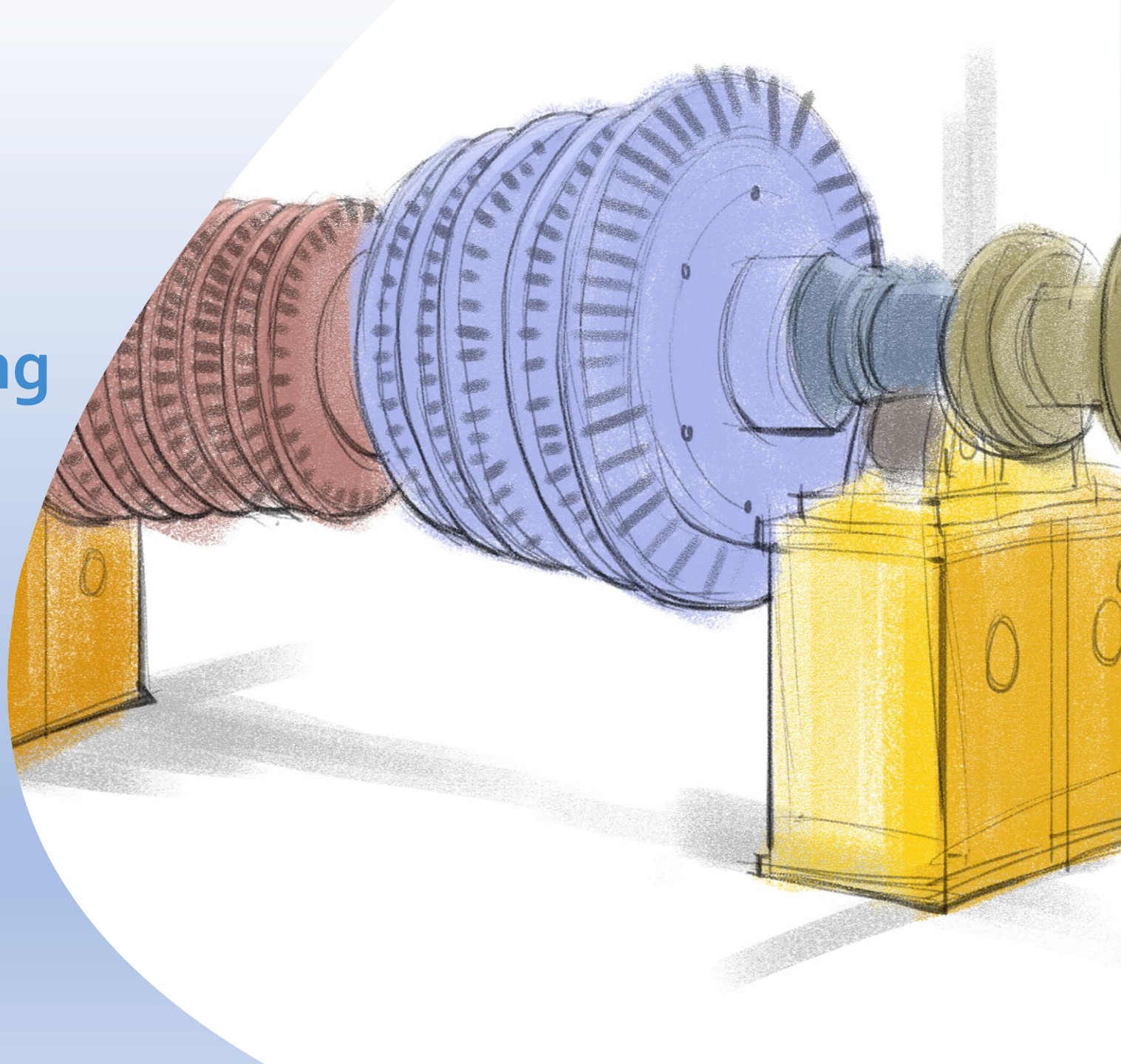


Steam Turbine On-site Balancing Using Emerson CSI 2140

By
Salah Attia



On-site Balancing – Steam Turbine Using Emerson CSI 2140

Brotherhood Steam Turbine 25MW

The turbine bearings vibration spectrum shows high amplitude vibration at the running speed of 1X (5478 CPM) at both turbine drive end and non-drive end bearings, especially in the horizontal (X) direction, 1X Vibration appears in the vertical(Y) direction too, but with lower amplitude.

