- Sensitivity
- Deformations
- TOOLS: ANSYS CFX, Ansys WB

► Oil temperature has been predicted to prevent oil cocking

Example of **multi-body** System Analysis

Analysis of Actuation System of Gas Turbine



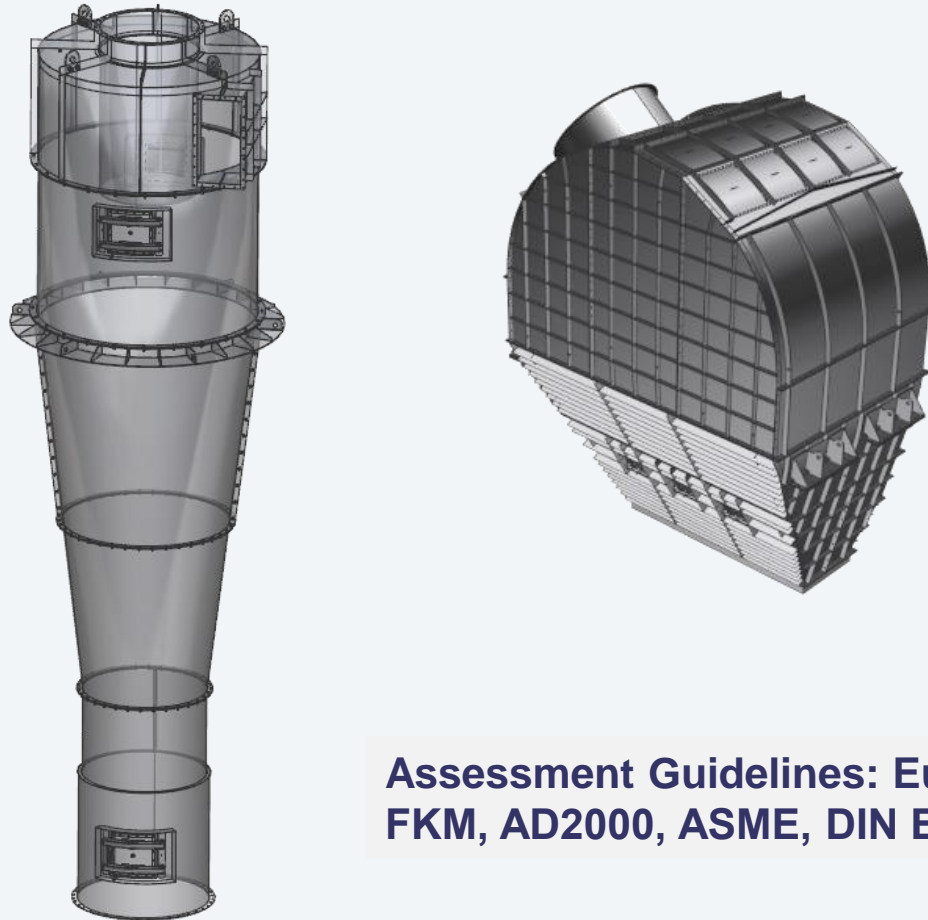
CONTEXT & OBJECTIVES

- Structural Integrity, Failure Load Cases
- Actuator Capacity Check – Power Increase
- Material Change – Cost Saving
- Kinematics
- HCF Analysis
- Buckling Analysis
- Bolted Joints
- Deformations, angle deviations
- TOOLS: CREO, ANSYS

► **Design & analysis of Actuation System – Harmonization for all Frames, Cost Reduction**

Analysis of thin-wall Metal Constructions

Example of FE-Analyses for Plant Construction



Assessment Guidelines: Eurocode, FKM, AD2000, ASME, DIN EN 13445,...

