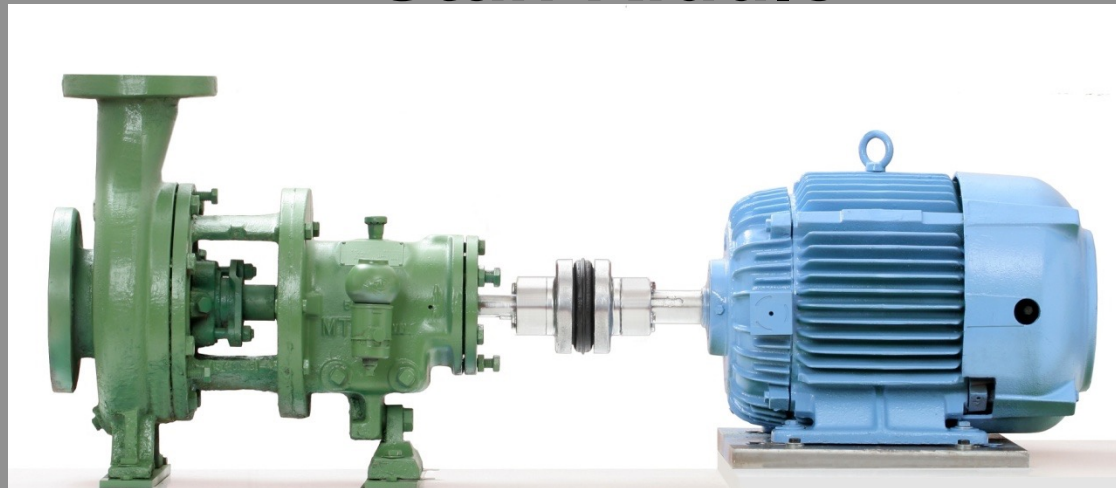
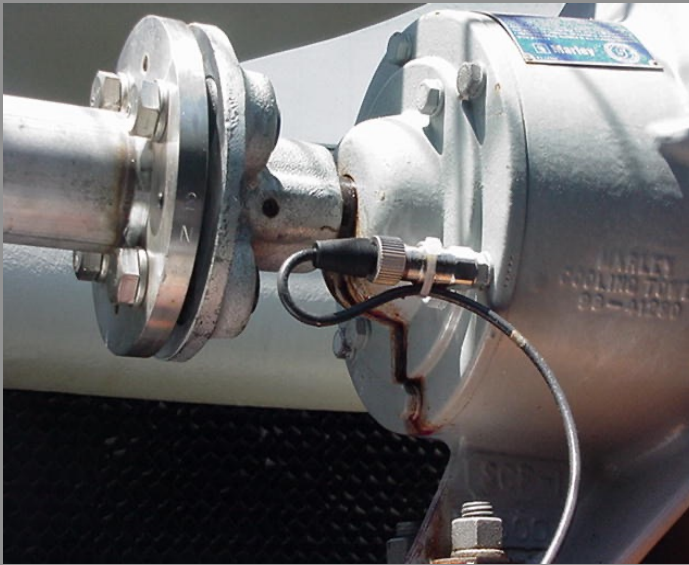

Pre-alignment: How 15 Minutes Can Save You \$\$\$\$\$\$ Stan Riddle



What is coupling alignment?

