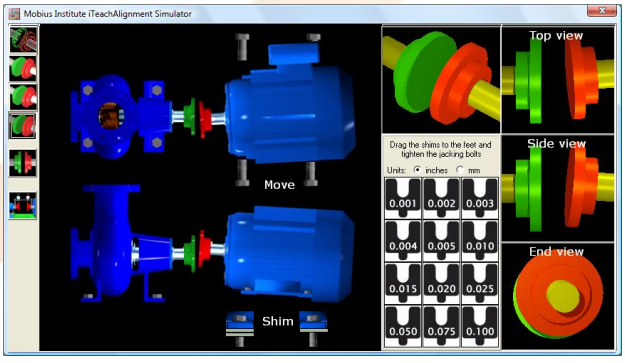
Precision Shaft Alignment: Master Class

Machines that have been precision aligned run longer, use less energy and cost less to operate. Vibration caused by misalignment greatly reduces the life of bearings, seals, shafts and couplings. This computer-based training program will equip you with the knowledge and skills to use a dial indicator tool or laser alignment system to precisely align two components. Using our step-by-step training system on your computer, you will learn how to recognize misalignment and successfully set up the alignment job, perform the alignment and move the machine.

After reviewing the important reasons for performing shaft alignment, we will discuss the pre-alignment checks and corrections, including how to identify and correct soft foot. We start with the operation of dial indicators, and cover the rim-face and reverse-dial methods. Importantly, we explain and demonstrate the process, and will teach you how the calculations must be performed.

Laser alignment systems have greatly improved the ease of precision alignment; we will discuss the benefits, basic theory of operation, and tips and techniques for successful use. Finally we discuss how to move the machine and deal with all the problems that you are bound to encounter at some stage. We will also review how to deal with thermal growth, and how to approach a larger machine train.

The Mobius Way

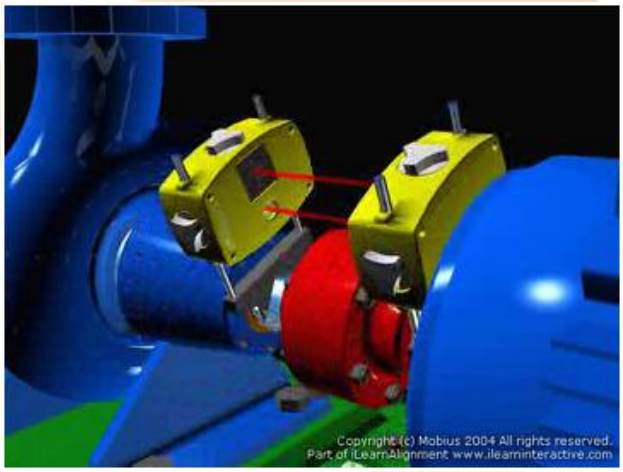


Mobius makes alignment training unique. We use 3D animations and software simulators that completely demystify and demonstrate the alignment process – you will see the machine from all angles and be able to fully visualize and understand the effects of misalignment and the three dimensional nature of moving and aligning the machine. You will completely understand the readings and the three-dimensional alignment process. With over 1,000 slides, the slides are fully narrated and illustrated and contain the text. The course is broken up into sections, so you can take the sections you want in any order. We also include quizzes throughout to let you test your knowledge as you go.

If you have previously performed shaft alignment, you will find that all of those steps and instructions will suddenly make a whole lot of sense – you will find yourself saying 'Ah, now I understand" or "I wish I took this course years ago".

If you align machines, you need this course. If you have a modern laser alignment system you have two choices: you can just set up the lasers, enter the dimensions, take the readings and do what the equipment tells you to do – or you can understand what you are doing, anticipate problems and complete any alignment job successfully. We will ensure you understand the entire process, and give you the skills to perform precision alignment. We can't explain the operation of every model of laser alignment system because of the fast evolution of products, but we will provide you with the knowledge so that you will be successful with whatever model you own.

While our training covers all of the essential procedures, and is filled with valuable tips and tricks, one of the greatest benefits is that our training will help people understand misalignment. We have developed over 50 3D animations that demonstrate procedures, explain how things work, and clarify confusing concepts.



Who Should Attend?

If you have to align machines, then you need this course. If you own a modern laser alignment system you have two choices: you can just set up the lasers, enter the dimensions, take the readings and do what the equipment tells you to do, or you can understand what you are doing and be prepared when things go wrong – and they will. We will ensure you understand the entire process, and give you the skills to return to the plant and perform precision alignment. Note:

Although we will not have time to explain the operation of every model of laser alignment system, we will provide you with the knowledge so that you will be successful with whatever model you own.

Course Description

Course Duration: 2 days, topics include:

Introduction to Shaft Alignment

- The benefits of shaft alignment
- Quick overview of the alignment process

What is Misalignment?

- What is misalignment?
- A closer look at misalignment
- Shaft fatigue
- Even bent shafts have rotational centerlines
- Offset and angular misalignment
- Alignment conventions
- Specifying misalignment
- Using feet corrections to specify misalignment
- Using Total Indicator Readings to specify the misalignment
- Using offset and angularity to specify alignment targets
- Angularity targets
- Visualizing tolerance
- Tolerances and speed
- Spacer couplings (jack shafts) conventions and tolerances
- Published tolerances
- Dynamic movement

Pre-Alignment checks and soft foot

- Pre-alignment tasks

Determining the alignment state

- Determining the alignment state
- Using a straightedge or feeler gauge
- Using Dial Indicators
- The Rim and Face method
- The Reverse Dial method
- Dial indicator limitations

Laser alignment systems

- Laser alignment systems
- Moving the machine
- Moving the machine vertically - shimming
- Moving the machine laterally
- Summary

Shaft Alignment Mathematics - Offset, angularity and alignment mathematics

- Introduction
- Equal triangles
- Triangles and alignment
- A triangle from two offsets
- Dealing with negative numbers

Understanding Dial Indicators

- Introduction
- What can go wrong?
- Zero the dial
- Bar sag
- Total Indicator Readings (TIR)
- Hysteresis
- Clock positions
- Backlash
- Why do we rotate both shafts?