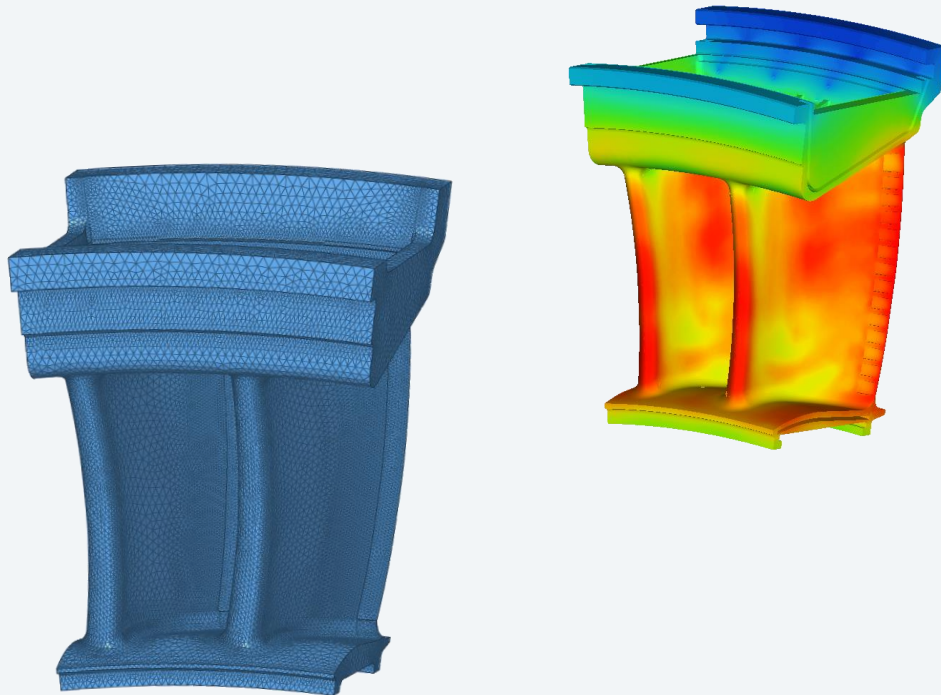
CONTEXT & OBJECTIVES

- Multiple projects with Assessments acc.
- Structural Integrity, Failure Load Cases
- Non-linear dynamics
- Fatigue Assessment
- Buckling
- Spectrum (Earthquake)
- Bolted Joints
- Welded Joints
- Deformations, deviations
- Geometry modifications to meet design targets
- TOOLS: ANSYS, LS-Dyna

