Selecting Alignment Instruments

Precision alignment of coupled rotating shafts is a fundamental tenet of good maintenance. Here are some guidelines for selecting the right instruments for your program.

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Precision alignment can increase equipment reliability, extend bearing life, and reduce power consumption, but only if trained plant maintenance technicians have the right instruments.

Should an alignment program include older mechanical dial indicators or modern laser instruments? In general, both types will be needed. Most plants have machine alignment situations that can benefit from laser technology for ease of use, speed, and zero bracket sag. However, these same plants also have alignment needs for which laser equipment is unsuitable, for example, tight spaces where laser instrumentation is too bulky. Neither the dial indicator nor the laser alignment approach, compared in the accompanying table, is superior in all respects. Having both options available allows the best choice for whatever alignment situation may arise.

Which laser instrument is best? The answer depends on circumstances at your plant. If you decide to buy laser equipment, you must answer some questions before approaching vendors. Then you must ask laser equipment vendors some additional questions.

Laser alignment setups vary widely in the details of equipment and fixtures, but all speed the alignment process when operated by experienced users. (Photograph courtesy Ludeca Inc.)

DIAL INDICATOR VS. LASER ALIGNMENT

Feature	Dial indicator	Laser	Advantage
Initial cost of kit	Typically $100 to $2000, depending on versatility. One electronic indicator analog computerized kit costs $9200; others, $4000 to $5000.	$12,000 to $50,000, depending on features and capabilities	Indicator
Accuracy	Used properly, with bracket sag accounted for, 0.0005 in. increments can be measured meaningfully.	0.0001 in. increments can be measured.	Laser, theoretically. If indicator bracket sag is not accounted for, the laser will definitely give better results. Corrective moves are in 0.001 in. minimum increments so laser theoretical advantage may be unattainable in practice.
Speed and ease of use	A good kit in the hands of an experienced aligner will do the job fairly quickly, but not as fast as a laser kit.	Fast and easy to use, especially with visible red spot aimer, which most modern laser kits have.	Laser
Complexity; resistance to damage; cost to repair	Simple. Moderately resistant to damage. Inexpensive to repair or replace.	Complex. Some laser equipment is fragile; other laser equipment is rugged. Laser equipment is expensive to repair or replace.	Indicator. Laser equipment should have calibration at 2 year intervals or if dropped.
Space required	Compact. Will fit into minimum axial and radial space.	Bulky. Requires more space than is sometimes available.	Indicator
Shaft rotation requirements	Reverse-indicator and face-face-distance setups require rotation of both shafts. Face and rim setup can work with rotation of one shaft. All setups can be used with partial rotation by using suitable math.	Most lasers require rotation of both shafts, either directly or via roller bracket. The latter cannot always be used. Most lasers handle partial rotation easily. One laser requires zero rotation, but its special brackets are bulky and require good shaft finish and concentricity, without interferences such as keyways.	Indicator
Measurement range: likelihood of insufficiency	Typical alignment indicator has 0.210 in. range. Range can increase to 0.420 in. by using a range doubler accessory that will handle most alignments without resetting part way around the rotation.	Laser targets vary from 0.150 in. in diameter to 20 mm (0.787 in.). If the target is smaller than 20 mm, the system should have partial rotation alignment capability, or "interrupt function" to extend effective range.	Variable
Measurement error if coupling backlash occurs during rotation	No, if indicator contacts coupling surface directly. Error can occur if indicator contacts auxiliary surface or jig post.	Present with some laser equipment but not with others.	Variable. Depends on individual situation.
Linearity through full range	Good	Good on some laser targets; poor on others.	Indicator, sometimes. Otherwise, a tossup.
Umbilical cord or clear infrared transmission path required	No, except with some electronic indicator analog kits.	Yes	Indicator
Accuracy or operability affected by sunlight, heat waves, steam	No	Sometimes	Indicator
Bracket sag calibration required	Yes	No	Laser
Separate calculations required	Yes, except with electronic indicator analog kits having umbilical cord.	No, in most cases. Most laser kits use a programmed calculator that receives the measurements and calculates the moves.	Laser
Bracket requirements and availability	Inexpensive universal brackets available for large range of shaft diameters and spans to about 18 in. More expensive universal brackets available for unlimited diameters and spans to 8 ft. Counterweight systems available to neutralize bracket sag. Affordable custom brackets also can be made, but they are limited to use with the machine for which they are made.	Moderately priced universal brackets are usable independent of span, which can be 20 to 30 ft with no sag to consider.	Tossup for short spans. Laser for long spans.
Multiple machine optimum move measurement and calculation	Will do the measurement, but calculations are done separately, usually with long graph paper plot.	Some laser equipment will do both the measurement and the calculations for these situations.	Laser, if speed is paramount and cost is no object. Indicator, if you are willing to do some stretched-out graphical plots.

