ACQUIP
ROTATING EQUIPMENT SOLUTIONS

Reciprocating Compressor Internal Alignment Report

Any Client

Compressor Station

Any place, World

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Objective:

The purpose of this consultation was to perform an internal alignment of the distance piece and compression cylinder to the stationary cross head guide of a General Electric SHM reciprocating natural gas compressor. The internal alignment study is to consider compressor bore out of round, concentricity, and perpendicularity to the crank shaft.

Equipment measured:

Reciprocating Compressor:

Manufacturer – Any Make

Model – Any Model

Background:

The unit was brought down due for an unscheduled outage. During the outage the crank shaft and compressor cylinders were removed for repairs.

Equipment Used:

The alignment was performed using the FARO Tracker system. The FARO has a resolution of 1 micron, thus offering unequaled accuracy. The system has a measurement range of up to 180 feet, a horizontal measurement envelope of +/- 270 degrees, and a vertical measurement envelope of 125 degrees (+72.5 to -52.5 degrees).

FARO Tracker measures locations using laser absolute distance meters (ADM). This, when combined with the CAM2 Measure 10 software allows users to track measurement points accurately, quickly, and reliably. While measurements are being taken the system monitors and compensates for changes in temperature, air pressure, and humidity. Work is able to continue during the measurement process because a laser based system is employed, the line of sight of the laser beam can be broken at any time without affecting the measurement accuracy.

To allow movement of the FARO Tracker system, reference target nests are installed around the measurement site. Using these reference points allows the system to accurately triangulate the current location of the measurement device, and provide a simple repeatability check to ensure measurement accuracy regardless of the FARO's location. Utilizing the nests, an SMR measurement tool can be placed in the same location for all measurements.

Procedure:

The crosshead guide, distance piece, and compressor cylinder bore surfaces to be measured were installed and thoroughly cleaned in preparation for the initial set of readings. The tracker is setup in the crank case with a clear line of sight from the cross head guide to the compressor cylinder bore

In order for the tracker to locate the center position of each component a reference line must be constructed. The reference line was set through the center of each crosshead guide to analyze the alignment of the distance piece and compressor cylinder to the crosshead guide centerline. The reference line was created in the CAM2 Measure 10 software by measuring the crosshead guide bore as a cylinder in order to find the centerline. (Measurements discussed below)

The measurement process of each component occurs in two steps. Each bore is measured as cylinder and along one of its faces as a plane. From the interception of the two a circle is constructed as shown on Figure 1, where the center of the circle represents the center of the component.

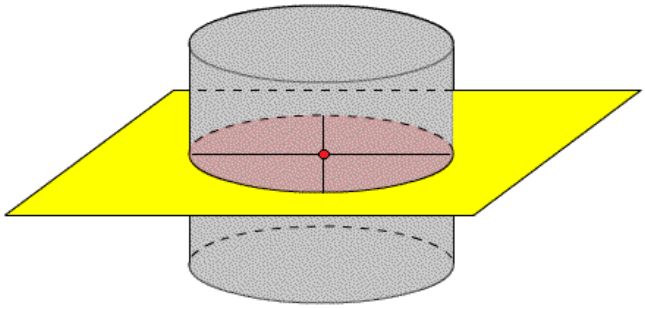

Figure 1 – Plane and Cylinder Interception

Several measurements are taken at each location in order to obtain a more accurate depiction of the center of the component. Standard deviation of the calculated center position is also examined; this is to ensure the accuracy of the measurements and to check the out-of-roundness of the components.

