• Alignment Definition

The process of reducing the misalignment of the two adjacent shafts connection by a coupling

so that the center or rotation for each shaft is as near as collinear as practical during normal operation.

• Purpose of Shaft Alignment

1. Good shaft to shaft alignment of rotating machinery is essential for long term operation.

2. History has indicated that it is good practice to limit operating misalignment to low values.

3. Good shaft alignment reduces forces acting on rotating shafts, bearings and other components.

• Benefits of Precision Alignment

1. Reduced vibration levels

2. Increased meantime between failures

3. Reduced maintenance costs

4. Reduced energy consumption

5. Increased production quantity and quality

• The Effects of Misalignment

1. Misalignment machines result in vibrations and premature wear of bearings, seals and couplings.

2. Misalignment will lead to harmful forces, deteriorating the machines performance

• Machinery Installation

1. Good practices during the machine installation and commissioning phase will likely result in

good operational shaft alignment.

2. Examples of this are : correct pipe work procedures being followed, Base leveling & conditioning and thermal growth evaluations.

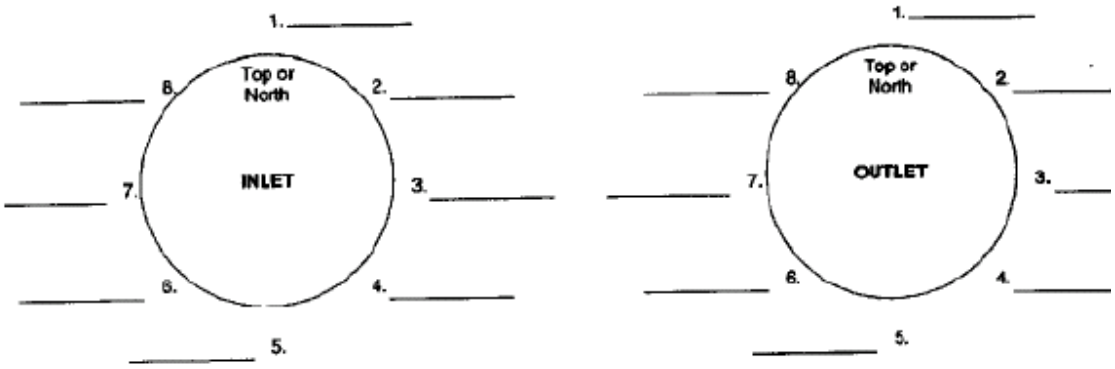
3. Standards to refer to are API 686 (Recommended practices for machinery installation design)

- **Pipe work Installation**

1. Flanges of connecting piping should not be sprung into place

2. Pipe flange bolt holes should be lined up to within 1.5mm (1/16”) without applying external force to the piping (API 686)

3. Pipe flanges should be parallel to 0.001” of flange outside diameter.



Maximum Allowable Tolerances: (difference between high & low readings)

- **Measuring Pipe Strain**

1. An alignment bracket , must be fitted to the machine being measured for pipe strain

2. Indicators will be mounted on the coupling hub to measure horizontal and vertical movement on the opposite machine as the flange bolts are being tightened using a torque wrench.

3. Bolts up will start with the largest flange first.

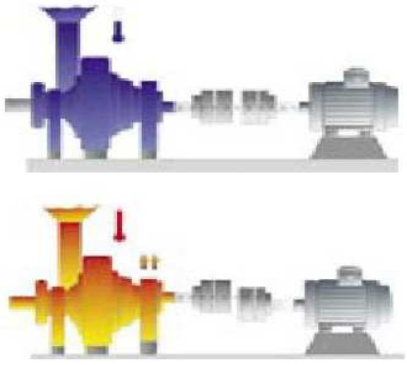
4. Bolts should be snug to 10% of total torque. Then tightened to 30% and then to 100% of total torque.