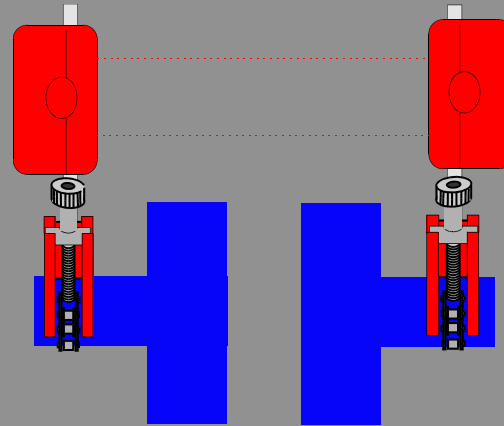
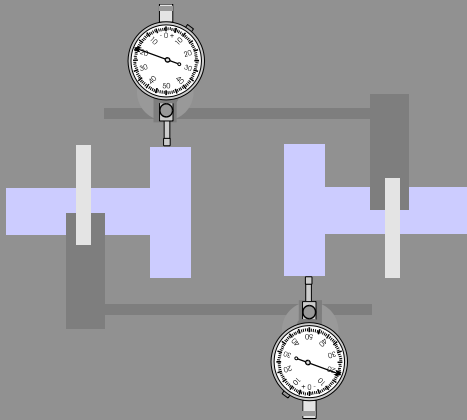
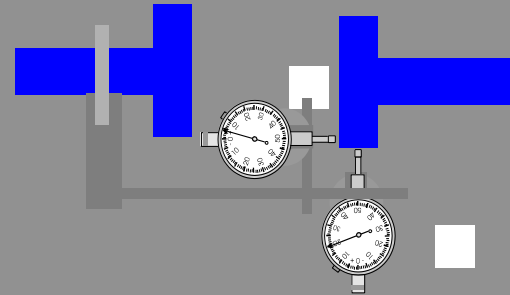
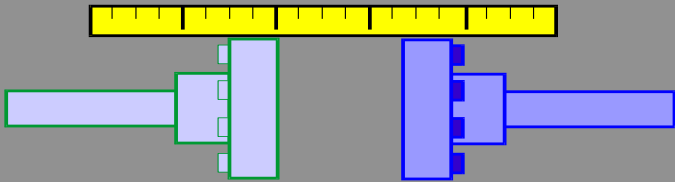


- **Coupling alignment is shaft alignment. If the shafts are aligned, the couplings will normally go along for the ride.**

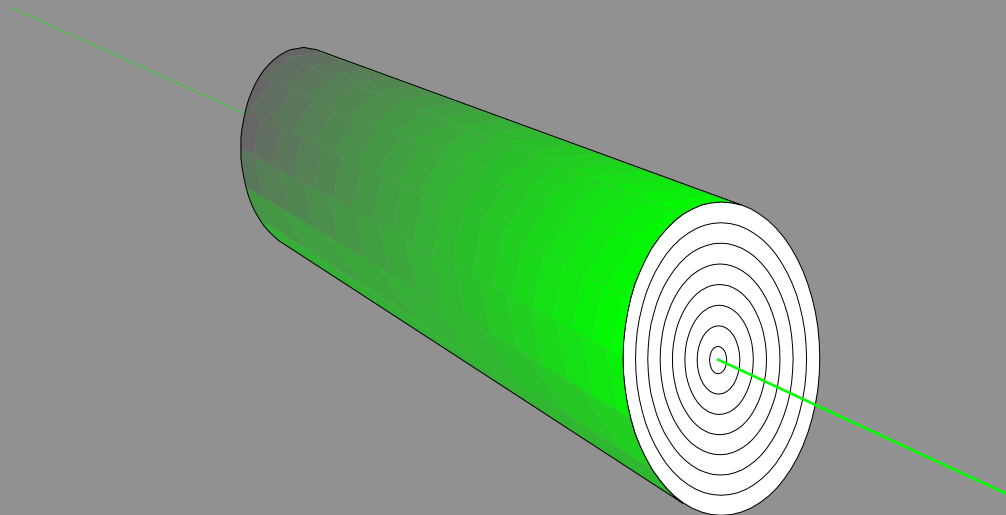
Types of Couplings

- **Rigid** – usually must be aligned to very close tolerances. Think of it as solidly bolting one shaft to another.
- **Flexible** – uses one or more elements to connect the shafts.
 - Mechanical
 - Elastomeric
 - MetallicThese can tolerate slightly more misalignment, thermal changes, and shock.

