Shaft Alignment

Davison Systems, LLC www.DavisonSoftware.com
Installation and Support

Introduction

The Shaft Alignment program calculates and records the shaft alignment correction between a driver and driven machine for either base-mounted or flange-mounted drivers. You enter the measurements required by the program and the program reports the amounts of shim and radial movement required to correct shaft alignment.

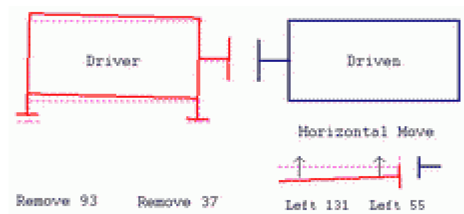
The alignment data entered comes from measurements of the machine and dial indicator readings taken for cross-indication (reverse) alignment. Each alignment record is retained as a history. Personnel can use printed reports with an image that illustrates the shim amount and movement to correct the alignment.

This Shaft Alignment program is integrated with Davison Maintenance CMMS and PredictMate ™ by Davison Systems, LLC.

Tutorial

How to use the Shaft Alignment program

About Shaft Alignment



Shaft Alignment Basics

Gravity Correction

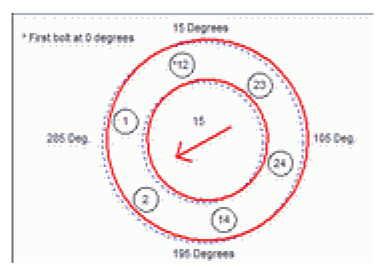
Thermal Change

Flange Mounted Alignment

Units of Measurement

See "Shaft Alignment" by J. T. Wilcox, Wilcox Consulting, Inc. for complete shaft alignment methods. About John T. Wilcox

Data Windows



Unit Information

Equipment for Alignments

Alignment Data Entry

Reports

Alignment Reports

Data Entry Forms

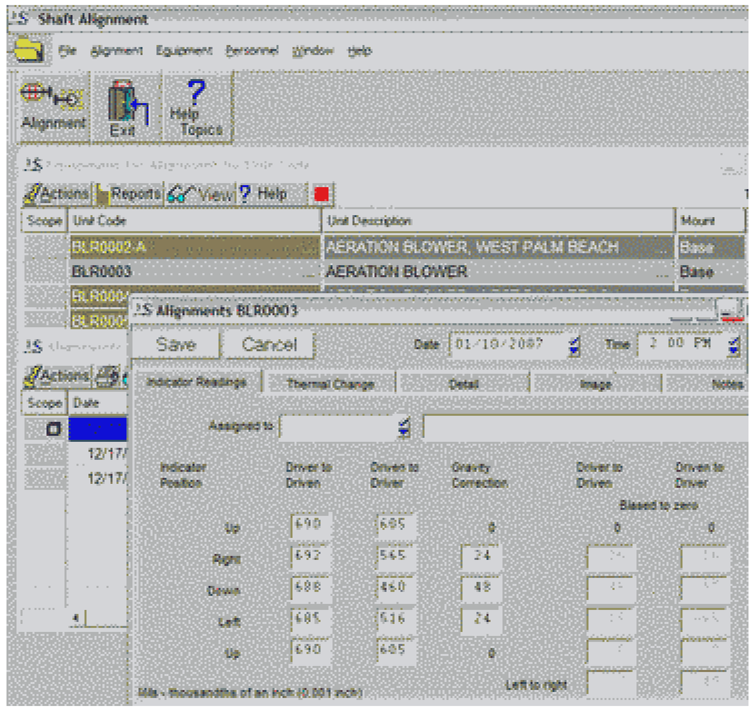
How to use the Shaft Alignment program

1) Print the data entry form or enter data on-site to the computer.
See Data Entry Forms

2) Measure the alignment.
See “Shaft Alignment” by J. T. Wilcox, Wilcox Consulting, Inc.
See Shaft Alignment Basics

