

Rotordynamics and Machinery Dynamics Training Course

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Overview

The Rotordynamics and Machinery Dynamics Training Course is a one-week course for rotating equipment engineers, vibration specialists, and mechanical reliability professionals who leave with an actionable rotordynamics evaluation dossier to stabilize turbomachinery trains. Undiagnosed subsynchronous vibration, fluid-film instability, and torsional resonance cause mechanical failures and costly production downtime in high-energy turbomachinery trains. This course resolves these challenges through rigorous critical speed calculation, unbalance response simulation, orbit analysis, and standard compliance. Agile Leaders Training Center delivers the Rotordynamics and Machinery Dynamics Training Course.

Who Should Attend

- Machinery reliability engineers responsible for monitoring turbomachinery health and troubleshooting chronic shaft vibration.
- Rotating equipment specialists evaluating vendor rotordynamic design audits, Campbell diagrams, and lateral stability margins.
- Condition monitoring analysts interpreting relative shaft displacement, orbit trajectories, and full-spectrum vibration signatures.
- Mechanical maintenance supervisors managing rotor balancing, bearing alignment, and overhaul quality verification.
- Plant asset engineers designing machinery protection transducer layouts and trip settings for critical process equipment.

The course assumes participants actively evaluate rotating machinery vibration spectra and fluid-film bearing arrangements, and it leaves out general shop fitting and basic rolling element lubrication tasks.

Departments and Industries

The course draws operational cases from heavy continuous processing and critical mechanical power generation sectors.

- Oil and gas processing facilities
- Petrochemical and chemical refining plants
- Thermal and combined-cycle power generation stations
- Industrial gas manufacturing and cryogenic plants
- Water transmission and large pumping stations

Learning Objectives

By the end of this course, participants will be able to:

- Evaluate undamped critical speed maps and Campbell diagrams to identify operational speed separation margins.
- Analyze lateral unbalance response curves and amplification factors in accordance with API RP 684 criteria.
- Diagnose fluid-film bearing instability mechanisms including oil whirl, oil whip, and the Morton Effect.
- Calculate cross-coupled aerodynamic stiffness coefficients and logarithmic decrements per API Standard 617 rules.
- Prioritize sensor configurations and probe separation angles per API Standard 670 machinery protection standards.
- Formulate rotor balancing correction weights using ISO 21940-11 multi-plane balancing methods.

Course Agenda

Day 1: Lateral Rotordynamics and Critical Speed Mapping

- Rigid and flexible rotor behavior classification using ISO 21940-11 and ISO 21940-12 criteria
- Undamped critical speed map generation and mode shape evaluation using XLRotor and Dyrobes models
- Gyroscopic stiffening effects and bearing support flexibility impacts on critical speed locations
- Separation margin and amplification factor calculation according to API RP 684 standards
- Campbell diagram construction for identification of forward and backward whirl excitation modes

Day 2: Fluid-Film Bearings, Seals, and Dynamic Stability

- Hydrodynamic fluid-film bearing stiffness and damping matrix calculation for tilting-pad designs
- Oil whirl and oil whip diagnostic methodologies using shaft centerline plots and orbit analysis
- Annular gas seal dynamic coefficients: hole pattern, labyrinth, and honeycomb seal modeling
- Aerodynamic cross-coupling forces and API Standard 617 Level 1 and Level 2 stability analysis
- Differential journal heating and thermal instability mitigation using Morton Effect screening methods

Day 3: Torsional Dynamics and Electromechanical Interaction

- Lumped-parameter mass-elastic modeling for multi-body turbomachinery shaft trains
- Torsional natural frequency calculation and Campbell diagram evaluation for gear and motor trains
- Variable frequency drive harmonic excitation and torsional-lateral electromechanical resonance analysis
- Transient start-up torque simulation and compressor trip stress evaluations using RBTS software
- Torsional vibration measurement techniques using phase reference probes and zebra tape encoders

Day 4: Machinery Diagnostics and Protection Instrumentation

- Radial shaft vibration probe orientation and nodal point avoidance under API Standard 670 guidelines
- Relative shaft displacement and casing absolute vibration evaluation under ISO 20816-1:2016 and ISO 20816-2:2017
- Transient run-up and coast-down analysis using Bode plots, Nyquist polar plots, and cascade waterlines
- Full-spectrum and orbit shape evaluation for misalignment and internal rub identification using Bently Nevada System 1
- Alarm and emergency trip boundary setting methodologies for critical turbomachinery protection

Day 5: Practical Dynamic Modeling and Vibration Diagnosis

- Suggested activity: Model an unbalance response and evaluate separation margins in Dyrobes for a multi-stage compressor
- Suggested activity: Audit an API Standard 617 vendor rotordynamic stability report for a high-pressure re-injection train
- Suggested activity: Diagnose fluid-induced instability and bearing clearance faults using Bently Nevada System 1 orbit plots
- Suggested activity: Calculate multi-plane balance correction weights for a flexible rotor using ISO 21940-12 procedures
- Capstone exercise: Formulate an integrated rotordynamics evaluation dossier resolving subsynchronous vibration on a process train

Practical Exercises

The course uses computational rotor models, transient vibration data packages, and machinery design reports.

- Suggested activity: Model a multi-stage compressor shaft in rotordynamics software to calculate critical speeds and amplification factors.
- Suggested activity: Audit an API Standard 617 Level 2 stability report to verify logarithmic decrement and seal effects.
- Suggested activity: Interpret filtered orbits, shaft centerlines, and Bode plots to diagnose hydrodynamic bearing instabilities.
- Suggested activity: Calculate two-plane balancing solution vectors to reduce synchronous residual unbalance.

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FAQs

Who suits the Rotordynamics and Machinery Dynamics Training Course?

The Rotordynamics and Machinery Dynamics Training Course suits machinery engineers, vibration specialists, and maintenance professionals. The course assumes working knowledge of basic vibration spectrum analysis and turbomachinery operation, leaving out entry-level technician tasks and basic mechanical assembly.

How does this course differ from general vibration analysis training?

General vibration analysis courses emphasize basic overall velocity measurements and rolling element bearing faults on standard equipment. This course focuses specifically on lateral rotordynamics, fluid-film hydrodynamic bearing behavior, torsional modeling, aerodynamic cross-coupling, and API standard compliance for critical turbomachinery.

Which standards are applied during the Rotordynamics and Machinery Dynamics Training Course?

The course applies API RP 684, API Standard 617, API Standard 670, and API Standard 610, alongside international vibration evaluation standards ISO 20816-1:2016, ISO 20816-2:2017, and balancing guidelines ISO 21940-11 and ISO 21940-12.

What modeling tools are examined in the Rotordynamics and Machinery Dynamics Training Course?

The course demonstrates engineering workflows using rotordynamics modeling software packages such as Dyrobes, XLRotor, and RBTS, as well as condition monitoring diagnostic platforms including Bently Nevada System 1 for orbit and transient analysis.

Conclusion

Participants return to their organizations equipped with an actionable rotordynamics evaluation dossier and machinery diagnostic toolkit. This technical asset enables engineering teams to verify manufacturer rotordynamic design reports, eliminate subsynchronous instability, and optimize machinery protection boundaries. Reliability specialists immediately deploy these simulation and diagnostic methods to protect high-energy turbomachinery from catastrophic failure.

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