► **Numerous Load Cases: Explosion, Assembly, Earthquake, Wind, Buckling**

Example of Creep, TMF

Turbine Vane full-Service MI-Support from Concept to Casting Release

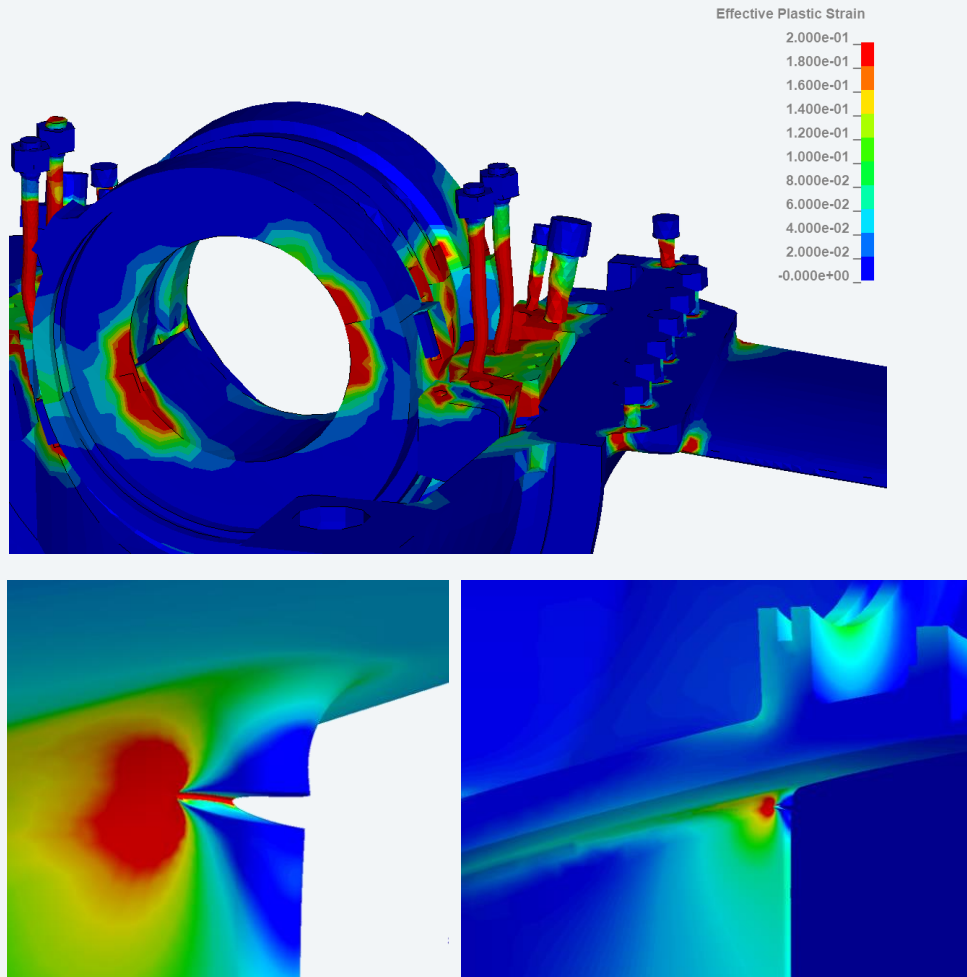


CONTEXT & OBJECTIVES

- Thermal & Structural Analysis (Abaqus)
- Design Sensitivity - Morphing (Hypermesh)
- Creep (user-defined Fortran Routine)
- TMF (incl. creep)
- Fracture Mechanics
- Oxidation
- Interface analysis (seal strips)
- Review Package (Report)
- Review verbal Presentation, Discussion
- TOOLS: ABAQUS, HYPERMESH, ANSYS, NASGRO, FRANC3D

► Turbine Vane has been successfully developed and released

Example of **Explicit Dynamic Simulation & Smart Crack Growth** Turbine Vane full-Service MI-Support from Concept to Casting Release



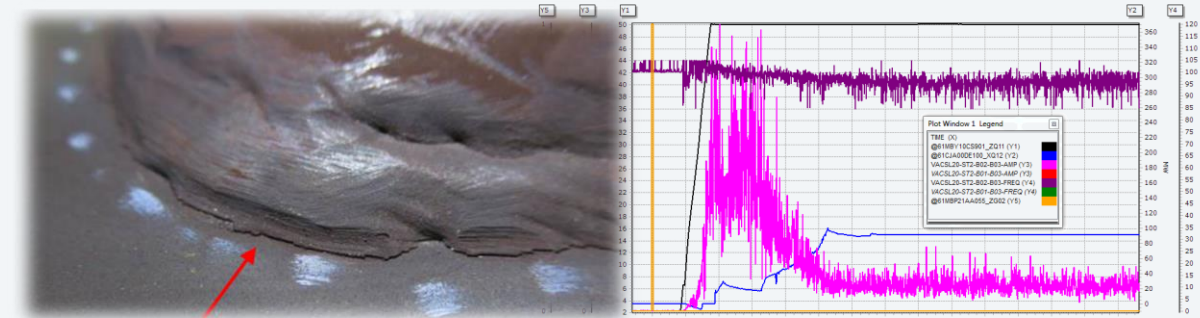
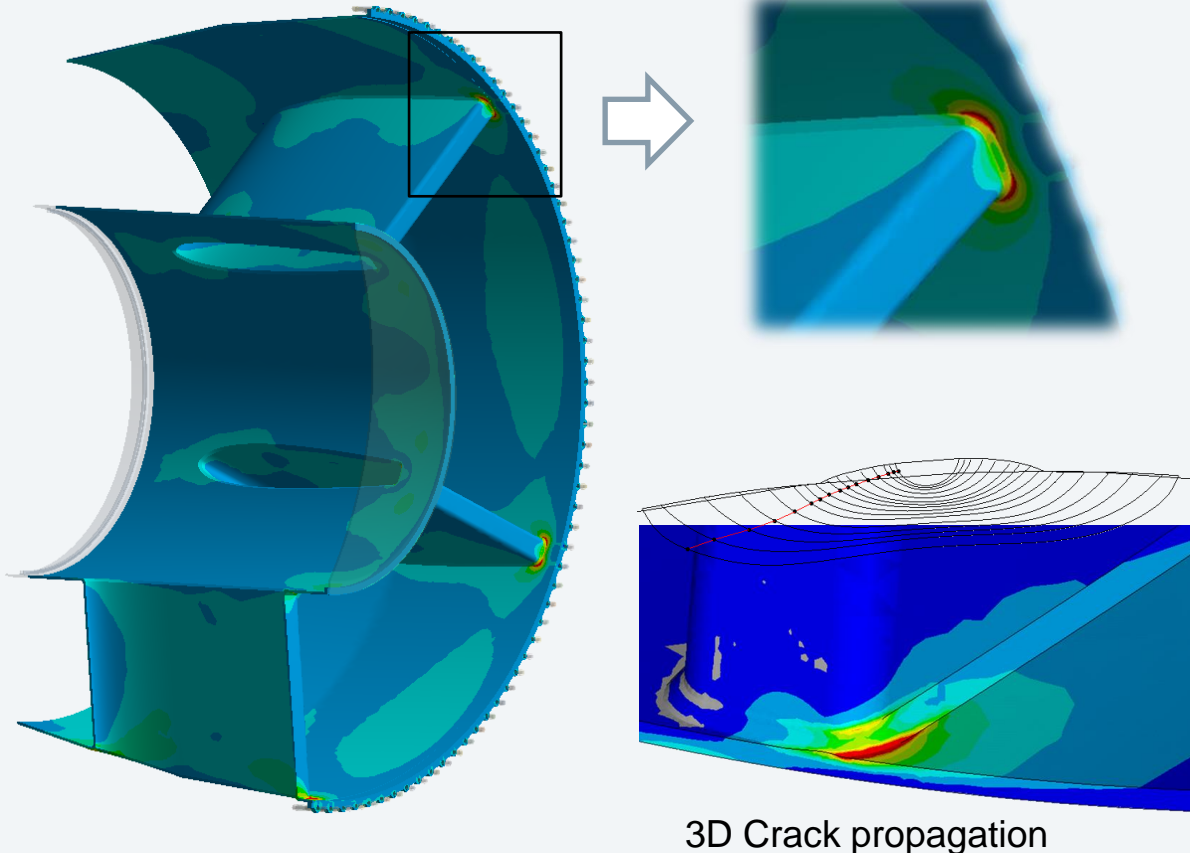
CONTEXT & OBJECTIVES

