

Making Machine Train Alignment More Efficient and Accurate

Written by MT Staff
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Machine trains, like all directly coupled equipment, must be aligned. The objective of any machine train alignment is to align the equipment within specified tolerances at operating conditions. Accurate shaft alignment will increase the life of machine components such as bearings, seals, and couplings, and prolong the life of the machinery. As a result, costly unscheduled downtime is reduced. If alignment can be improved, machinery failure rates decrease. One way to improve the process of alignment is by using a laser alignment system.

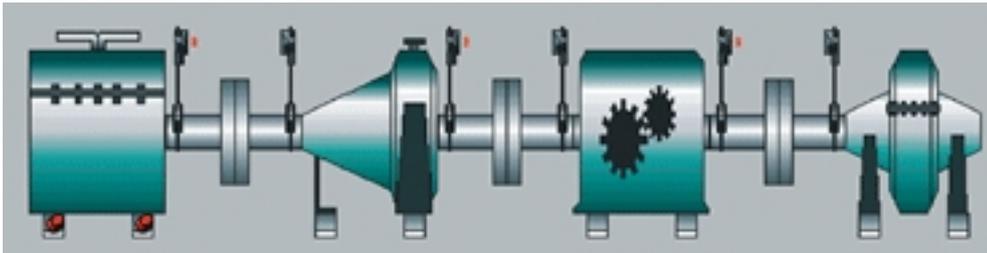


Fig. 1. Schematic of steam turbine-boiler feed pump-gearbox-booster pump machine train that was recently aligned using a laser alignment system.

A machine train consisting of a steam turbine, boiler feed pump, gearbox, and booster pump—shown schematically in Fig. 1—was recently aligned at a power company using a laser shaft alignment system. Because a laser alignment tool was used, the time necessary to complete this alignment task was reduced from 4 days to 2 days. The following steps were taken to align the machine using THE laser alignment system.

Alignment obstacles

This machine train possessed many alignment obstacles: the turbine base had settled over time due to environmental issues; the booster pump was subjected to considerable machine frame distortion (soft foot) due to excessive pipe strain; and prior to the outage, the gearbox was overhauled and the bearings were replaced.

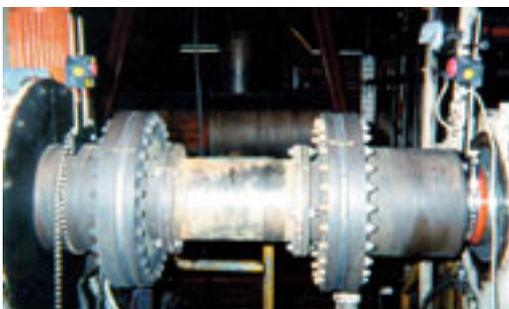


Fig. 2. Coupling 1, between the turbine and the main feed pump

Laser mounting accessories

In this example, the provided chain brackets used to mount the laser and receiver were not sufficient to take readings at each of the three couplings. Each coupling required additional accessories for mounting.

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Coupling 1, between the turbine and the main feed pump, utilized the standard chain brackets, using the provided 600mm long chains to accommodate the large shaft diameter (Fig. 2). Coupling 2, between the main feed pump and the gearbox, required narrow brackets due to extremely limited clearance axially (Fig. 3). Coupling 3, between the gearbox and booster pump, used magnetic brackets with offset support posts because of obstructions to rotation and limited axial clearance (Fig. 4). The coupling bolts protruded from the coupling hub, requiring a different option than straight support posts. The hardware obstacles were resolved with the optional accessories supplied by the manufacturer of the laser alignment kit.

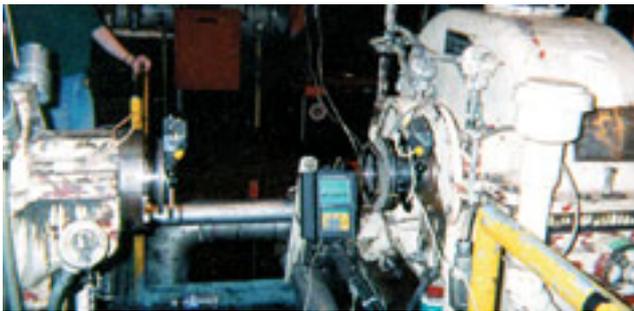


Fig. 3. Coupling 2, between the main feed pump and the gearbox

“As found” measurements

Multipoint mode. At couplings 1 and 3, measurements are taken with the multipoint measurement mode, which permits rotation of the shaft to a desired location using turning gear, without taking readings along the way. Once rotated, the shaft is relaxed into its natural position so a reading can be taken. Multipoint mode achieves alignment readings without the forces from noncontinuous rotation influencing alignment results.

If excessive vibration from nearby equipment is present, it is necessary to take more samples during each multipoint reading in order to increase the averaging and mitigate possible erroneous information.



Fig. 4. Coupling 3, between the gearbox and booster pump

Pass mode. Coupling 2 provides a challenge for most laser shaft alignment tools. The spool piece is removed during the alignment process. Rotating both coupling halves simultaneously is

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usually impossible. Pass mode is used to combat this challenge. When measuring with pass mode, the laser is simply rotated past the receiver at least five times over at least 70 degrees of rotation to complete alignment readings automatically.

Once misalignment readings have been taken at all couplings, an overall picture of the “as found” alignment is produced, as shown in Fig. 5.

Machine alignment

One goal during the alignment process is to minimize movement and still reach the alignment objective. Once the “as found” picture is in view, the smallest possible move or optimal move can be calculated. By doing so, the risk of becoming bolt-bound or base-bound (having to lower a machine with no shims under the feet) is reduced.