Turbine Speed = 5478 Rpm

Generator Speed = 1500 Rpm

Number of holes on the right side = 16

Number of holes on the left side = 12

The angle between holes for the right side = 22.5

The angle between holes for the left side = 30

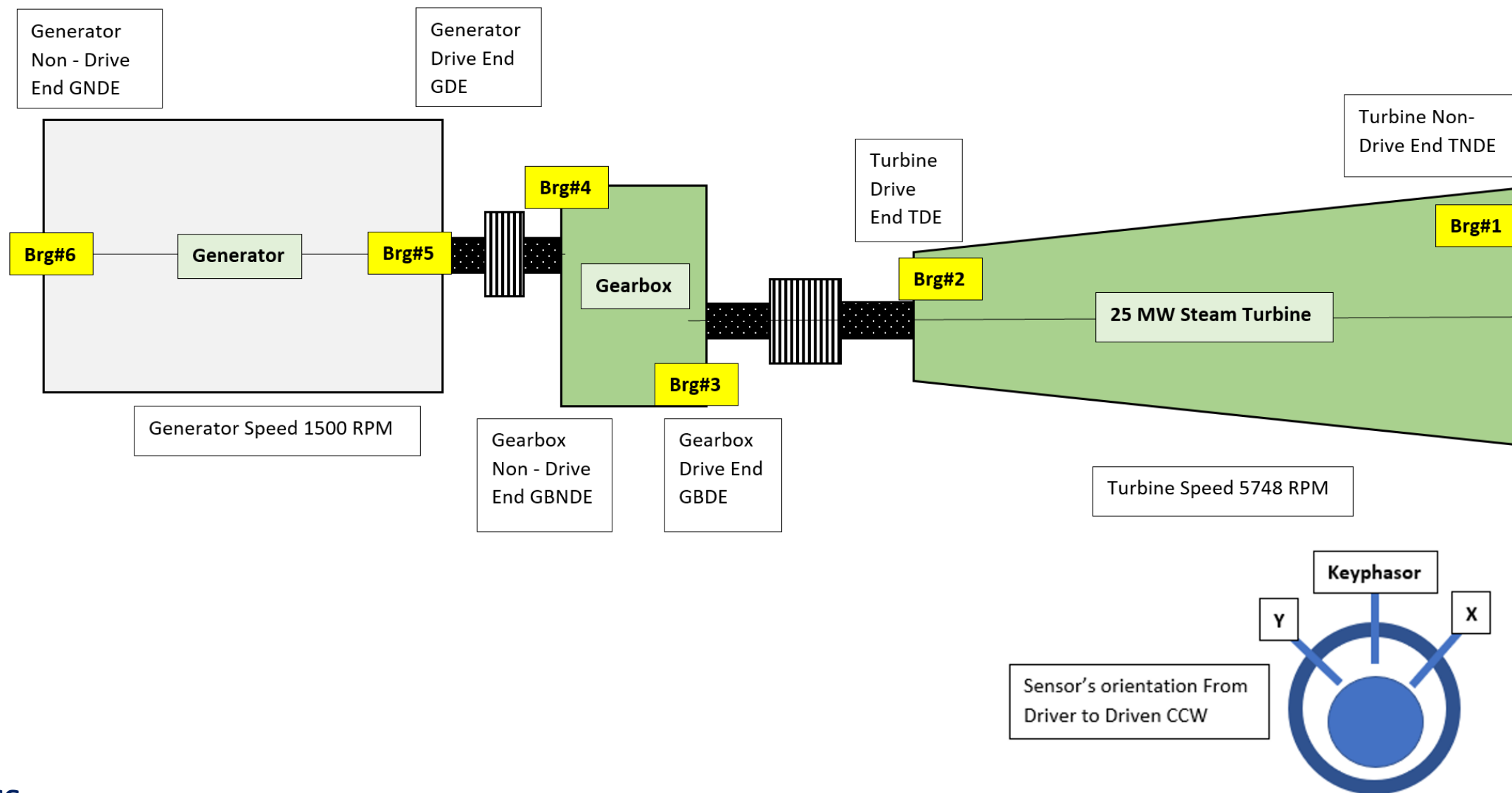
Balancing Type = Two Plane Balancing



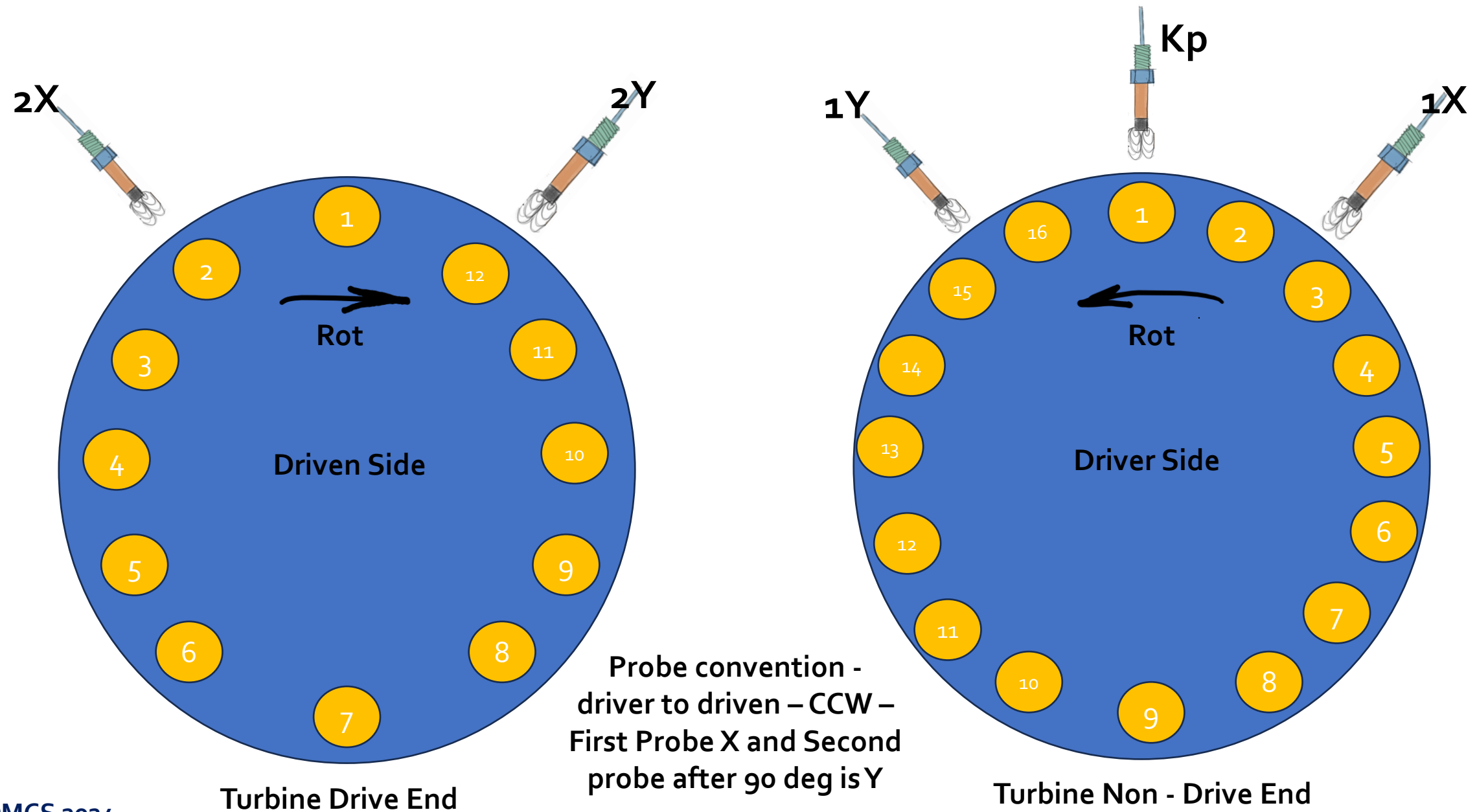
On-site Balancing – Steam Turbine Using Emerson CSI 2140