- Simulation of Bearing housing Failure
- Highly non-linear Analysis
- Impact and large plasticity
- Full dynamics incl. natural frequencies
- 3D Crack Growth
- TOOLS: LS-DYNA, ANSYS

► Integrity safety has been analytically predicted

Example of Failure Analysis

Exhaust Cracking - Root Cause Analysis Support

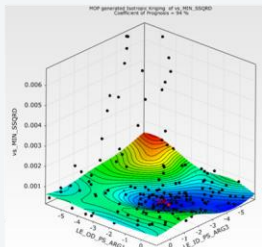
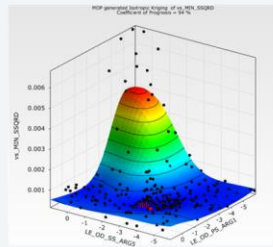
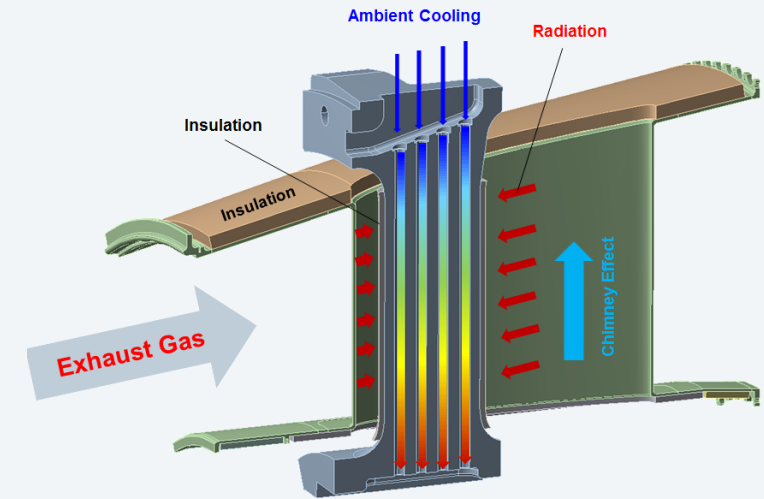
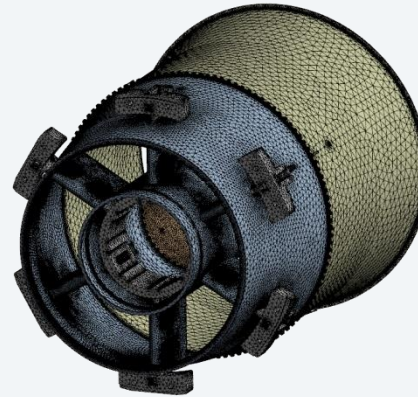
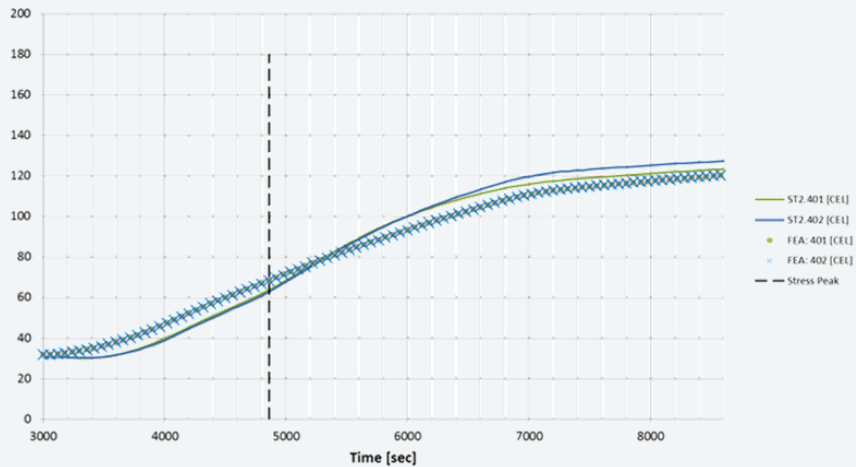


