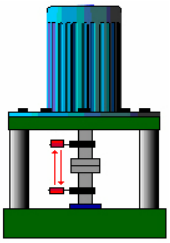

MECH-301:
Advanced Precision Shaft Alignment

Abstract

At every industrial facility, there exist unusually difficult shaft alignment tasks, often on machines commonly called “bad actors.” Unfortunately, these bad actors are typically machines that are critical to facility operations. When they are shutdown because of catastrophic failure or excessive vibration, much too often the entire line, system, or facility in which they operate is also shutdown ...costing dearly in lost production, parts, labor, etc.

The fact that shaft misalignment is the largest contributing factor to premature machinery failure has been emphasized in recent years. As a result, alignment tools and alignment training, along with the “precision maintenance movement,” have improved significantly. Yet, certain machines continue to either run poorly or fail prematurely due to misalignment. Why?

Certain alignment tasks are simply not suited to beginners or those who perform alignment on an infrequent basis. Effectively dealing with the changes in shaft position that occur between static (not operating) and dynamic (operating) conditions due to thermal growth, pipe strain, e.g. requires a different mindset; we’re NOT shooting for zero-zero alignment, but something else. Questions and answers regarding the subject of dynamic movement such as “how to measure it” and “how to compensate for it” aren’t that difficult; they are just not suited to the beginner.

Another alignment subject of frequent debate centers around vertical machines. Vertical machine shaft alignment is a subject of many misconceptions, with many arguments and thoughts that vertical machine alignment is NOT necessary. This subject will be dealt with in a detailed manner, including vertical machine inspections and alignment procedures using dial indicator and laser alignment methods. Hands-on vertical alignment will be performed.

This seminar provides solutions to such “complex” alignment tasks. Included in the curriculum are also procedures and techniques for efficient alignment of multiple machine trains such as turbine-generator and compressor sets, alignment of machines with vertical shafts, proactive solutions for dealing with bolt-bound and base-bound problems, as well as an advanced look at soft foot, base problems, and the adverse effects of machine frame distortion.

Detailed procedures on each subject, a minimum of 50% hands-on activities, and the how-to’s specific to certain alignment methods/instruments make this seminar truly unique. Application of generic seminar content to the rim-face dial indicator method, reverse dial indicator method, Optalign® laser, Combi®laser, Rotalign®, Fixturlaser Shaft 100 and Shaft 200®, Hamar®, etc. is provided.

Knowledge and experience with shaft alignment basics, such as that provided in Universal Technologies’ “Precision Shaft Alignment: Dial Indicators and/or Laser Methods” live seminars is a strongly recommended prerequisite. For those who question whether or not the level of course

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content is appropriate for certain individuals, Universal Technologies will provide alignment competency and knowledge assessment tools upon request.

Seminar Duration

The duration of this seminar ranges from 24 to 32 hours depending on client preference, worker availability, and the attendees' backgrounds.

Who should attend?

This seminar is designed primarily for maintenance, engineering, technical support and management personnel whose job functions involve alignment of rotating machinery. The scope of content is appropriate for those who align machines, those who detect, investigate and resolve premature machinery failure problems due to misalignment, as well as those who direct activities relative to alignment and machinery reliability.

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Associated Task(s)

1. Align two or more coupled horizontal or vertical rotating machinery shafts to specified tolerances using specific dial indicator and/or laser alignment system(s), including proper planning, rough and precision alignment per approved procedure.

2. Resolve complex alignment problems, including one or more of the following conditions:
   A. Base-bound/bolt-bound conditions
   B. Multiple machine sets/trains
   C. Dynamic Movement due to thermal growth, pipe strain, etc.

Seminar Objectives

Upon completion of this training the student will be able to properly:

1. Explain fundamental alignment concepts and basic dial indicator and/or laser alignment processes for horizontal machines.

2. Resolve machine foundation, machine frame, and soft foot problems.

3. Explain and demonstrate how to find the optimum alternate moves when base-bound or bolt-bound conditions are encountered while trying to move a horizontal machine.

4. Explain and demonstrate how to find optimum moves during alignment of three or more machines in a set/train.

5. Explain the general effects of dynamic movement on alignment processes and machine operation.

6. Explain and demonstrate how to compensate for dynamic movement during alignment tasks on horizontal machines subject to thermal growth, pipe strain, etc.

7. Perform alignment tasks on vertical machines using dial indicator and/or laser alignment systems.

8. Evaluate symptoms of complex alignment tasks and generate potential causes and solutions for typical alignment problems.

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Seminar Outline

1.0 Introduction
- 1.1 Seminar Overview, Objectives, and Schedule
- 1.2 Maximizing Machinery Reliability

2.0 Alignment Fundamentals Review
- 2.1 Importance of Precision Alignment
- 2.2 Shaft Alignment and Misalignment Overview
- 2.3 Overview of Alignment Processes
- 2.4 Pre-alignment Considerations
- 2.5 Foundation, Machine Frame, and Foot Plane Problems
- 2.6 Overview of Alignment Methods
- 2.7 Alignment Fundamentals Activities & Critique

3.0 Dial Indicator/Laser Systems Alignment Processes Review
- 3.1 Proper Use of Dial Indicators for Alignment
- 3.2 Rim-Face Alignment Process Review
- 3.3 Reverse Dial Alignment Process Review
- 3.4 Laser Systems Alignment Process Review
- 3.5 Zero-Zero Alignment Hands-on Activities & Critique

4.0 Advanced and Special Alignment Processes
- 4.1 Foundation, Machine Frame, and Foot Plane Problems
  - A. Overview of Common Problems
  - B. Soft Foot Analysis
  - C. Proactive Solutions
- 4.2 Base-bound and Bolt-bound Problems
  - A. Overview of Common Problems
  - B. Proactive Solutions
- 4.3 Alignment of Multiple Machine Sets/Trains
  - A. Overview of Common Processes and Problems
  - B. Proactive Train Alignment Procedures
- 4.4 Considerations for Dynamic Movement
  - A. Static vs. Dynamic Alignment Overview
  - B. Determining the Amount of Dynamic Movement
  - C. Determination of Target Offsets/Angles
  - D. Dynamic Movement Alignment Procedures
- 4.5 Precision Alignment of Vertical Shafts
  - A. Common Assumptions and Misconceptions
  - B. Critical Inspections on Vertical Machines
  - C. Rim-Face Vertical Shaft Alignment Procedures
  - D. Reverse Dial Vertical Shaft Alignment Procedures
  - E. Laser Systems Vertical Shaft Alignment Procedures
  - F. Vertical Shaft Alignment Troubleshooting
  - G. Vertical Shaft Alignment Hands-on Activities & Critique

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