Machine Layout



On-site Balancing – Steam Turbine Using Emerson CSI 2140

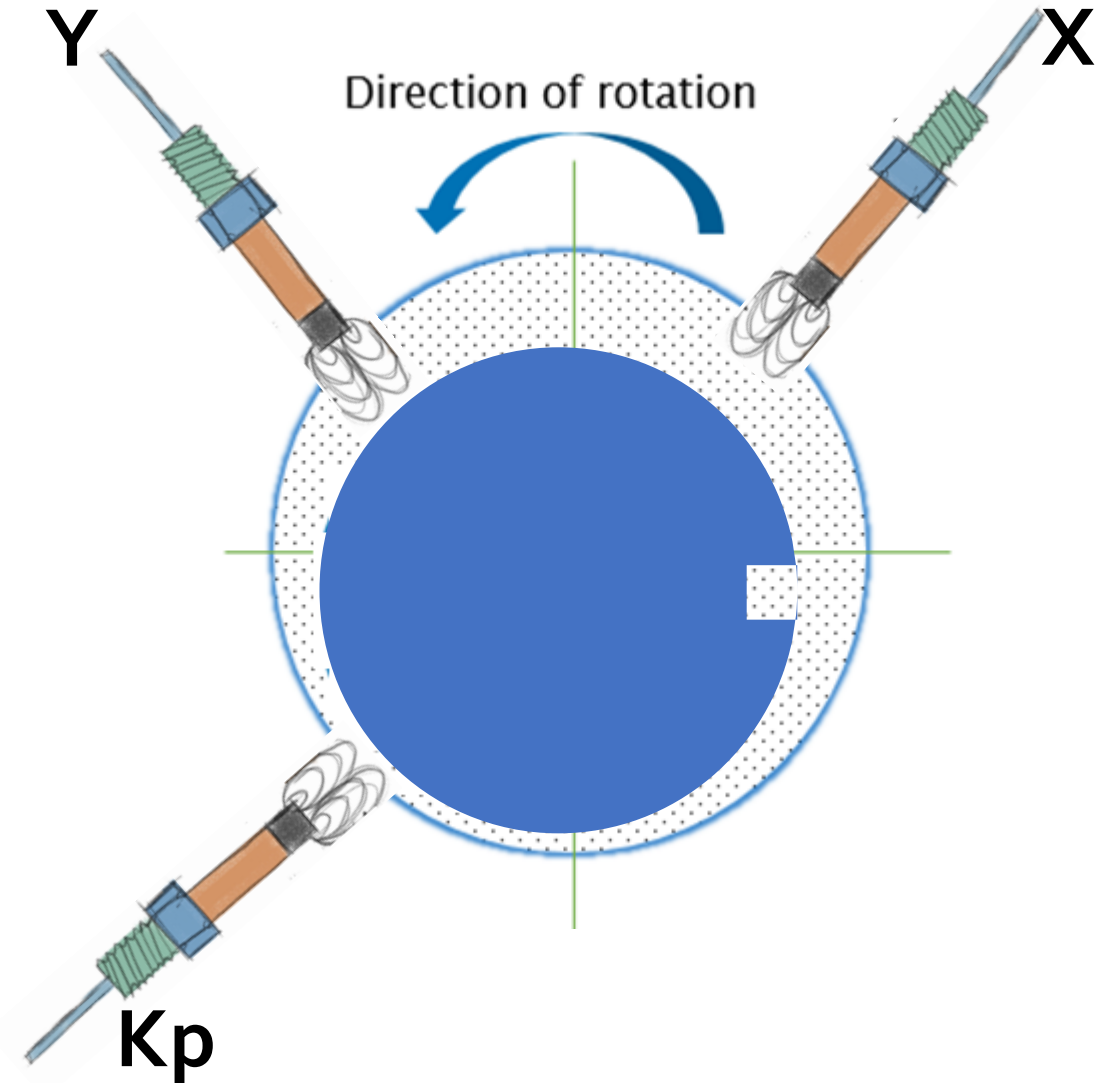


On-site Balancing – Steam Turbine Using Emerson CSI 2140

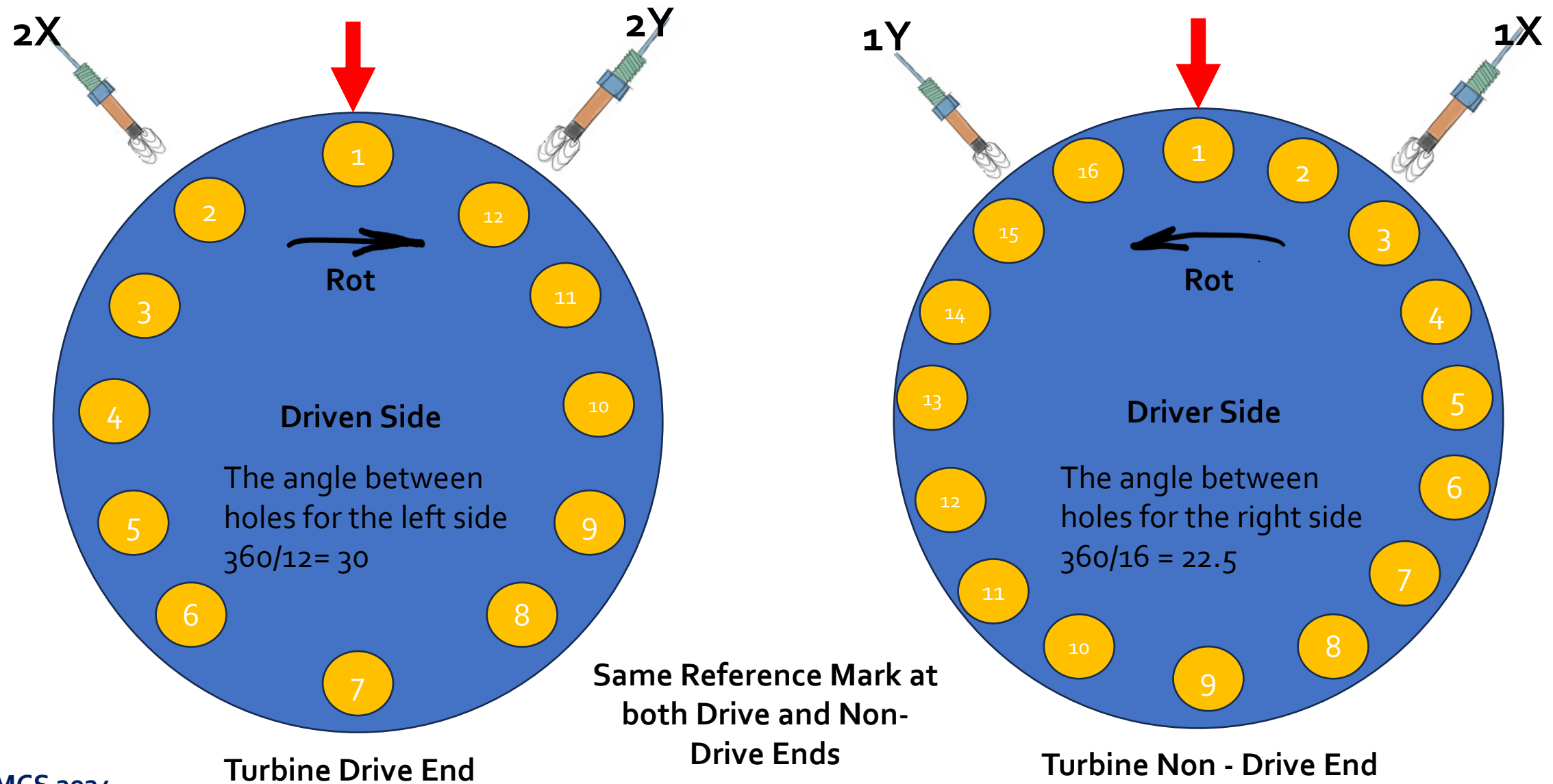


Transducer Convention

- The Common convention used which describes the transducers' locations on a machine is done by viewing the machine from the driver to the driven side and the Y probe will be 90 degree counter-clockwise X probe.
- The X probe represents the horizontal direction, and the Y probe represents the vertical direction.