CONTEXT & OBJECTIVES

- Analysis of Test Data (Accelerations, Strain, Temperatures)
- BC Calibration on Test Data (Heat Transfer)
- Transient thermal & structural Analyses
- LCF Analysis (calibrated) for welded joints
- Modal & Harmonic Response Analysis
- HCF Analysis (based on calibrated Bump Test, HRA)
- Fracture Mechanics (Crack Growth)
- TOOLS: ANSYS, OPTISLANG, IMC FAMOS, NASGRO, FRANC3D

► Root Cause Analysis of Weld Cracking / Mitigation Solution / Implementation / Testing / Validation

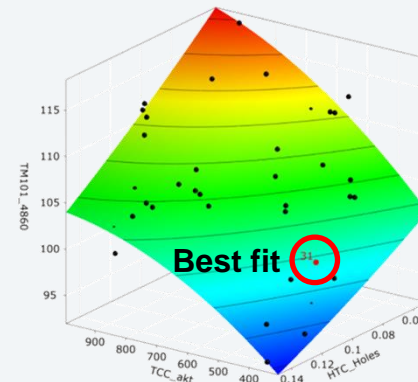
Example of Calibration of FE-Analyses on the Measurement Data Cooling of Turbine Exhaust



Parameter	Value	Value	Value	Value	Value
LE_PS_ARG1	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG2	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG3	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG4	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG5	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG6	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG7	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG8	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG9	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG10	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG11	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG12	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG13	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG14	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG15	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG16	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG17	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG18	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG19	0.000	0.000	0.000	0.000	0.000
LE_PS_ARG20	0.000	0.000	0.000	0.000	0.000

advanced Latin Hypercube Sampling

Best fit from DOE: Parameters:
 LE_OD_PS_ARG1: -1.63
 LE_OD_PS_ARG3: -2.83
 LE_OD_SS_ARG5: -2.97
 LE_OD_SS_ARG7: -0.035