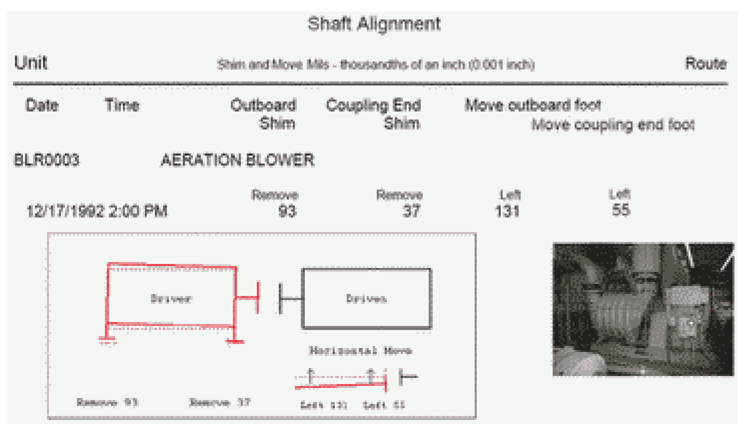
3) Write data on the form, or enter it in the program on the computer.

See Alignment Data Entry



4) Print the alignment correction or read the results from the computer.

See Alignment Reports



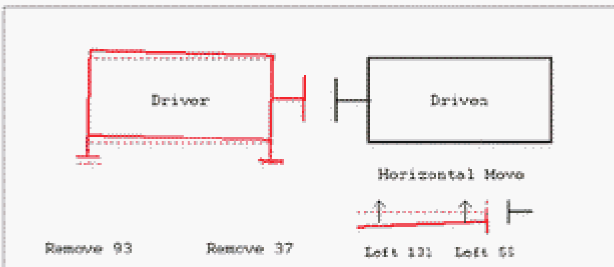
Alignment Reports

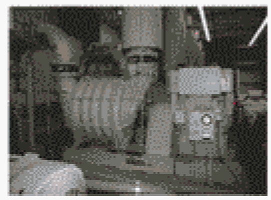
Alignment reports show the shim amounts and movement required for correct alignment. Graphic images show the same shim and movement.

Shaft Alignment

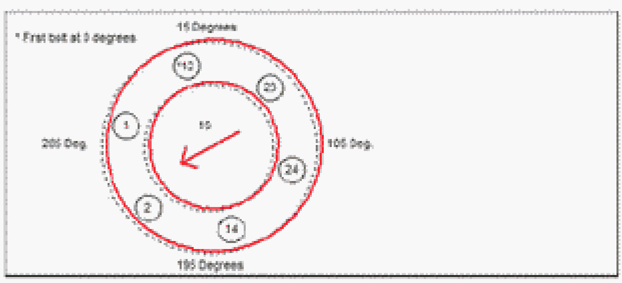
Unit — Shim and Move Mils - thousandths of an inch (0.001 inch) — Route

Date	Time	Outboard Shim	Coupling End Shim	Move outboard foot	Move coupling end foot
BLR0003	AERATION BLOWER				
12/17/1992	2:00 PM	Remove 93	Remove 37	Left 131	Left 55





Date	Time	Radial Move ** Degrees	Amount	Shim at each bolt Bolt	Shim
SL101	SLURRY PUMP				
4/12/1993	10:00 am	256	15	1	12
				2	23
				3	24
				4	14
				5	2
				6	1



** Degrees clockwise from first bolt

In the flange-mounted images, shim amounts print within circles that represent each bolt. The red, solid circle is the current radial position. The blue, dotted circle is the target position. The red arrow indicates the direction of radial movement.