On-site Balancing – Steam Turbine Using Emerson CSI 2140

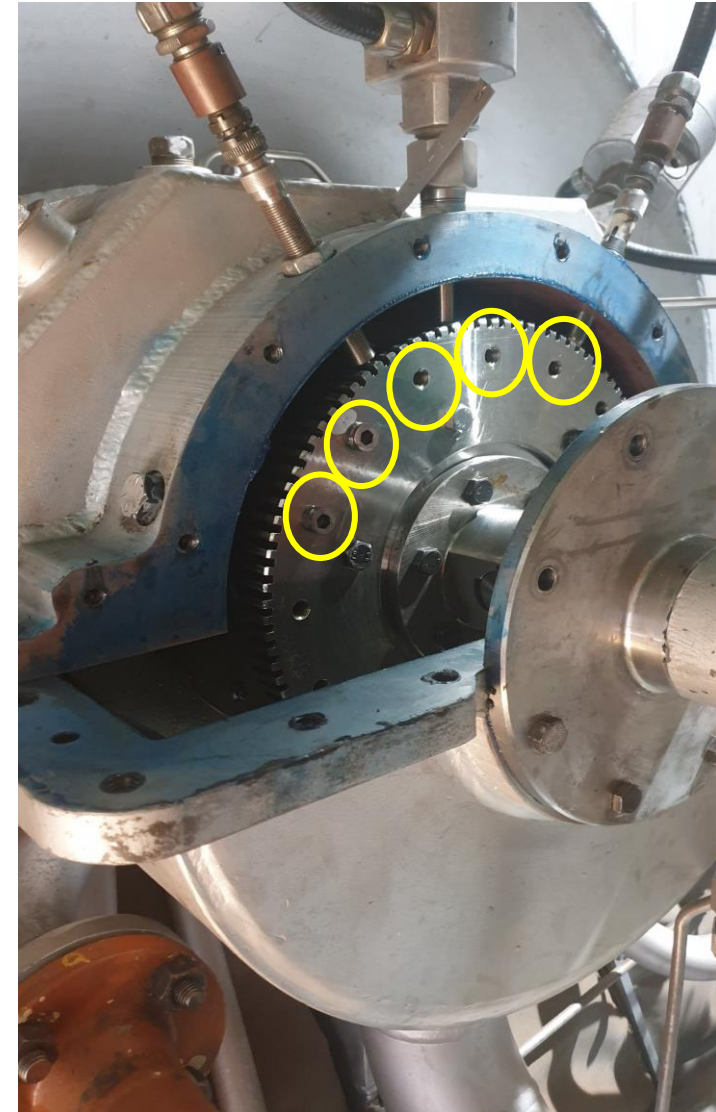


On-site Balancing – Steam Turbine Using Emerson CSI 2140



Turbine Drive End

Balancing Weight Location



Turbine Non - Drive End

On-site Balancing – Steam Turbine Using Emerson CSI 2140

The data were collected using the CSI 2140 from the proximity probes via the BNC connection, as shown in the photo. The turbine had five proximity probes: two for the drive end, two for the non-drive end, and one key phasor for the speed reference, as seen in the photo.

Proper setup for the job is crucial to collect accurate data; without it, everything might go wrong.

- Amplitude units: Microns or mils P-P
- Sensor sensitivity: 0.0078 V/EU
- Tacho voltage should be set to -12 DCV
- Run-up data (polar plot and Bode plot) must be collected
- Checking for critical speeds is very important
- Slow roll vibration data should be collected for compensation



On-site Balancing – Steam Turbine Using Emerson CSI 2140



Home Reset Enter Back Help

ALT1

7:48 PM -- 21.8.2024

ALT1

File Utility

Set Display Units

Comm Setup

Program Manager



EMERSON

AMS

2140

Machinery Health Analyzer

Battery 62%

Four Channel

SN: B21401238059

Memory 98%

Adv. Analyze

Route

Balance

Basic Laser Align

Adv. Transient

ODS/Modal

1

Home Reset Enter Back Help

ALT1

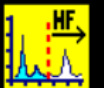
Analyze Application

ALT1

Manual Analyze

Review Data

Listen To Live Data





Job ID: DEC BASE

Equipment: Equipment1