Shaft Alignment

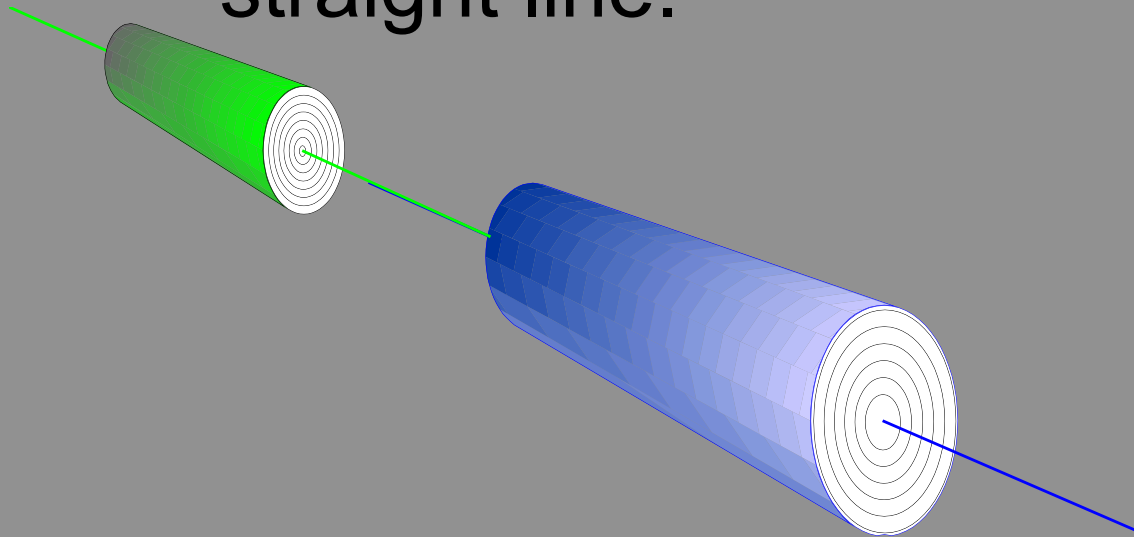


Every shaft, bent or straight, rotates about an axis that forms a straight line.

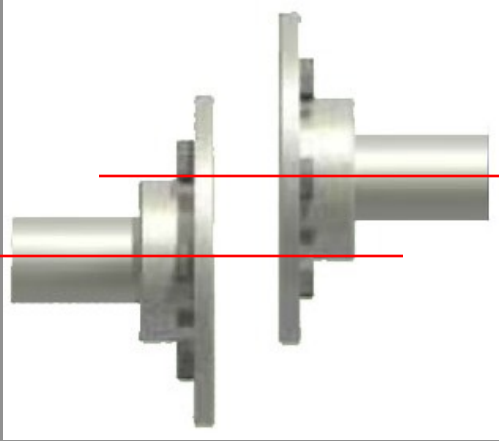


Co-linearity

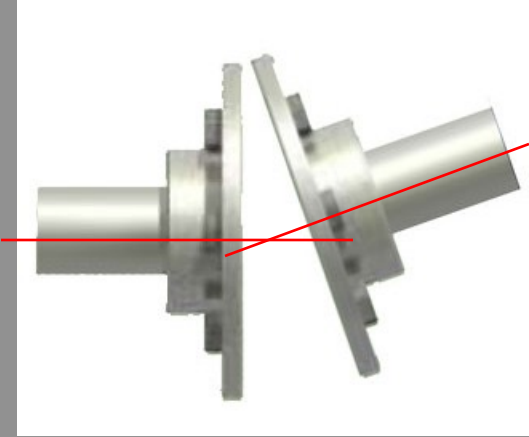
Shafts in this same straight line are considered co-linear, or in the same straight line.



Types of Misalignment



Offset, or Parallel – the shafts are parallel to each other, but are not coplanar, or in the same plane. This can be both vertical and horizontal.

