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Vibration Problems & Solutions for Pumps and Other Turbomachines

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Abstract

This course presents analysis and testing methods for pumps and turbomachinery. Focus is on centrifugal pumps of all types, centrifugal compressors, axial compressors, fans, steam turbines, and gas turbines. Rotordynamics and bladed disk vibration are included as modules as well as discussion of fluid-induced vibration (e.g. rotating stall and blade pass frequencies), acoustics, and mechanically induced vibration (imbalance misalignment, rubs, looseness). Troubleshooting methods and fixes are discussed with many detailed case histories.

Turbomachinery Vibration Basics

- Internals & Problems of Major Types of Turbomachinery
  - Gas Turbines
  - Steam Turbines
  - Axial and Centrifugal Compressors
  - Horizontal and Vertical Pumps
- Effects of Operating Point: Turbomachinery vs. System
- Off-Design Flow Pulsation & Vibration: Surge, Stall, Recirculation
- Inlet Conditions as Vibration Excitation
- Rotordynamics & Structural Dynamics of Casing/ Foundation
- Bladed Disk Vibration
- Vibration Specs
- Test Instrumentation & Procedures
- Case Histories & Animations of Problems

Turbomachinery Operation for "Good Vibrations"

- **Rule # 1:** Match Design Point to System Head & Flow Requirements
- **Rule # 2:** For Pumps, Require NPSHA Above NPSHR, with Margin
- **Rule # 3:** Use a Long Straight Piping Run to the Inlet
- **Rule # 4:** Careful When & How You Throttle
- **Rule # 5:** Avoid H-Q Slopes Being Similar, Machine vs. System
- **Rule # 6:** Minimize Nozzle Loads & Use Expansion Joint Tie Rods
- **Rule # 7:** Avoid Structural Natural Frequencies & Rotor Criticals
- **Rule # 8:** Minimize Load Cycling, if Practical
- **Rule # 9:** Select Materials Based on Corrosion, Galling, Fatigue & Erosion Resistance
- **Rule # 10:** You Get What You Spec & Pay For