Location: Internal

Analysis Experts

High Frequency Analysis

High Resolution Analysis

PeakVue Analysis - Bearing/Gear

PeakVue Plus

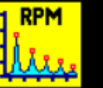
Turning Speed Detection

Laser Speed Detection

More Experts

Review Data

Job Setup


2

On-site Balancing – Steam Turbine Using Emerson CSI 2140

Home Reset Enter Back Help

Analyze Setup		Tach Setup
Set Analyze Mode	Analyze Mode: Spectra	PeakVue Demod
Set Spectra Params	Fmax: 500 Hz Fmin: 0.0 Hz Lines: 800	Set Trigger
Set Averag-ing	Peak Hold Average Averages: 4 Acquire Mode	
Set Window	Window: Uniform	
Set SST / AWeight	SST: ☐ A-Weighting: ☐	
Inputs A (microns) B (mm/sec) C (mm/sec) D (mm/sec)		Input Setup

3

Home Reset Enter Back Help

Input Setup		Sensor Setup
Select Input	Input: A, B, C and D	
Input A Wavefrm Units	Input A: Accelerometer	Input B Wavefrm Units
Input A Spectrm Units	Waveform: microns	Input B Spectrm Units
	Spectrum: microns	
Input C Wavefrm Units	Input C: Accelerometer	Input D Wavefrm Units
Input C Spectrm Units	Waveform: microns	Input D Spectrm Units
	Spectrum: microns	

4

On-site Balancing – Steam Turbine Using Emerson CSI 2140

Home Reset Enter Back Help

ALT1 **Sensor Setup** **ALT1**

	Input A	Input B	
Change Sensor Type	Type: Displacement	Type: Displacement	Change Sensor Type
Change Sensitivity	Sensitivity: 0.0078 V/EU	Sensitivity: 0.0078 V/EU	Change Sensitivity
Change Sensor Power	Power OFF Volts Input	Power OFF Volts Input	Change Sensor Power
Change Signal Coupling	AC Coupled	AC Coupled	Change Signal Coupling