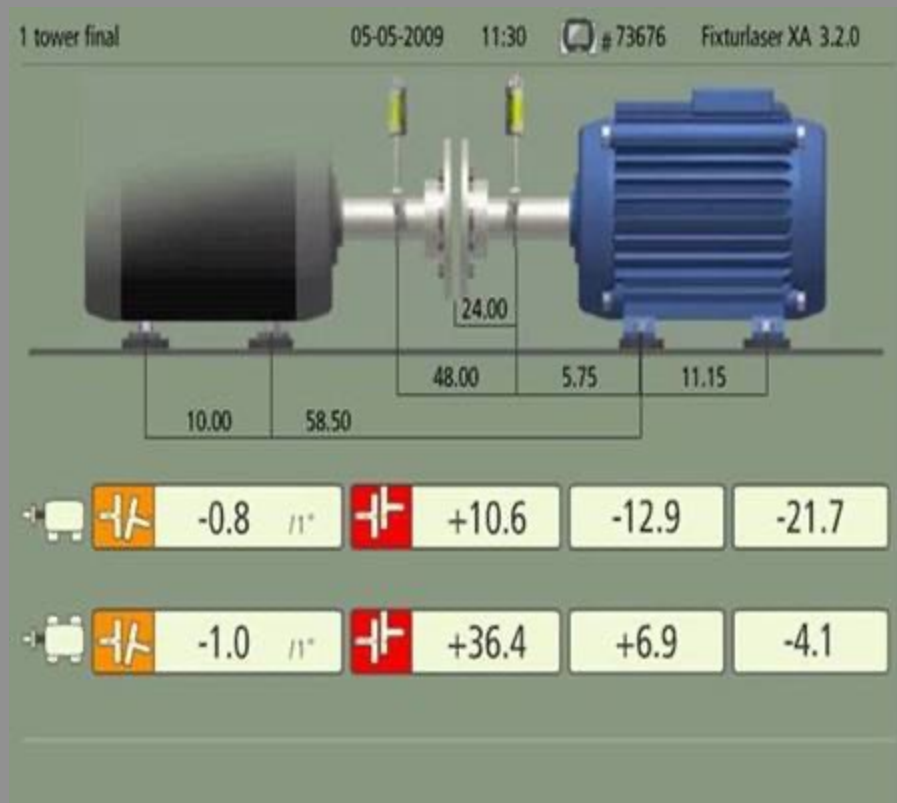


Angular – the shafts are not in the same plane, which causes a difference in measurement between measurements made 180 degrees opposite on the coupling faces.

It's almost always a combination of both!

Measurement Conventions

- **Offset or Parallel Misalignment** is measured in thousandths of an inch (0.000”), also called mils.
- **Angular Misalignment** is measured in thousandths of an inch (0.000”), or mils, per inch of coupling diameter.



Pre-alignment Steps

15 minutes or so of preparation time can save you hours, and dollars, in alignment costs.

It can also save you a lot of unnecessary work

The following slides list some of the most common errors made both before, and during, shaft alignment.

Error #1

ASSUMPTIONS AND THE LACK OF OBSERVATION

Example



Assumptions

- **NEVER ASSUME IT'S LOCKED AND TAGGED!**
- **Don't assume it's aligned correctly, even if you did it the last time.**
- **Can the shafts be rotated together? Can they be rotated individually? You may have to modify your alignment technique.**
- **Is there a soft foot issue? Check and minimize before alignment.**
- **Is there going to be thermal growth? How much? Which direction? Is it going to get hotter, or colder?**
- **Is the coupling insert worn? Does it need replacement?**
- **Is there adequate spacing between the shafts? Between couplings?**
- **Has pipe strain been minimized?**
- **Is the pump assembly sitting on isolators? Are they functioning properly?**
- **Is the pump assembly sitting on an inertia block? Is it properly affixed to the floor?**



Assumptions

- Do you notice any cracks in the floor around the base? Can you feel vibration in the floor?
- Does the coupling insert have excessive backlash?
- Are the coupling flanges tight to the shaft?
- Are set screws and bolts tight?
- Are keys in place?
- Are the hubs concentric? You may be able to align an eccentric hub, but may cause vibration, and make you look bad, if you miss it.
- Does the coupling guard clear the coupling?
- How clean is the area?
- Soft foot is not limited to just under the motor feet. It can happen between a riser and frame, and between a frame and a floor.
- Are there jackbolts? Are they screwed tight to the motor?