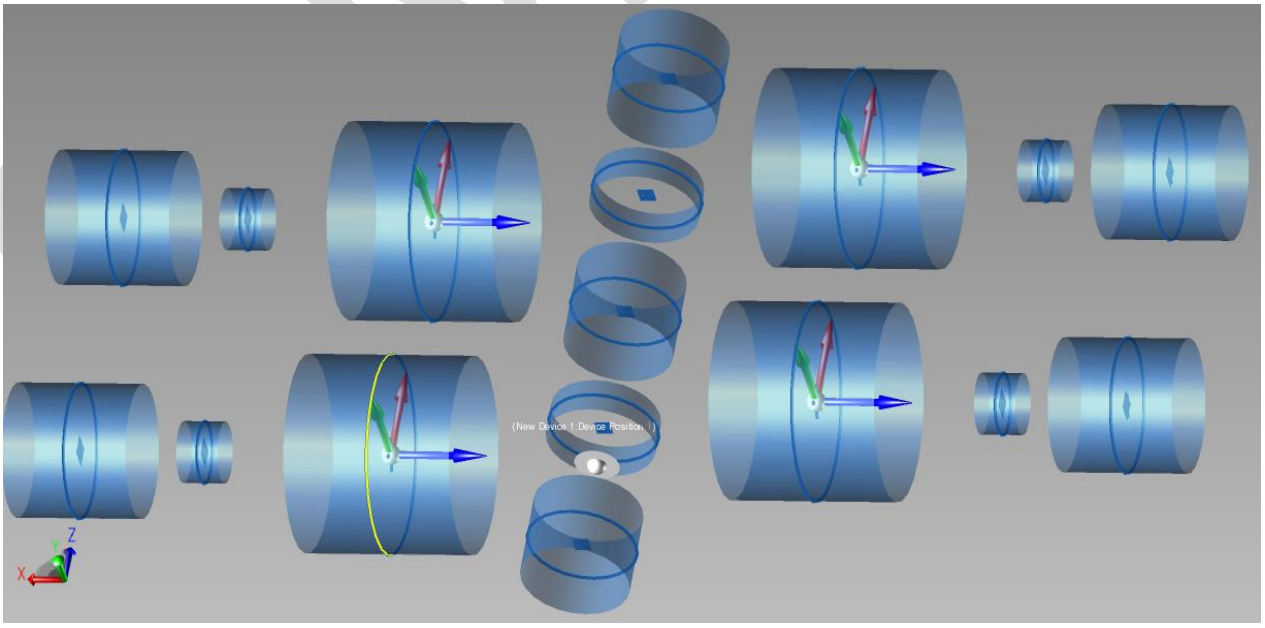

Figure 2 – 3D measurement image of all internal components

As Found:

Cylinder Assembly 1

Crosshead Guide 1

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		0.0000in		-0.0020in	0.0020in	
Diameter		22.5000in		-0.0020in	0.0020in	

Distance Piece 1

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		-0.0110in		-0.0020in	0.0020in	
Y (Vertical)		-0.0080in		-0.0020in	0.0020in	
Z (Axial)		-22.5000in		-0.0020in	0.0020in	
Diameter		7.0000in		-0.0020in	0.0020in	

Compressor Cylinder 1

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		-0.0070in		-0.0020in	0.0020in	
Y (Vertical)		-0.0130in		-0.0020in	0.0020in	
Z (Axial)		-37.5000in		-0.0020in	0.0020in	
Diameter		15.2500in		-0.0020in	0.0020in	

Cylinder Assembly 2

Crosshead Guide 2

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		0.0000in		-0.0020in	0.0020in	
Diameter		22.5000in		-0.0020in	0.0020in	

Distance Piece 2

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		-0.0100in		-0.0020in	0.0020in	
Y (Vertical)		0.0020in		-0.0020in	0.0020in	
Z (Axial)		22.5000in		-0.0020in	0.0020in	
Diameter		7.0000in		-0.0020in	0.0020in	

Compressor Cylinder 2

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0140in		-0.0020in	0.0020in	
Y (Vertical)		0.0050in		-0.0020in	0.0020in	
Z (Axial)		37.5000in		-0.0020in	0.0020in	
Diameter		15.2500in		-0.0020in	0.0020in	

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Cylinder Assembly 3

Crosshead Guide 3

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		0.0000in		-0.0020in	0.0020in	
Diameter		22.5000in		-0.0020in	0.0020in	

Distance Piece 3

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0030in		-0.0020in	0.0020in	
Y (Vertical)		-0.0020in		-0.0020in	0.0020in	
Z (Axial)		-22.5000in		-0.0020in	0.0020in	
Diameter		7.0000in		-0.0020in	0.0020in	

Compressor Cylinder 3

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0040in		-0.0020in	0.0020in	
Y (Vertical)		-0.0010in		-0.0020in	0.0020in	
Z (Axial)		-37.5000in		-0.0020in	0.0020in	
Diameter		15.2500in		-0.0020in	0.0020in	

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Cylinder Assembly 4

Crosshead Guide 4

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		0.0000in		-0.0020in	0.0020in	
Diameter		22.5000in		-0.0020in	0.0020in	

Distance Piece 4

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0080in		-0.0020in	0.0020in	
Y (Vertical)		-0.0130in		-0.0020in	0.0020in	
Z (Axial)		22.5000in		-0.0020in	0.0020in	
Diameter		7.0000in		-0.0020in	0.0020in	