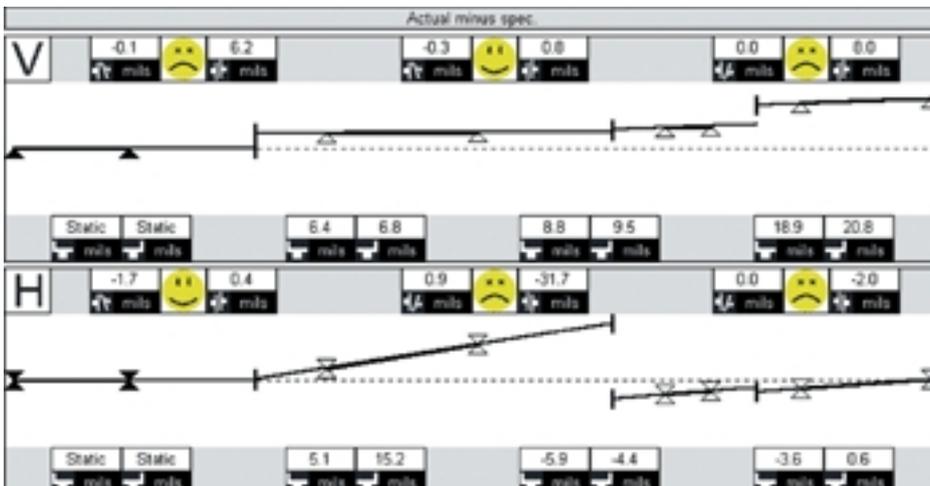


Fig. 5. “As found” alignment condition

Becoming bolt-bound is one of the most common problems during machine train alignment. When the stationary machine in a train is angled on its base, the other machines in the train need to be aligned to this angle. When moving any given machine in the train, the movements required to achieve tolerances may not be met because the move required is greater than the space remaining between the bolts and the bolt holes. This obstacle then requires additional moves to achieve alignment tolerances, or other less-desirable alternatives, such as enlarging the anchor bolt holes in the feet.

To combat a bolt-bound condition, it is vital to look at the overall picture and explore the various move options. In the example of a pump-gearbox-motor machine train, a quick glance would assign the gearbox as stationary and the pump and motor as moveable. What if the alignment cannot be completed with this configuration? Other alignment options must be explored.

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The best option is the static foot function available in some laser alignment systems. This feature permits viewing alignment conditions throughout the machine train while choosing different individual pairs of stationary feet rather than only entire static machines. This allows the user to find a solution with the smallest possible move for the bolt-bound machine.

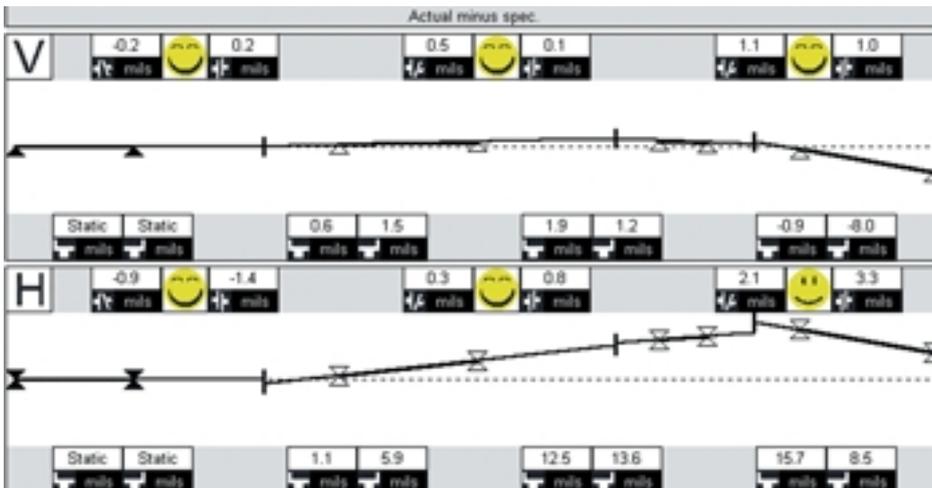


Fig. 6. "As left" alignment condition **Live move mode.**

In this example, the alignment was performed designating the turbine as the stationary machine. Movement of machinery commenced at the main feed pump, continuing with the gearbox and then the booster pump. The live move mode, which monitors each piece of equipment while it is moved, informs the user when tolerances are met. Because the move is monitored at each pair of feet, machinery is moved without guesswork, and the chances of over-shooting the required correction are reduced.

Target specification computation

The alignment is considered complete when all equipment is within tolerance while incorporating target specifications. Target specifications are deliberate values of offset and angularity that the machines are misaligned to in the nonrunning condition to compensate for expected changes in the alignment that will occur when the machines are made to run and are put under load, usually due to thermal growth or dynamic load shifts. All computations are done in the alignment computer, eliminating the need for cumbersome calculations on graph paper.

"As left" readings

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After each piece of equipment is moved into tolerance, a new set of readings should be taken at each coupling. In this case, each coupling was within the suggested alignment tolerances, while incorporating targets (see Fig. 6). The appearance of the smile symbol ensured that the speed-related tolerances were met at each individual coupling.

There are a myriad of machine train configurations for every possible application. Machine trains are often the lifeblood of a plant or mill. Their alignment is crucial due to the cost of downtime, cost of the equipment, and their criticality. Using a versatile laser alignment tool will reduce frustration, save time, and help accomplish the original goal of aligning a machine train within specified tolerances. **MT**

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