5. The maximum shaft movement in either horizontal or vertical direction after tightening should not be more than 0.002”

- **Thermal Growth Considerations**

1. Machines move and grow from offline to running conditions.

2. How much depends upon a number of different factor such as work load, machine casing material, pipe strain and more.



• **Considerations of Reverse Dial Method**

- Advantages or reverse dial method :

2. Relatively inexpensive and has been carried out by tradesmen for years.

3. Most plants have dial gauges at hand

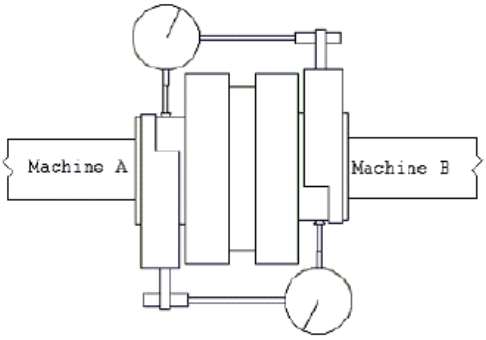
- Disadvantages are :

1. Moves must be manually calculates

2. Possibility of reading errors

3. Coupling run out errors

4. Bracket or bar sag.

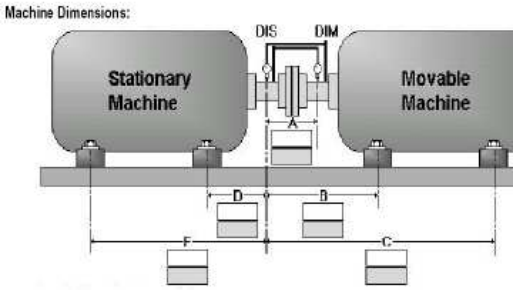


• **Reverse Dial Method**

1. Dial gauges mounted on each shaft

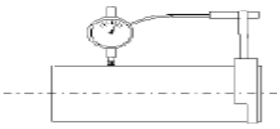
2. Machine dimensions are recorded.

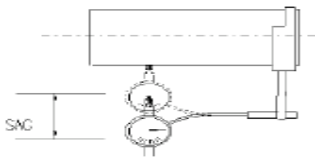
3. Machine moves are calculated mathematically or by scaling.



• **Bracket Sag**

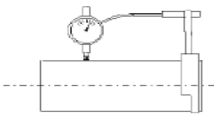
1. If you have indicators attached to a bracket you have bracket sag.
2. In order to properly correct misalignment, bracket sag must be measured and accounted for.
3. Sag is caused by gravity working on the weight of the brackets and indicators.

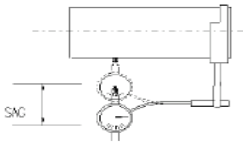




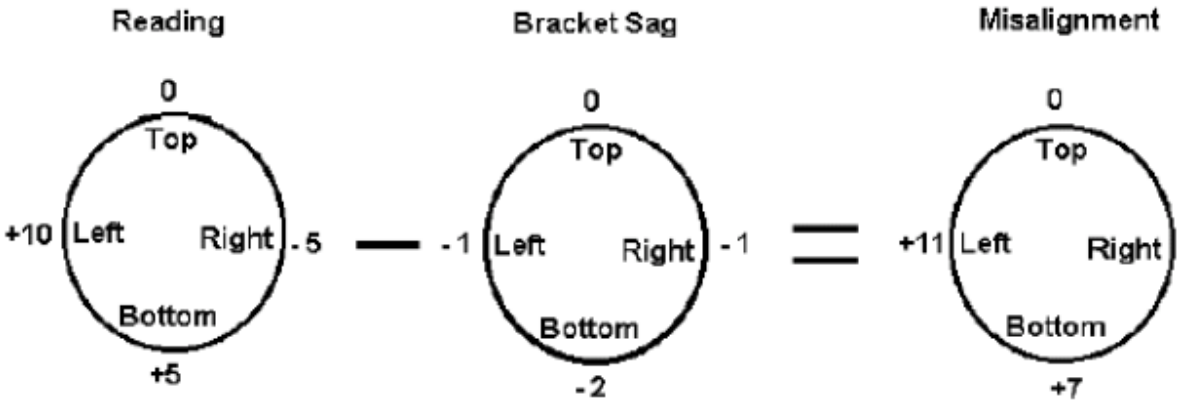
• **Measuring Bracket Sag**

1. Mount the indicators on pipe, bar stock etc as they are to be mounted on the machine 0 at 1200.
2. Rotate through 0300, 0300 and 0900 positions and record dial readings.
3. Check the dial returns to 0 at 1200, repeat the process and check for repeatability.
4. Bar sag should always be (-).