Compressor Cylinder 4

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0070in		-0.0020in	0.0020in	
Y (Vertical)		-0.0110in		-0.0020in	0.0020in	
Z (Axial)		37.5000in		-0.0020in	0.0020in	
Diameter		15.2500in		-0.0020in	0.0020in	

The measured values shown above are then used to calculate the first set of moves needed to get the components aligned to the crosshead guide. A negative X value is to the South of the centerline, a positive X value is to the North. North is determined by looking down the crankshaft from bearing 1 to bearing 5. A negative Y value is low to the centerline and must be moved up, and a positive Y value is high to the centerline and must be moved down.

Several sets of moves were performed by the crew on site, where the components had to be once again measured and new moves calculated until a final set position was achieved. The final set of moves reflected that most of the components were within the desired tolerance of (±0.002 in) therefore no further moves were done. Shown below on is the Final position or As-Left moves.

As Left:

Cylinder Assembly 1

Crosshead Guide 1

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		0.0000in		-0.0020in	0.0020in	
Diameter		22.5000in		-0.0020in	0.0020in	

Distance Piece 1

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		-0.0010in		-0.0020in	0.0020in	
Y (Vertical)		0.0020in		-0.0020in	0.0020in	
Z (Axial)		-22.5000in		-0.0020in	0.0020in	
Diameter		7.0000in		-0.0020in	0.0020in	

Compressor Cylinder 1

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		-0.0010in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		-37.5000in		-0.0020in	0.0020in	
Diameter		15.2500in		-0.0020in	0.0020in	

Cylinder Assembly 2

Crosshead Guide 2

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		0.0000in		-0.0020in	0.0020in	
Diameter		22.5000in		-0.0020in	0.0020in	

Distance Piece 2

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		-0.0010in		-0.0020in	0.0020in	
Y (Vertical)		0.0020in		-0.0020in	0.0020in	
Z (Axial)		22.5000in		-0.0020in	0.0020in	
Diameter		7.0000in		-0.0020in	0.0020in	

Compressor Cylinder 2

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0010in		-0.0020in	0.0020in	
Z (Axial)		37.5000in		-0.0020in	0.0020in	
Diameter		15.2500in		-0.0020in	0.0020in	

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Cylinder Assembly 3

Crosshead Guide 3

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		0.0000in		-0.0020in	0.0020in	
Diameter		22.5000in		-0.0020in	0.0020in	

Distance Piece 3

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0010in		-0.0020in	0.0020in	
Y (Vertical)		-0.0020in		-0.0020in	0.0020in	
Z (Axial)		-22.5000in		-0.0020in	0.0020in	
Diameter		7.0000in		-0.0020in	0.0020in	

Compressor Cylinder 3

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0020in		-0.0020in	0.0020in	
Y (Vertical)		-0.0010in		-0.0020in	0.0020in	
Z (Axial)		-37.5000in		-0.0020in	0.0020in	
Diameter		15.2500in		-0.0020in	0.0020in	

Cylinder Assembly 4

Crosshead Guide 4

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0000in		-0.0020in	0.0020in	
Y (Vertical)		0.0000in		-0.0020in	0.0020in	
Z (Axial)		0.0000in		-0.0020in	0.0020in	
Diameter		22.5000in		-0.0020in	0.0020in	

Distance Piece 4

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		0.0020in		-0.0020in	0.0020in	
Y (Vertical)		-0.0010in		-0.0020in	0.0020in	
Z (Axial)		22.5000in		-0.0020in	0.0020in	
Diameter		7.0000in		-0.0020in	0.0020in	

Compressor Cylinder 4

	Nominal	Actual	deviation	low tol	up tol	oot
X Horizontal		-0.0010in		-0.0020in	0.0020in	
Y (Vertical)		0.0010in		-0.0020in	0.0020in	
Z (Axial)		37.5000in		-0.0020in	0.0020in	
Diameter		15.2500in		-0.0020in	0.0020in	

Conclusion or Comments:

The data collected is valid and what the FARO tracker measured is representative and subjective to the conditions when the data was taken. Each distance piece and compressor cylinder was properly aligned and should provide accurate clearances based upon alignment data and client provided tolerances.

Tolerance for alignment provided by the client was ±0.002.

Report by:

Acquip Services

Info@acquip.com

305-538-7101