See Data Entry Forms

Alignment Data Entry

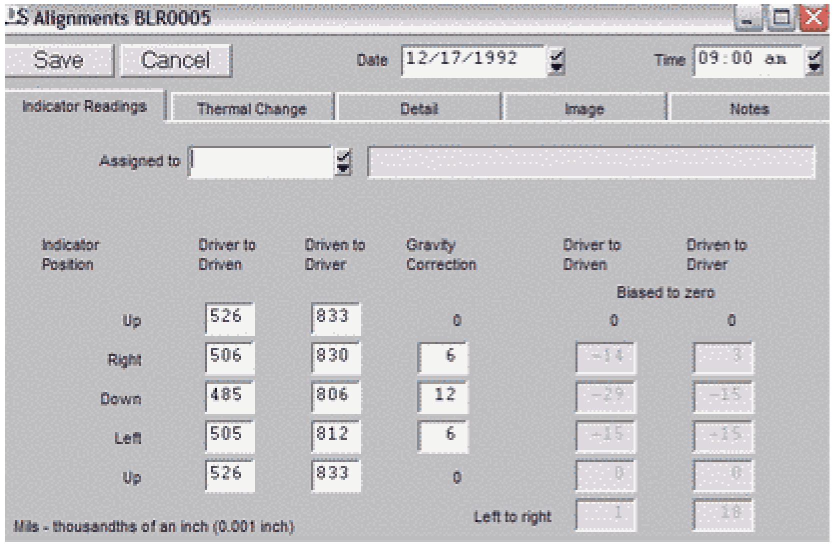
Base-Mounted Alignments

Enter shaft alignment readings in the Driver to Driven, Driven to Driver columns, and Gravity Correction.

To correct the alignment for thermal change, enter temperatures in the thermal tab if they are different for this alignment. Dimensions of the equipment are displayed from the equipment record, since the dimensions do not change.

Press Save to calculate shim amounts and horizontal move.

Enter data in either English - U.S. customary units, or Metric - International System of Units (SI). See Units of Measurement

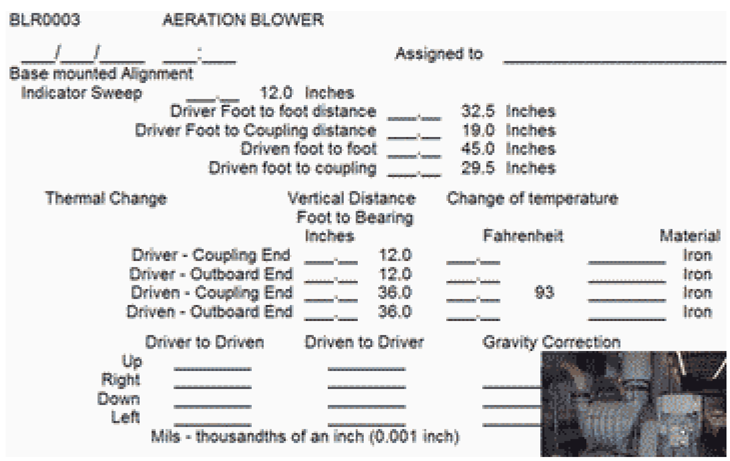


Data Entry Forms

You can print blank alignment data forms from Reports "Data Entry Forms".

Equipment information prints on this form. Current equipment data is shown for distance, temperature change, and material. You only need to enter new equipment data if it is different.

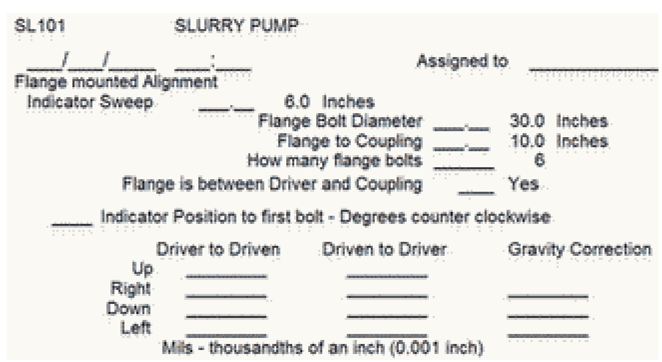
For new equipment print "New Equipment Entry Form".



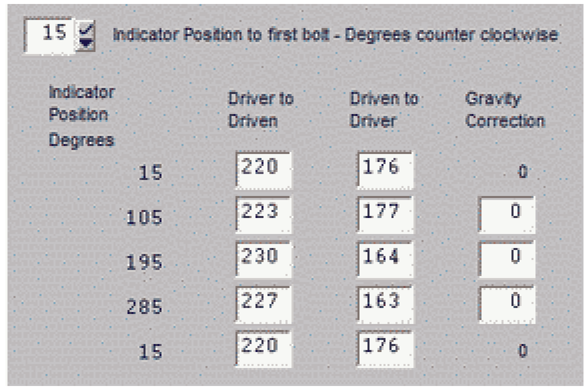
Flange-Mounted Alignments

Flange Bolt Diameter: The diameter of the circle of bolts on the flange.
Flange to Coupling: Distance from the center of the coupling to the flange.
Flange is between Driver and Coupling (Yes/No).