Using Dial Indicators for Shaft Alignment

- Introduction
- Rim measurements
- Face measurements
- Axial end-play and float
- Repeat all tests
- Validity rule

Pre-Alignment Checks and Corrections

- Introduction
- Plan and review maintenance history
- Why is the machine not aligned?
- Installing a new machine
- Decide on the required tolerance and coupling gap
- Pipe strain
- Mechanical looseness
- Bent shafts and coupling runout
- General preparations on site: Safety
- General preparations on site: Clean up
- General preparations on site: Shims

- General preparations on site: Jacking bolts

Soft Foot Checks and Corrections

- Introduction
- Different types of soft foot
- Rocking soft foot
- Short foot - parallel air gap
- Even foot
- High foot
- Bent foot
- Squishy foot
- Induced soft foot

Why is soft foot important?

- Why is soft foot important?
- Shaft fatigue
- Bearing distortion
- Impact on the alignment task

Testing for soft foot

- Testing for soft foot
- Taking soft foot measurements
- Recording results
- Using dial indicators to measure soft foot

Correcting soft foot

- Correcting rocking soft foot
- Short cut number one: The Casanova method
- Short cut number two: The 80% Rule
- Using feeler gauges
- Using a "stair" of shims
- More complex shim patterns
- Detecting and correcting induced soft foot
- Mysterious soft foot
- Summary

The Rim-Face Dial Indicator method

- Introduction

- What if only one shaft can be rotated?
- Accuracy issues
- Setup problems
- Axial end-float
- Rim-Face Measurement Procedure
- Compensate for bar sag
- Alternative method
- Determine the alignment corrections
- Performing the calculations
- Computing the offset
- Computing the angularity
- Computing feet movements
- Shim calculations
- Move calculations
- Example calculations
- The graphical method
- Summary

The Reverse-Dial Method

- Introduction
- Reverse dial procedure
- Compensate for bar sag
- Performing the calculations
- Computing the offset
- Computing the angularity
- Computing feet movements
- Shim and move calculations
- An example
- Example:
- The graphical method
- Summary
- Alternative method

Laser Alignment

- Introduction
- The basic components in a laser alignment system

- Benefits of laser alignment systems over dial indicators
- How do laser alignment systems work?
- Using a Prism - Return Beam Method
- Beam Splitter - Single Beam Method
- Twin Emitter/Detector Pairs - Dual Beam Method
- Using a horizontal beam and a vertical detector

Using the laser alignment system

- Performing the laser alignment
- Pre-alignment
- Preparing the coupling
- Attaching the brackets
- Attach the brackets
- Check the optics
- Mount the laser heads
- Aim the heads
- Zeroing the beam
- Check for repeatability
- Rough alignment ("roughing-in")
- Correcting gross angularity
- Correcting gross parallel offset
- Dealing with gross misalignment
- Rough alignment with a laser system
- Dealing with distance and angularity
- Cones and circles and distance
- Enter the machine dimensions
- How accurate should the dimensions be?
- Entering the coupling diameter

Performing laser alignment measurements

- Performing the measurements
- The 3:00-12:00-9:00 method
- Swept measurements
- Getting the results
- Aligning spacer shafts or jackshafts
- What if you can't rotate one shaft?
- What if the shaft can't be rotated easily?

- What if you can't rotate either shaft?
- Limitations of laser systems
- Backlash
- Vibration
- Heat, steam, sunlight, water vapor
- General comment about commercial systems

Moving the Machine

- Introduction
- Perform the vertical move first
- Gross misalignment
- Using a laser alignment system
- Moving the machine vertically - shimming
- Base bound and bolt bound
- Base bound
- Machine the feet
- Moving the machine horizontally
- Using a dial indicator to measure the horizontal move
- Using shims to measure horizontal machine moves
- Bolt bound
- Turn-down the bolts
- Open the bolt holes of the machine feet
- Moving the stationary machine
- Drill new holes

Dynamic and Thermal Movement

- Introduction
- Which machines will be affected?
- Thermal effects
- Manufacturer's supplied offsets
- Sources of heat
- Internal or system sources of heat
- External sources of heat
- Mechanical effects
- Pipe strain
- Oil wedges

- Jacking fluid
- Catenary sag
- Foundation changes

Dealing with Dynamic Movements

- Temperature compensation
- Take 'hot' readings
- Monitoring the movement of the shaft or bearings
- Using laser heads to measure relative movement
- Issues to consider
- General issues to consider
- What do you do with the offset data?
- Manufacturer's offset data
- Determining targets graphically
- Summary

Machine Train Alignment

- Introduction
- Repeat your measurements
- Plan ahead
- Graphical method
- Optimizing the alignment
- Movement limitations
- Move in the vertical direction first
- Summary

Hands-on Training

- Time will be spent hands-on performing shaft alignment jobs