Error #2

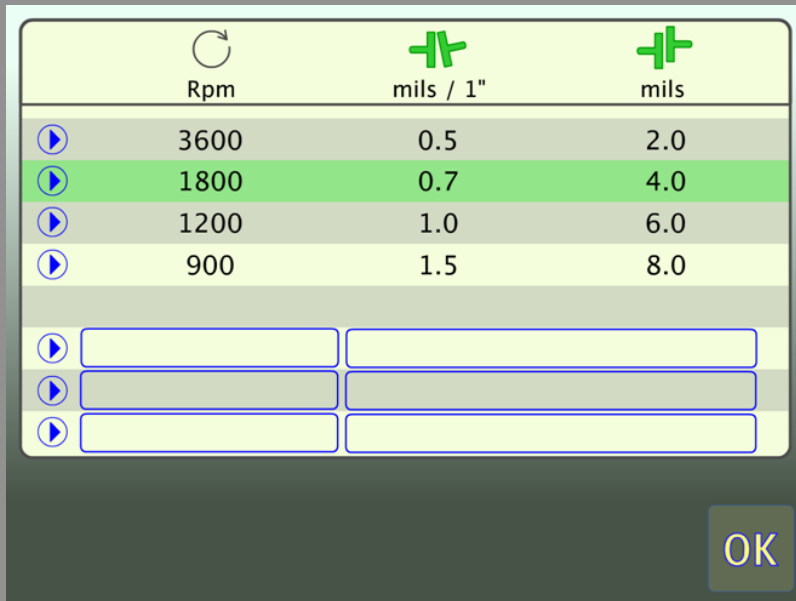
**You do not know what your
alignment target, or
tolerance, is.**









Alignment Targets


- Does your company have an alignment criteria, or tolerance?
- **DON'T GO BY THE COUPLING MANUFACTURER'S TOLERANCE!**
 - The coupling manufacturer's tolerance is based upon the amount of misalignment the coupling will tolerate,
 - NOT what the bearings and seals will tolerate!
- Think of it like a rubber band...



Alignment Tolerances



		
Rpm	mils / 1"	mils
 3600	0.5	2.0
 1800	0.7	4.0
 1200	1.0	6.0
 900	1.5	8.0
 <input type="text"/>	<input type="text"/>	
 <input type="text"/>	<input type="text"/>	
 <input type="text"/>	<input type="text"/>	



VibrAlign's tolerance table

Alignment tolerances are based on many things, including:

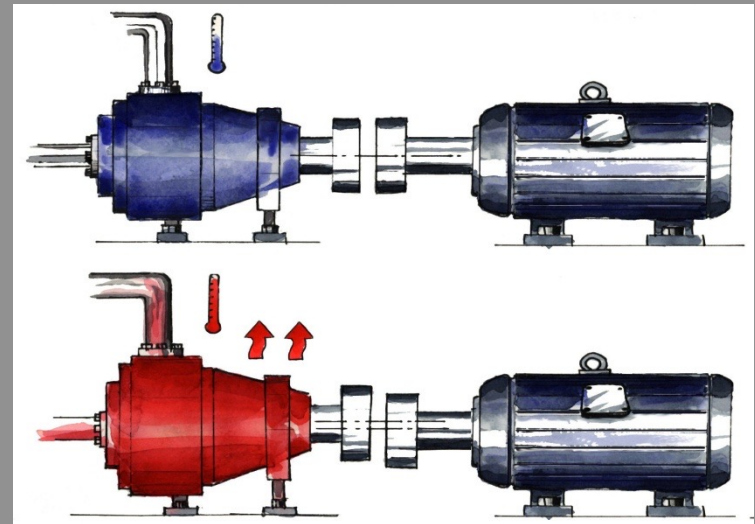
- Coupling type
- Running speed
- Company guidelines

Most alignment tool manufacturer's also have tolerances. Consult your Engineering department, or your alignment tool representative, for more information.

