BLACKBIRD FOR TRAINING

Advanced Rotordynamics and Machinery Analysis Training Course



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Introduction:

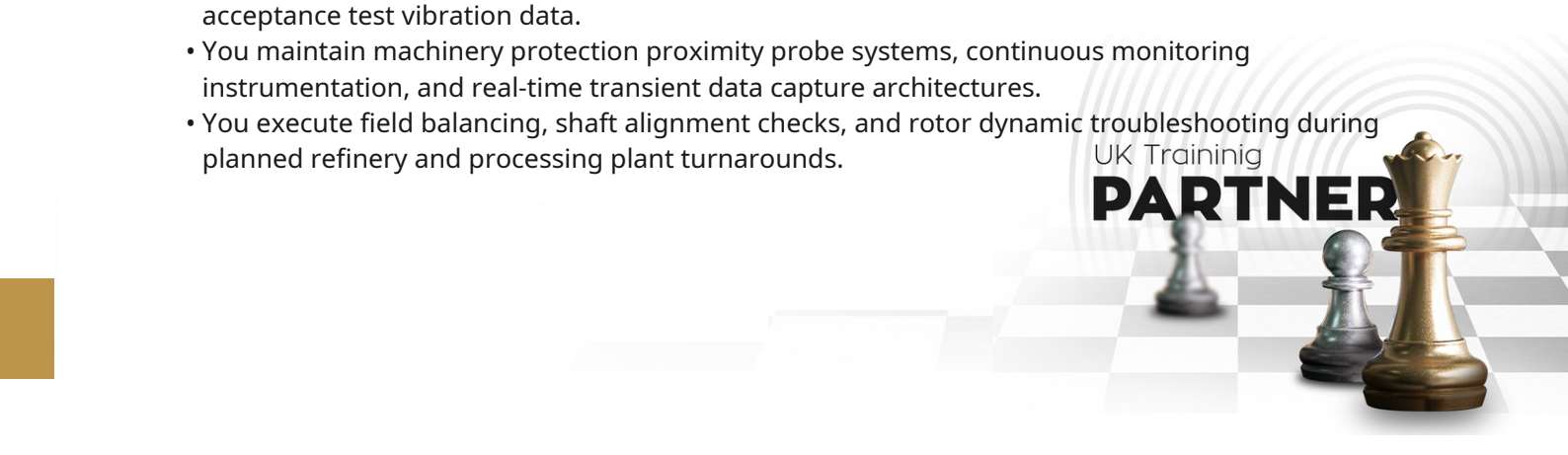
This Advanced Rotordynamics and Machinery Analysis Training Course equips you to model rotor-bearing system dynamics, diagnose complex vibration mechanisms, and evaluate turbomachinery stability across one week. You will build a complete Turbomachinery Rotordynamic Analysis and Vibration Verification Dossier containing lateral beam models, fluid-film bearing stiffness matrices, Campbell diagrams, and unbalance response evaluations. You need prior field experience in rotating machinery diagnostics, mechanical design, or vibration analysis, as this expert-level course examines advanced numerical formulations and machine dynamics. You will practise through an iterative modelling build, configuring numerical rotor models, calculating stability margins, and validating machinery response.

Course Objectives:

- Build lumped-mass beam finite element rotor models using transfer matrix methods for critical speed identification on plant turbomachinery trains.
- Map fluid-film bearing stiffness and damping coefficients using hydrodynamic Reynolds equation solvers for journal bearing stability calculations.
- Run damped lateral natural frequency simulations using Campbell diagrams to evaluate operational separation margins and amplification factors.
- Test unbalance response sensitivities using API Standard 617 mechanical running limits to evaluate peak-to-peak shaft displacement thresholds.
- Score subsynchronous stability logarithmic decrements using cross-coupled aerodynamic excitation models to prevent compressor rotor whip.
- Draft multi-plane dynamic balancing correction protocols using influence coefficient methods to resolve residual vibration on flexible shafts.

Target Audience:

- You calculate rotor critical speeds, bearing dynamic properties, and torsional natural frequencies for high-speed turbomachinery trains.
- You diagnose high vibration events, shaft centerline movement, and subsynchronous instability in critical process gas compressors and steam turbines.
- You verify rotating equipment procurement specifications, rotor dynamics design audits, and factory acceptance test vibration data.
- You maintain machinery protection proximity probe systems, continuous monitoring instrumentation, and real-time transient data capture architectures.
- You execute field balancing, shaft alignment checks, and rotor dynamic troubleshooting during planned refinery and processing plant turnarounds.