Since most flange-mounted alignments are vertically positioned, there is usually no gravity correction.



Indicator Position to 1st bolt Degrees CCW: The position from the first bolt to the indicator, counter-clockwise. This indicator position is the same as the "Up" position for a base-mounted alignment. Flange-mounted positions are in degrees from the first bolt, not Up, Right, Down, Left.

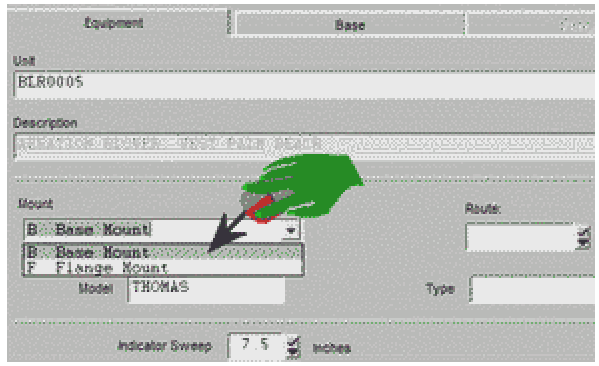


Equipment for Alignments

The tabs for Base-mounted or Flange-mounted are enabled according to your selection of Base or Flange mount. This window contains equipment information that remains constant for all of the equipment's base-mounted alignments.

Indicator Sweep: The distance from the indicator to the indicating point. See the diagram below.

Route indicates the order that you travel among machines. You can sort on the route code before printing alignment corrections or data entry forms.



Base-mounted Alignment

Driver foot to foot distance: A "Foot" is where shim is added or removed. Foot to foot distance is parallel to the shaft measured at the base of the driver unit.

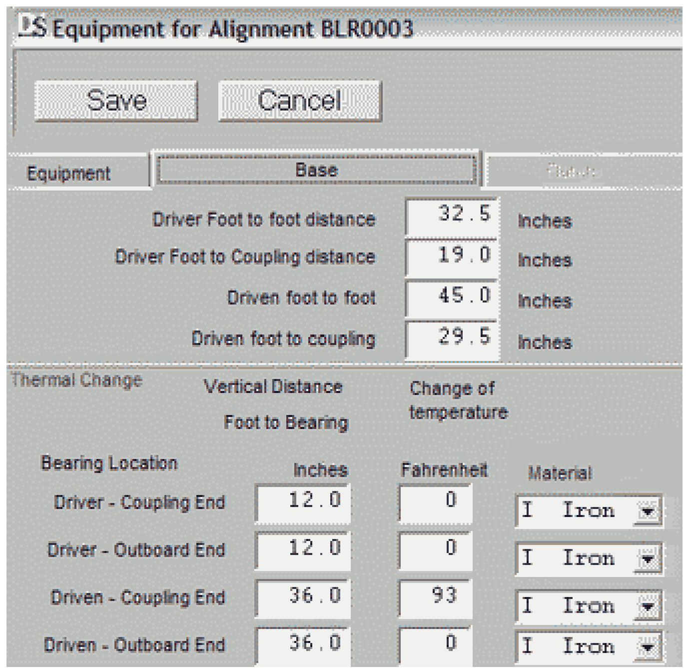
Driver Foot to coupling distance: The foot to coupling distance is parralel to the shaft, measured from the driver foot to the center of the coupling.

Driven foot to foot: Foot to foot distance is parallel to the shaft measured at the base of the driven unit.

Driven Foot to coupling: parallel to the shaft, measured from the driven foot to the center of the coupling.