Thermal Growth Targets

Machines that operate at a considerably hotter or colder condition than the ambient room temperature should be thermally compensated.

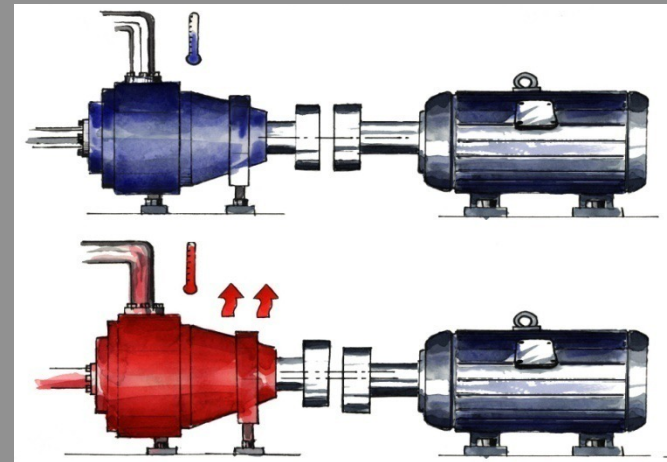
They will “grow” or “shrink” as they heat up, or cool off



The machine manufacturer's specs are a good place to start

But, the machine manufacturer probably does not know:

- The exact temperature of the driver and driven machines
- Ventilation quality or cooling effects
- Piping strain influences
- Piping thermal changes



Coefficient of Thermal Expansion

**Coefficient of expansion:
carbon steel**

**.0063 x length x
temperature change
= Thermal Growth (mils)**

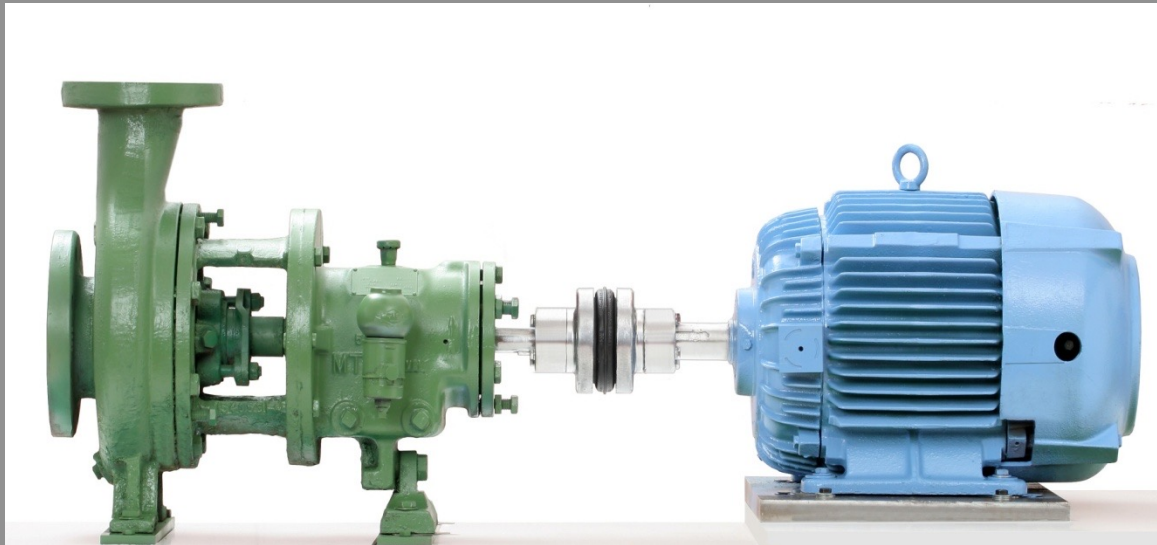
length (inches)	temp change	growth (mils)
15.0	100	9.5
15.0	125	11.8
15.0	150	14.2
15.0	175	16.5
15.0	200	21.3

If you can't remember this chart, remember this:

1foot of steel get 100 degrees hotter, it grows about 8 mils (0.008")

However, this is not a magic formula!