Questions for the user

- What do you hope to accomplish through laser alignment equipment? If you plan to eliminate the need for the aligner to think and reason, you are asking for trouble.
- What types of work do you expect laser equipment to handle? Plant alignment needs might include the following:

–Basic horizontal and vertical coupled shaft alignment measurement and calculation

–Alignment thermal growth measurement (however, several good methods also exist that do not use lasers)

–Soleplate leveling

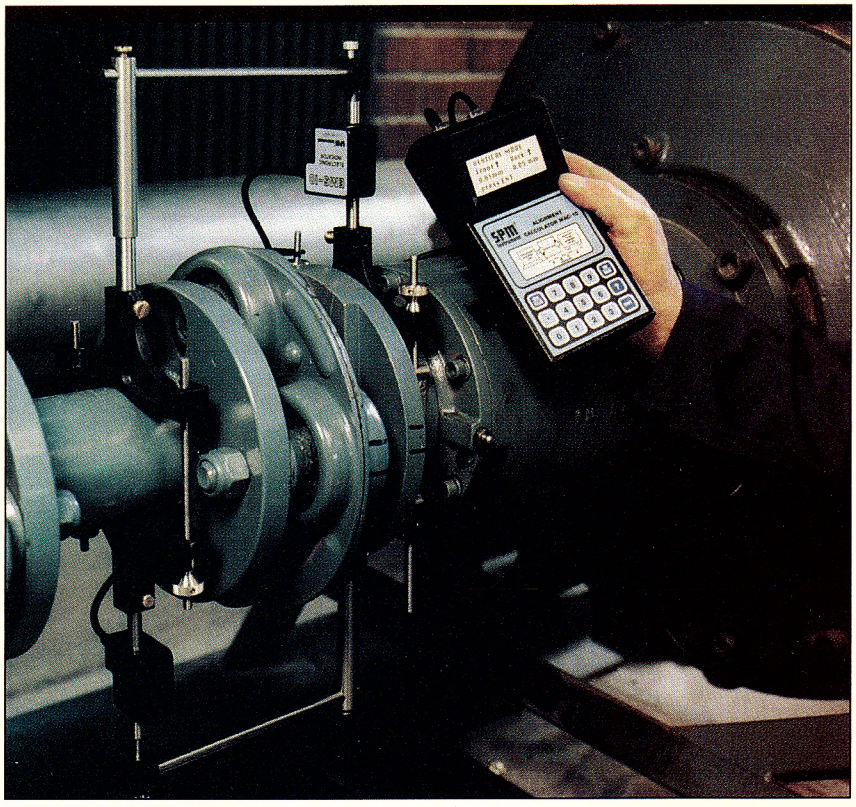
If you plan to eliminate the need for the aligner to think and reason, you are asking for trouble.

–Bore alignment (compressor bearings and cylinders, extruders, etc.)

–Multielement optimum-move measurement/calculation

–Work in areas requiring intrinsically safe or explosion-proof equipment.

- Who will operate the equipment, a well-trained elite group or anyone with a need? Training and equipment ruggedness become major issues when the user base is large.
- How many alignment jobs do you expect to do simultaneously? What happens if alignment equipment is out for repair and an urgent job must be completed? It is imperative that you do not lose your dial indicator alignment capability, even if you have multiple laser equipment, loaner arrangements, etc.
- How many machines do you expect to align with the laser equipment? Will the equipment justify the investment in improved accuracy or time savings? Does your facility include machines that cannot take advantage of the laser equipment because of space limitations or other factors?



Electronic indicator analog kits use attached handheld computer for alignment calculations. (Photograph courtesy SPM Instruments)

Questions for the supplier

- What will your laser equipment do and how much does it cost?
- What are the dimensions of the brackets that attach to the shafts or coupling hubs, especially thickness along the shaft axis and minimum radial height with laser and target installed? Can a less-than-perfect shaft surface condition or keyway, where the bracket attaches, reduce accuracy?
- Is accuracy or operability reduced by coupling backlash, sunlight, heat waves, steam?

ALIGNMENT REFERENCES

Murray, Malcolm. "Shaft/Coupling Alignment Thermal Growth Measurement Methods." Reprinted from *Proceedings of CSI User Conference,* 9/93, Louisville, KY. Also available from Murray & Garig Tool Works, Baytown, TX.

Piotrowski, John. *Shaft Alignment Handbook,* 2nd Edition. Marcel Dekker, Inc., New York, 1995.

Murray, Malcolm. *Alignment Manual for Horizontal, Flexibly-Coupled Rotating Machines,* 3rd Edition. Murray & Garig Tool Works, Baytown, TX, 1983.

● What materials are used for housings of laser source, target, and (if used) reversing mirror or prism? Unless vendors prove that no problems exist, avoid plastic housings. Most plastics have a high coefficient of thermal expansion and are likely to distort and cause inaccuracy if subjected to radiant heat. Metal housings are more stable.

● How big is the target aperture? Is the target signal linear for its full display range? What is the maximum percent nonlinearity? What is the range and how is it achieved? I prefer a basic range of 20 mm, but some targets manage satisfactorily with less basic range by having an extended "interrupt function" range or a partial rotation alignment capability.

● Can the equipment handle partial rotation alignment? If so, are manual calculations required? What minimum degrees of arc are required for acceptable "final" alignment? A good figure is 45 deg each side of top dead center.

● Does the laser source have a visible red spot aimer or does it require a separate beam finder? The red spot aimer is easier to use.

● Describe your service, recalibration, and loaner equipment capability including typical costs, frequency, and turnaround times.

● Can your basic coupled shaft laser alignment equipment handle thermal growth measurement, soleplate leveling, bore alignment, use in areas requiring intrinsically safe or explosion-proof equipment? If not, can you supply equipment that does accommodate these situations, and at what cost? (This question, or parts of it, can be omitted if you do not need these capabilities.)

Important fundamentals

Having a good understanding of alignment principles and geometry is important. Eliminating this understanding in favor of button pushing to get answers, and not realizing whether or not they make sense, is asking for trouble. Having the capabilities to perform good coupled shaft alignment with both laser and dial indicator equipment makes sense, because either approach can be superior or simply the only practical way, depending on circumstances.

A list of suppliers of alignment instruments and related products appears on pg 21. The material was developed by the editors with input from the author.

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