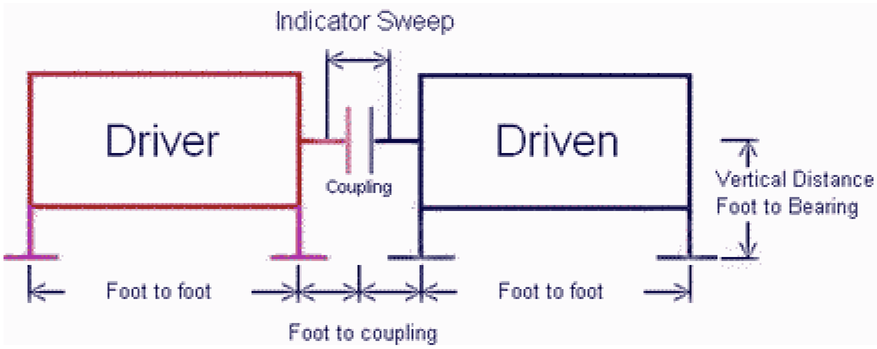
Vertical Distance, Foot to Bearing: The vertical distance from the foot to the bearing center, in inches (or centimeters).

Change of Temperature: Enter the CHANGE from "cold" to normal operating temperature at that bearing location. Numbers entered here are the default for each alignment's thermal change.

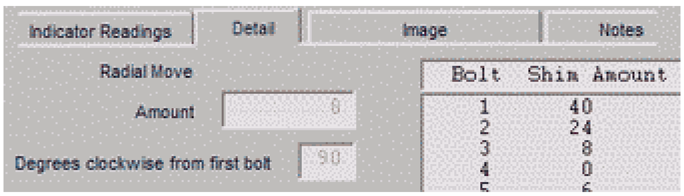


Material: Valid materials are aluminum, iron, brass, and steel. Each type of material has a different coefficient of thermal expansion, in degrees F/inch (or degrees Celsius/centimeter).

Most base-mounted machines are in horizontal position. Example base-mounted machine.



Flange-mounted Alignment



Radial Move - Amount: The distance in mils (or millimeters) of radial movement required for a corrected alignment.

Radial Move - Degrees Clockwise from First Bolt: The DIRECTION of radial movement required. For example 180 degrees means move towards opposite of the first bolt.

Bolt / Shim Amount: The amount of shim to place at each bolt for a corrected alignment.

Example flange-mounted machine

Shaft Alignment Basics

The cross-indication method of shaft alignment is very accurate and determines both radial and parallel alignment in one set of data. Both machines are turned simultaneously to record the data, therefore, flexible couplings can be left coupled up, and solid couplings must be uncoupled, leaving one loose coupling bolt in place to establish simultaneous rotation.

An indicator is placed on a solid part of the driver shaft, indicating to the driven shaft. The connected part of the indicator, and indicating point of the indicator should be at least four inches apart. The degree of accuracy is increased, as this dimension gets longer.

The alignment data is taken in four positions, 90 degrees apart. On horizontal base mounted machines the four positions would be, up, right, down, left, and back to up.

The alignment data is recorded in the "raw" condition, that is, the actual numerical value of the indicator will be recorded. The recorded numbers will be of three digits, such as 167 or 475 in mils (thousandth of an inch) or millimeters. The indicator is not set at zero in the starting, or "up" position.

The first set of data is taken reading the indicator in the four positions and back again to the starting point. Repeating the starting point reading assures the indicator setup did not move during rotation of the two shafts. This data is entered in the Driver to Driven column.

If only one indicator is used, the indicator setup is removed from the driver shaft and reversed, that is, attached to the driven shaft indicating back to the driver shaft. Care should be taken to not change the indicator setup in any way, such as repositioning the indicator bars or clamps. The point of clamping the indicator to the driven shaft should be as near as possible to the location at which the previous setup had indicated. Use of two indicators is simpler. Another set of data is taken and entered, in the Driven to Driver column.

Gravity Correction

Gravity Correction is often referred to as “sag”. All horizontal indicator setups deflect to some degree when rotated. The load of the indicator spring and the force of gravity acting on the mass of the indicator bars cause this. This correction is easy to obtain experimentally. Simply clamp the indicator setup on a piece of pipe that is about the same diameter as the part of the shaft being aligned. Hold the pipe such that the indicator is in the "up" position and note the reading. Then rotate the pipe and indicators to the "right" position and again note the reading. The indicator will read less in the "right" position than in the "up" position. The difference is the gravity correction.