- Machines do not usually heat or cool at the exact same temperature top to bottom.
- You need to find a mean, or average temperature of the machine – from the centerline of the shaft, to the bottom of the foot.



The Best Way to Know Thermal Growth Changes...

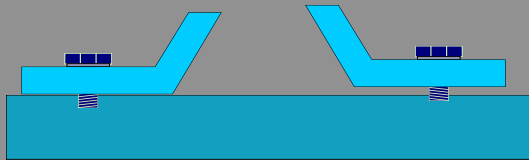
- ...is to measure them yourself.
- Measure the machine in the cold condition, and pre-set it to the manufacturer's recommendations.
- Re-measure in the hot condition, if possible.
- Some lasers can do this calculation for you, or you can simply plot it on paper.
- In addition, some laser alignment tool manufacturers sell equipment that allow you to measure the thermal changes.

Error #3

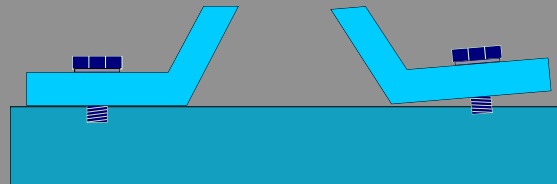
Not correcting for soft foot

Soft foot...

Soft foot occurs when machine feet do not rest flatly on the machine base.



Soft foot is caused by deformed machine base plates or by deformed machine feet.



Soft foot can be offset, angular, or both.

Error #4 – Not knowing when to say when

- When the machine is aligned to within your alignment tolerance, you are done.
- Don't try to get it all the way to zero.
- You may cause more problems than you correct.
- AND, you will certainly waste time.

Error #5 – Not roughing in

Straightedge, flashlight, feeler gauges, taper gauge, outside caliper, etc...



A Quick Comment on Shims...

- **Try to use a maximum of 4 or less shims under each foot. It's not always possible, but try to minimize the number of shims per foot.**
- **Use pre-cut stainless steel shims.**
- **You can't cut them for less than you can buy them.**
- **When you insert shims under the foot, slide them all the way in, then back them out 1/4", so the bolt threads don't bend them.**
- **Don't reuse painted, or badly bent shims.**
- **Be careful. A 0.003" shim can cut you like a knife. Trust me on this one!**
- **Keep them neat.**

Error #6 Not controlling backlash or unwanted movement

- **Some alignment systems are sensitive to backlash or “play” in the coupling. Not only lasers, but indicators can be misread due to backlash, especially if there is any eccentricity in the coupling.**
- **Beware of bumping your indicators or laser detectors.**
- **Beware of any binding or tightness in the machines as they are rotated.**

Error #7 – Incorrect sequence of moves

- **Always correct vertical misalignment first.**
- **Once the vertical (top to bottom, up and down) is corrected, you can theoretically move the machine side to side as far as it will go, without changing the vertical alignment.**
- **Then, correct misalignment in the horizontal plane (side to side).**

Now we're ready to align!