← Less important

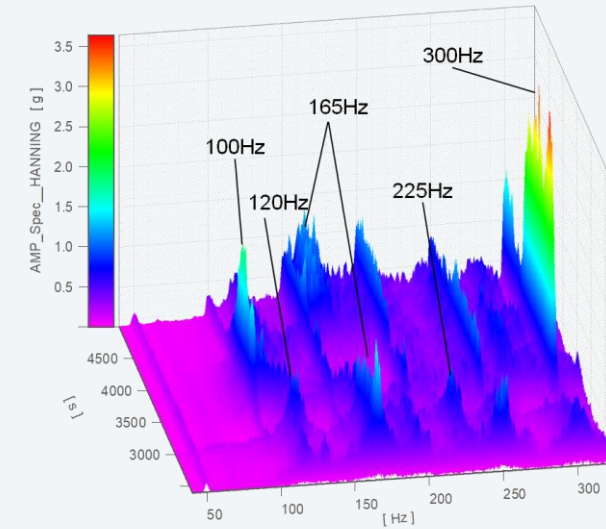
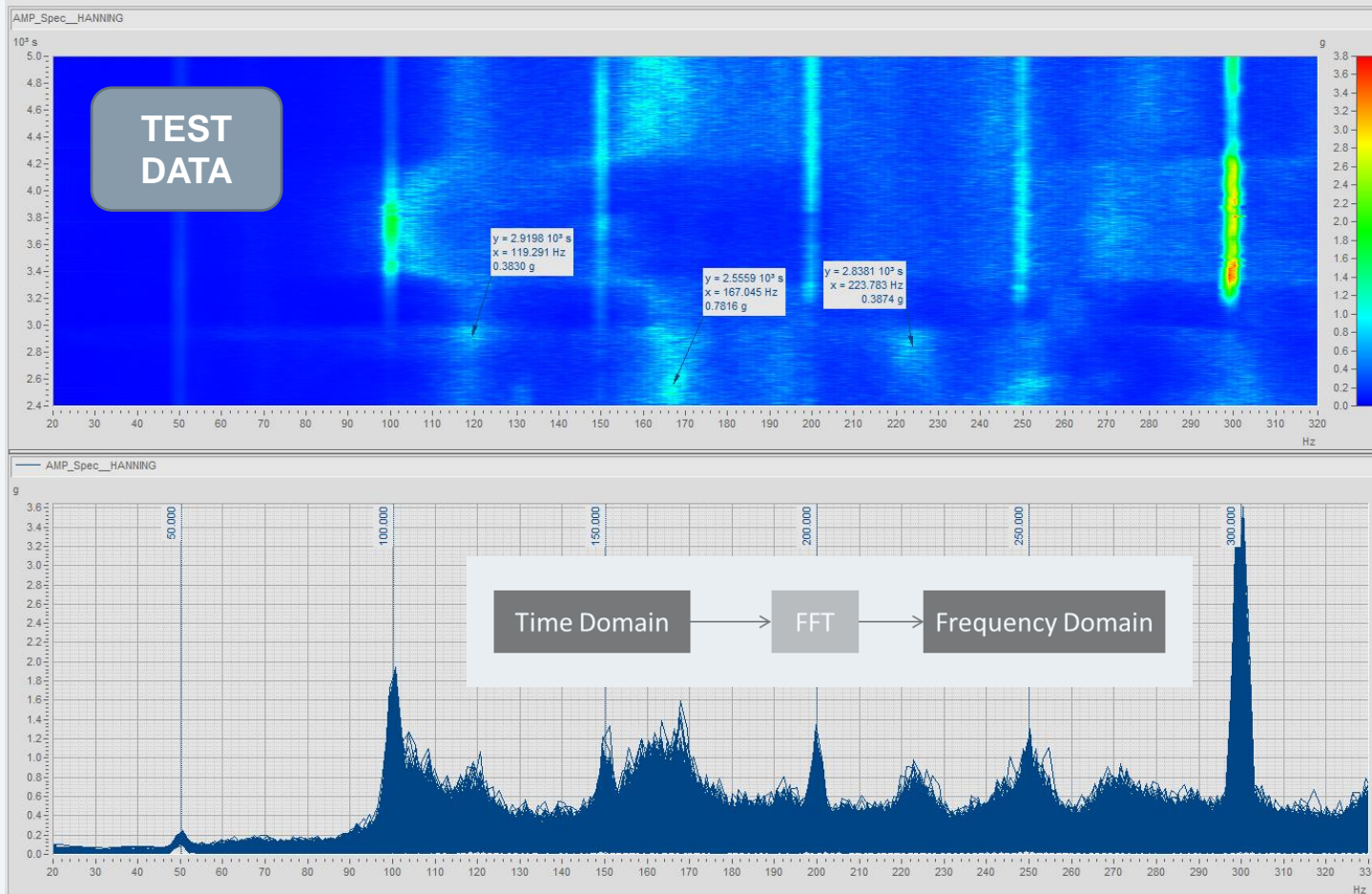
← Important

CONTEXT & OBJECTIVES

- Post-processing of temperature data
- Post-processing of vibration data
- Transient temperature calibration / LCF
- Strain amplitude calibration / HCF
- Transient Calibration: ±10K fit
- TOOLS: ANSYS, OPTISLANG

► Calibration of Heat Transfer FE-Analyses on the Measurement Data – Improvement of Life Prediction