The same procedure is used in the "down" position. Usually the "down" position will be double or more than double the "right" or "left" positions. The "left" position likewise should be checked because there is occasionally a difference between "left" and "right" correction with certain indicator setups. These corrections are entered in the gravity correction column.

Thermal Change

Most machines when operating at full load and capacity will thermally "grow" to a different alignment condition than that of the "cold" alignment. The running alignment can be detected and compensated for through the measurement of the bearing of the machine in respect to space. However, if the thermal growth can be determined prior to the alignment, and so corrected for, the machine should operate very well in the running condition. The calculation of this change is relatively simple and can save time and re-work of the alignment in most machines.

The most important factor in "running" alignment is the thermal changes that take place in the bearing supports of the driver and driven machines when the two machines finally reach load and thermal stability. This change can be fairly accurately pre-determined and taken into account during the alignment calculations.

The easiest and best way to determine the thermal changes is to actually measure the temperatures on a similar machine that is running at the normal load expected of the machine under alignment. The temperature changes in the similar machine can then be used to determine what the cold alignment of the new machine should be. The equipment manufacturer will usually state what the thermal changes will do to the machine alignment in their installation specifications. These numbers are normally a calculated estimate of the change, and not a measured amount. Therefore, if possible, the most accurate method is to measure the temperatures on an operating similar machine.

Thermal changes can occur because of many reasons. The most common is the electric motor driving a centrifugal compressor. The compressor, because of adiabatic compression, will run hotter on the discharge side of the compressor than the inlet side. This means the discharge side of the machine will "grow" more than the inlet side and therefore require alignment compensation. Motors driving pumps in petro-chemical or refrigeration applications may also have large thermal differentials that must be taken into account when doing an alignment.

Flange Mounted Alignment

The flange mounted motor and driven device is normally constructed to eliminate the requirement of alignment. However, this alignment does in fact require adjustment in many cases. Distortion in the support structure of the system can affect the alignment. Bearing replacement in the driver or the driven can occasionally change the alignment. Distortion on pump casings can also affect alignment. The most common way to correct the alignment in the past has been re-machining the driver and/or driven flanges to correct the misalignment. This is a costly and time consuming operation and may not correct the misalignment if caused by distortion.

If the machine shows high vibration or some other signs of misalignment, such as frequent coupling failures, the alignment can be checked using the procedures for base-mounted shaft alignment. The correction of this type of alignment is much more difficult than is the base mounted machine correction. The base mounted machine was simply corrected for slope with shims under the feet of the machine. The flange mounted machine does not have machine feet as such. Rather, the machine is mounted on a flange to flange system of driver to driven, and may have as little as four hold-down bolts to as high as 24 or more on larger machines.

The majority of flange mounted machines are verticals, and thus the indicator positions cannot be "up", "right", "down", and "left". The indicator positions must be labeled with the position that the reading was taken, relative to the first bolt position that corrections will be made. This direction is usually determined by the mechanical configuration of the machine being checked. A vertical turbine pump for instance will have "windows" in the packing area that provide access to the coupling and the packing. The indicator positions are then usually in-line with and 90 degrees from these windows. There may or may not be a hold-down bolt in line with these windows, and thus the displacement of the first, or zero degree position bolt must be taken into consideration.

The first bolt is considered the nearest bolt to the driver to driven machine indicator position that is counter-clockwise from that position. The counter-clockwise direction must be determined from the driver to the driven machine. Or, as though one were standing at the number one bearing, (the first bearing on the driver machine) and looking toward the driven machine.

Some machines will have a bolt directly in line with the first data set position, and therefore the first position would be 0 If the first bolt is 30 degrees counter-clockwise from the first indicated position the first data set would be entered 30. The program simply adds 90 degrees to the first data set position to determine the following positions.

The indicator correction factors need be included only in horizontally mounted flanged machines. If the machine is vertically mounted, the indicator corrections will be zero (0), since the forces of gravity and the spring constant of the indicators will be equal all around the coupling.