Machine Train Alignment

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Machine train alignment doesn't have to be a complicated, mind boggling task. There is a basic step by step procedure to follow which will allow you to maximize all of the benefits of aligning a machine train. When you follow this procedure and adhere to its principles, you will find that machine train alignment can often be easier to accomplish than a one coupling "vanilla" alignment.

First, let's discuss exactly what qualifies as a machine train. *A machine train is any machine that has at least three separate machines and two couplings.* This is important because the way that you align a machine train is entirely different than the way that you align two machines connected by one coupling. When you have a machine train there will always be at least two movable machines, in fact all the machines may be movable with two stationary points. You must always have this flexibility when aligning a machine train or you will often induce a bolt bound condition.

It is essential to model the machines at the beginning of the alignment. You can either due this on a sheet of graph paper or in the laser alignment computer, if it is an available option. The machine train should be dimensionally modeled with all of the couplings and feet positions represented. This will come in handy later when it comes time to make movement decisions.

Take measurements at all of the couplings. Do not move anything until all of the measurements have been recorded. At each coupling ascertain the coupling conditions. Either write the misalignment of each coupling on a sheet of paper or allow the misalignment to be recorded in the alignment system computer. Make sure that you take each set of measurements at least twice, in order to check for repeatability. It is more important to do this with a machine train alignment that with a single coupling alignment because an incorrect reading can cost you substantially more time with a machine train than a single coupling alignment.

View the current alignment conditions. Some alignment systems will allow you to do this in the computer, if yours does not then graph out the alignment conditions. Even if you have an alignment system that can display the alignment conditions of a machine train it is not a bad idea to graph out the alignment. To graph out the machine train you will have to choose one machine to be stationary, then graph the misalignment of the other machines referenced to each other. For instance, if you have a three machine train, chose the middle machine to be stationary then graph the machine on each end to be misaligned to the machine in the middle. This may or may not be the most feasible alignment scenario, but it is the easiest way to get the misalignment reference on to the graph paper. Once you have the misalignment onto the graph paper then you can move the reference line anywhere.

Now that the misalignment is now represented on a sheet of graph paper or in the alignment system you can determine the possible moves. For a machine train you do not have to have a stationary machine you only need to have two stationary points. Each point can be on a different machine. These points can be different for the horizontal and the vertical alignment scenarios. You are trying to make the smallest moves possible to avoid a bolt bound condition. Most times the easiest way to do this is to have different stationary points for the vertical and horizontal positions. There will obviously be limitations to which points you can pick to be stationary. Usually there will be a machine that is difficult to move because it is heavily piped in. Graph out an alignment scenario where this machine is stationary and the others are movable. There may be a machine with no shim under the feet, making it a lot of work to adjust this machine down. Graph out a vertical alignment scenario with this machine as stationary. There may be a machine that cannot move horizontally because it is either bolt bound to one side or the bolt hole clearance is not large. Graph out a horizontal alignment scenario with this machine as stationary. Always graph an alignment scenario with the two end points as stationary and all interior points as moveable. This will generally be the smallest move possible scenario and even if there is a heavily piped in machine, the moves will be small enough to not affect the piping.

Examine all of the possible moves. Which move seems to be the most feasible? Which move will avoid a bolt bound condition? Which move will not be possible because of piping or access to movement points? Should there be different stationary points for the horizontal alignment and vertical alignment? These are all questions to ask in order to determine the best alignment scenario. Spend some time to graph out the alignment move possibilities and to determine the best scenario. It is much easier to correct a mistake on paper than once you have started moving the machines.

Chose an alignment scenario for the vertical and horizontal misalignment that seems the most reasonable based on your alignment conditions and limitations. The alignment will be done correcting vertical misalignment first and horizontal misalignment second. This is done because vertical feet correction will effect the horizontal position, but horizontal correction will not effect the vertical position. Make all of the vertical corrections at once by either adding or removing shims at each movable machine foot. Take another set of misalignment readings after all of the vertical corrections are made. You have to take measurements after each set of moves are made. This is to confirm the moves that were just performed and to determine the next set of moves to be made. Perform alignment corrections at each movable position for the horizontal alignment. Take another set of measurements at each coupling. Finish the vertical alignment; keep performing moves and taking measurements until the vertical misalignment is to within acceptable alignment tolerances. Complete all horizontal moves until the horizontal misalignment is to within acceptable alignment tolerances. Take a final set of misalignment readings to confirm that each coupling is within acceptable alignment tolerances.

It is important to document the machine train alignment. Most alignment systems can automatically generate an alignment report. At the very minimum your alignment report should at least include the as found coupling conditions, the as left coupling conditions, and the soft foot values. A key part of any alignment program is to document alignments. This will help to track alignment problems and for scheduling regular alignment checks.

If you follow all of these steps to perform a machine train alignment, you will find that you will do a better job and it will take less time. By using this approach to perform a machine train alignment you will generally not encounter a bolt bound condition. This will mean the alignment can be performed from start to finish at one time without machining the machine feet or base plate. After the alignment is performed to acceptable alignment tolerances the machine train will run more efficiently. This will mean the alignment will have to be performed less often; the couplings, seals, and bearings will last longer; and there will be less power loss due to useless heat transfer.

About the Author

Damian Josefsberg is an applications Engineer for Acquip, Inc. He currently performs service work and teaches training classes. He has performed numerous laser shaft alignments, bore alignments, diaphragm alignments, machine train alignments, and thermal growth monitoring studies. He has performed internal and shaft alignments on compressors, gearboxes, motors, pumps, and turbines. Damian has provided plant maintenance support for the power, oil and gas, pulp and paper, food processing, automotive manufacturing, pipeline, and marine industries.

Damian has a degree in Mechanical Engineering from Florida Tech. He is also certified in vibration analysis and on several laser alignment systems.