Course Outline:

Day 1: Formulating Lumped-Mass Rotor Models and Critical Speeds

- Discretising shaft geometry using lumped-mass finite element beam formulations
- Calculating undamped critical speeds using transfer matrix method algorithms
- Characterising gyroscopic effects using rigid disc polar inertia equations
- Measuring shaft runout vectors using API Standard 670 procedures
- Build: Lumped-Mass Rotor Model and Undamped Critical Speed Map

Day 2: Evaluating Hydrodynamic Bearing Dynamics and System Criticals

- Calculating journal dynamic coefficients using fluid-film hydrodynamic bearing solvers
- Assessing tilting-pad pivot stiffness using linearized Reynolds lubrication equations
- Plotting operational speed maps using Campbell diagrams per API TR 684-1
- Verifying critical speed separation margins using API Standard 617 criteria
- Build: Hydrodynamic Bearing Dynamic Coefficient Matrix and Campbell Diagram

Day 3: Simulating Forced Unbalance Response and Orbit Diagnostics

- Locating unbalance distribution weights using ISO 21940 rotor grade standards
- Computing forced response amplitudes using damped unbalance numerical solvers
- Extracting rotor amplification factors using Bode and Nyquist response plots
- Interpreting shaft vibration orbits using dual-probe API Standard 670 configurations
- Build: Unbalance Response Verification Model and Probe Orbit Profile

Day 4: Assessing Rotordynamic Stability and Aerodynamic Cross-Coupling

- Quantifying subsynchronous destabilising forces using Wachel and Alford equations
- Calculating logarithmic decrements using lateral stability damped eigenvalue algorithms
- Evaluating annular seal stiffness coefficients using hole-pattern damper formulations
- Formulating multi-plane trim corrections using influence coefficient balancing matrices
- Build: Aerodynamic Cross-Coupling Threshold and Seal Stability Assessment

Day 5: Completing the Turbomachinery Dynamic Verification Modelling Build

- Consolidating shaft models using numerical rotordynamic finite element engines
- Validating lateral vibration limits using ISO 20816-3:2022 severity vibration thresholds
- Simulating drive train torsional frequencies using transient motor start models
- Benchmarking test run vibration data against shop running limits
- Build: Turbomachinery Rotordynamic Analysis and Vibration Verification Dossier



Skills You Will Gain:

- Lumped-Mass Finite Element Rotor Modelling
- Fluid-Film Bearing Dynamic Coefficient Calculation
- Campbell Diagram Separation Margin Verification
- Forced Unbalance Response Simulation
- Subsynchronous Rotor Stability Assessment
- Annular Pressure Damper Seal Evaluation
- Influence Coefficient Multi-Plane Rotor Balancing
- Machinery Protection Proximity Probe Orbit Analysis

Why Attend This Course:

- Formulate numerical rotor models to determine critical speeds and evaluate operational stability margins before machinery commissioning.
- Calculate bearing stiffness and damping matrices to select optimum journal geometry and eliminate oil whirl risks.
- Analyse shaft centerline orbits and cascade spectra to diagnose misalignment, rub, and unbalance faults on operating machinery.
- Deliver a verified Turbomachinery Rotordynamic Analysis and Vibration Verification Dossier to audit vendor dynamic reports and validate factory acceptance tests.

Conclusion:

Returning to your desk, you will open your Turbomachinery Rotordynamic Analysis and Vibration Verification Dossier to benchmark your operational turbomachinery dynamic models against API Standard 617 and API TR 684-1 criteria. You will present the lateral critical speed maps, bearing coefficient matrices, and stability assessment logs to your plant engineering manager and machinery reliability team for formal technical review. Following its initial deployment during machinery vibration audits, you will check field shaft displacement amplitudes against model predictions to verify that rotor response stays within design thresholds.

Frequently Asked Questions FAQ:

What will you be able to do after the Advanced Rotordynamics and Machinery Analysis Training Course?

You will be able to construct finite element rotor models, calculate hydrodynamic bearing coefficients, verify separation margins on Campbell diagrams, and evaluate lateral stability margins. You can also evaluate forced unbalance response and diagnose subsynchronous vibration faults using proximity probe orbit analysis on critical turbomachinery.



What do you need to know before starting the Advanced Rotordynamics and Machinery Analysis Training Course?

You need practical working knowledge of rotating machinery mechanics, basic vibration spectrum analysis, and plant turbomachinery operation. Prior familiarity with bearing arrangements, shaft dynamics, and engineering math is essential, as this expert-level course focuses on advanced numerical rotor-bearing modelling and lateral stability calculations.

What deliverable do you build during the Advanced Rotordynamics and Machinery Analysis Training Course?

You build a Turbomachinery Rotordynamic Analysis and Vibration Verification Dossier. This package includes lumped-mass beam models, undamped critical speed maps, bearing dynamic coefficient matrices, Campbell diagrams, forced unbalance response evaluations, and aerodynamic stability screening worksheets aligned with API and ISO standards.

How does the Advanced Rotordynamics and Machinery Analysis Training Course differ from a general vibration analysis course?

This course develops predictive numerical rotor dynamic modeling and lateral stability engineering rather than routine casing vibration monitoring. Instead of focusing merely on overall velocity spectrum thresholds, you calculate bearing cross-coupled coefficients, model flexible rotor unbalance response, and verify design separation margins against industry specifications.