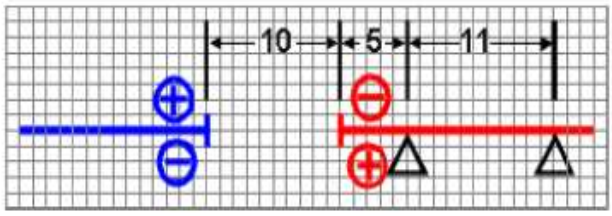




5. When carrying out alignment on the machine, indicators readings are a sum of misalignment and bracket sag.
6. Readings – bracket sag = misalignment
7. Sag must be subtracted from the measured reading as follows.



- **Reverse Dial graphical Method – E.g.**

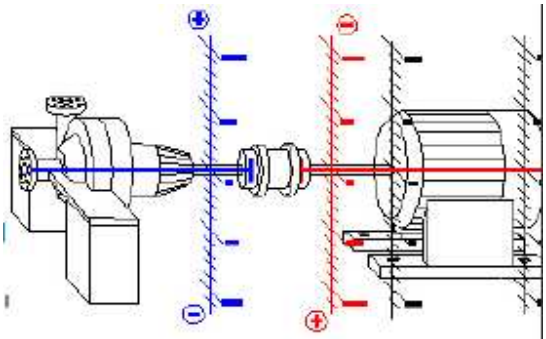


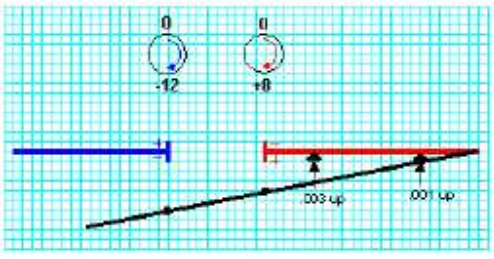
1. Pick a suitable scale on the graph paper and plot similar as below.

2. The machine on the right hand side in red we will consider as our movable machine.

3. In alignment it is easiest to solve the misalignment in the vertical plane first.

4. Assume we attach our indicators and after sag is accounted for we get the following readings.





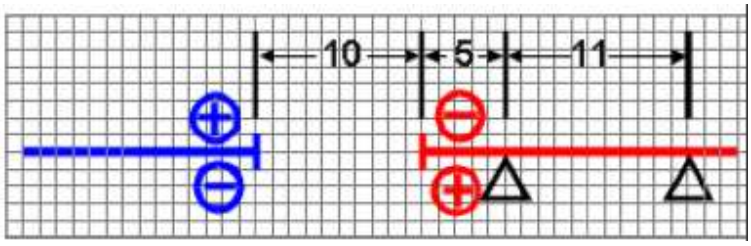
5. Plot the readings on your graph. Remember, dial readings are TIR and actual misalignment is half of TIR.

6. After plotting, we can see the shimming that is required to bring the machine into alignment.

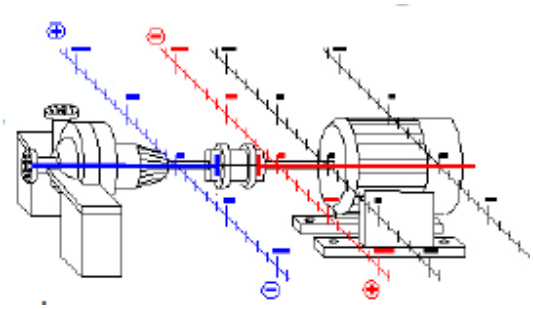
7. 0.003” in at the front and 0.001 in at the back

8. We still have to solve the horizontal misalignment.

9. Scale another diagram the same as we did for the vertical plane.

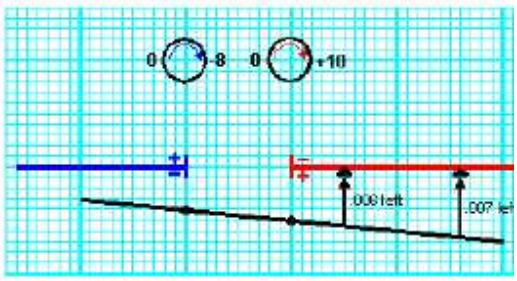


10. After attaching our indicators, measuring and accounting for sag, we get following reading :



11. Plot the readings on your graph. Remember, dial readings are TIR and actual misalignment is half of TIR.

12. After plotting, we can see the movement that is required to bring machine into alignment.



13. 0.006” at the front and 0.007” at the back

14. Alignment complete. Readings can be verified again.