Example of Test Data Evaluation Exhaust Liner Vibration

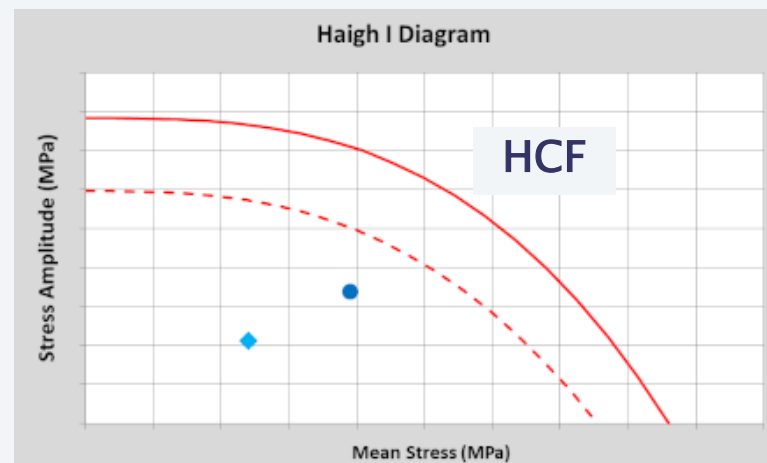
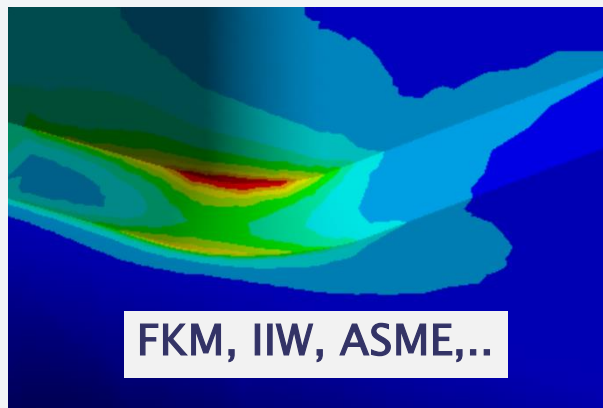
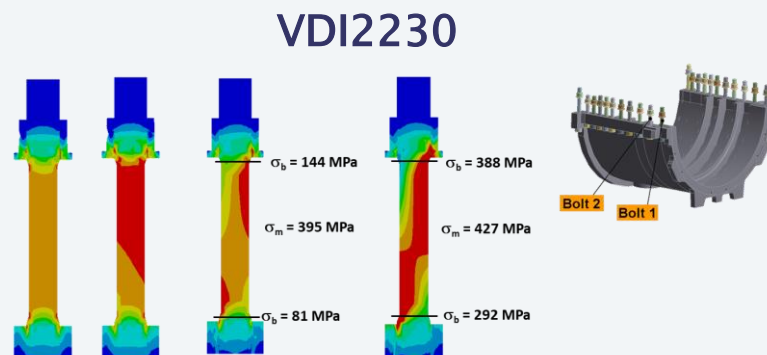
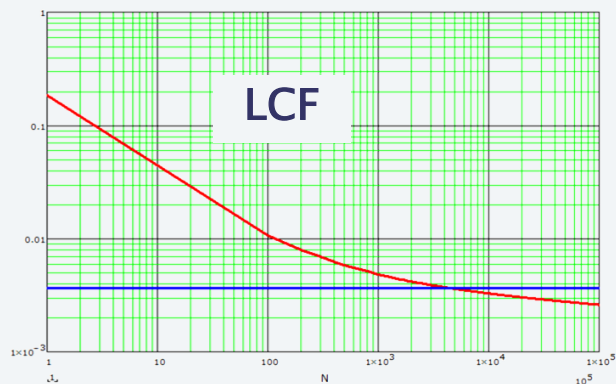


CONTEXT & OBJECTIVES

- Post-processing of raw ACC data
- FFT (IMC FAMOS)
- Verification of modal FEA
- HCF based on scaled Modal shapes
- TOOLS: ANSYS, IMC FAMOS

► Cracking risk assessment based on the vibration test data

Assessments for Joints



CONTEXT & OBJECTIVES

- Numerous methods and approaches for Joint assessments due to working with different customers/countries
- Tools experience
- Guidelines & Standards
- Experience in creation of internal Manuals & Guidelines (e.g. LCF, fracture mechanics)
- Many studies, use-cases, service feedbacks,...

► High amount of different Assessment Methods for Joints, Codes, thumb rules,...