**You got to make the right
moves!**

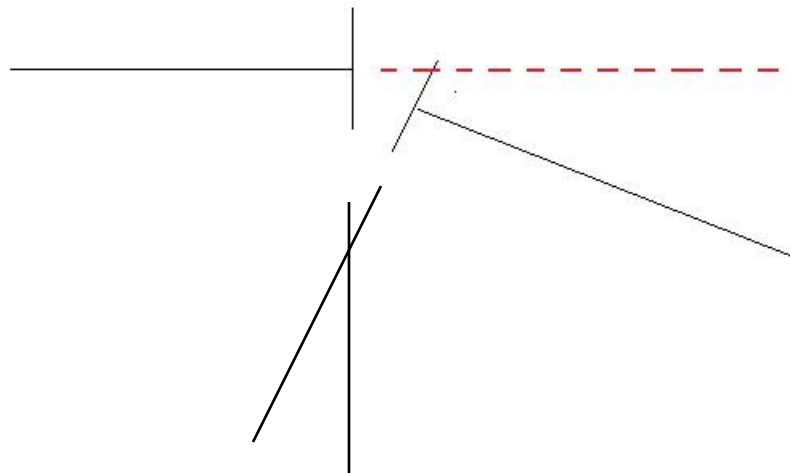


**Regardless of the method
you use, alignment needs
to be done in four steps**



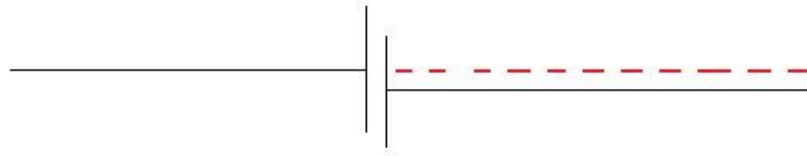
Angular misalignment in the Vertical Plane

Side View



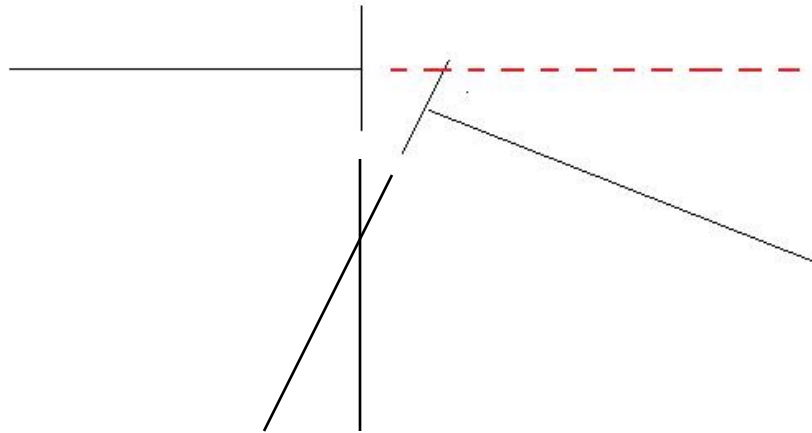
Parallel Offset in the Vertical Plane

Side View



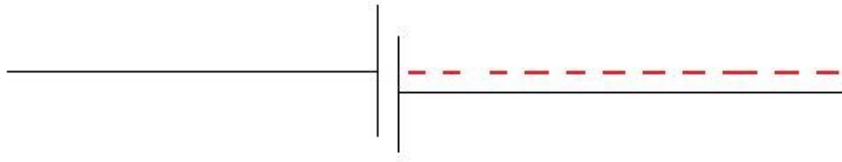
Angular misalignment in the Horizontal Plane

Top View



Parallel Offset in the Horizontal Plane

Top View



**THAT'S THE
WAY IT'S
SUPPOSED TO
HAPPEN!**



So what do we do if it doesn't?

- Check for soft foot.
- Check for bolt or base bound condition.
- Check to make sure you haven't bumped or moved your alignment tools
- Check for coupling backlash.
- Check for excessive vibration in the area
- Re-measure, and see if your results are repeatable.

Stan's Tricks of the Trade

- A straightedge, an outside caliper, a Starrett taper gauge, and a flashlight are good roughing-in tools.
- A can of compressed air, like those used for cleaning electronics, is good to clean dirt out from under motor feet.
- A 0-1" micrometer is great for measuring the thickness of shim stacks.
- When aligning, excessive backlash can be compensated with a few rounds of duct tape.
- Two dial indicator magnetic bases make great stops to rest the laser tool or indicator brackets at the 3 and 9 o'clock positions. It gives you an extra set of hands.

Questions?

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