5

Home Reset Enter Back Help

Analyze Setup

Analyze Mode: Spectra

Set Analyze Mode	Fmax: 500 Hz Fmin: 0.0 Hz Lines: 800	PeakVue: ☐ Demodulation: ☐	Tach Setup
Set Spectra Params	Peak Hold Average Averages: 4 Acquire Mode	Level Trigger PreTrigger: 10 % Level: 12.7 microns Edge: Rising Input: A	PeakVue Demod
Set Averaging	Window: Uniform		Set Trigger
Set Window	SST: ☐ A-Weighting: ☐		
Set SST / AWeight	Inputs A (microns) B (microns) C (microns) D (microns)		Input Setup

6

On-site Balancing – Steam Turbine Using Emerson CSI 2140

Home Res **7** k Help

Tachometer Setup

Pseudo Tach	Disabled	Falling Edge	Set Trigger Edge
		-12.0 Volts	Set Trigger Level
		0.0 Seconds	Set Edge Delay
Tach Power	OFF		Show RPM
Save / Recall Setup			Set Defaults

Enter Back Help

8

Analyze

Analyze Mode: Waveform

Fmax: 500 Hz

Fmin: 0.0 Hz

Lines: 800

Peak Hold Average

Averages: %

Acquire Mode: Filtered Orbit

DC Volts ns

Window: Uniform

SST: ☐

A-Weighting: ☐

Inputs

A (microns) B (microns)

C (microns) D (microns)

On-site Balancing – Steam Turbine Using Emerson CSI 2140

9

Home Reset Enter Back Help

Analyze Setup

Analyze Mode: Peak and Phase

Order: 1 xRPM	Delta Time: 0.0 Seconds
Bandwidth: 0.1 xRPM	Delta RPM: 0 RPM
Average: ☐	High RPM: 6000 Low RPM: 0

Inputs

A (microns)	B (microns)
C (microns)	D (microns)

Set Analyze Mode
Set Order
Set Band-Width
Set Average Enable
Tach Setup
Set Delta Time
Set Delta RPM
RPM Range
Input Setup

10

Home Reset Enter Back Help

Peak and Phase Data

RPM:

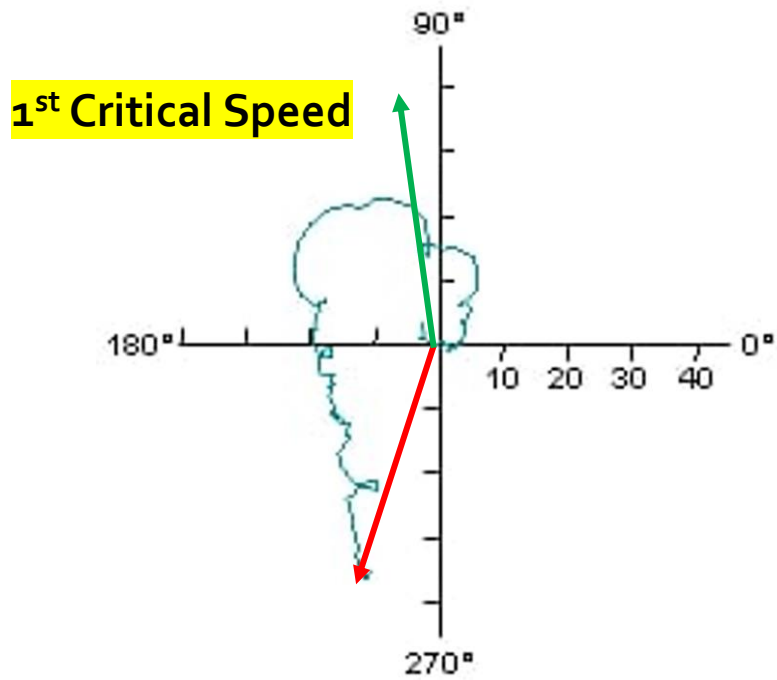
Input: A	microns Degrees
Input: B	microns Degrees
Input: C	microns Degrees
Input: D	microns Degrees

PK-PK:
Phase:

Stop

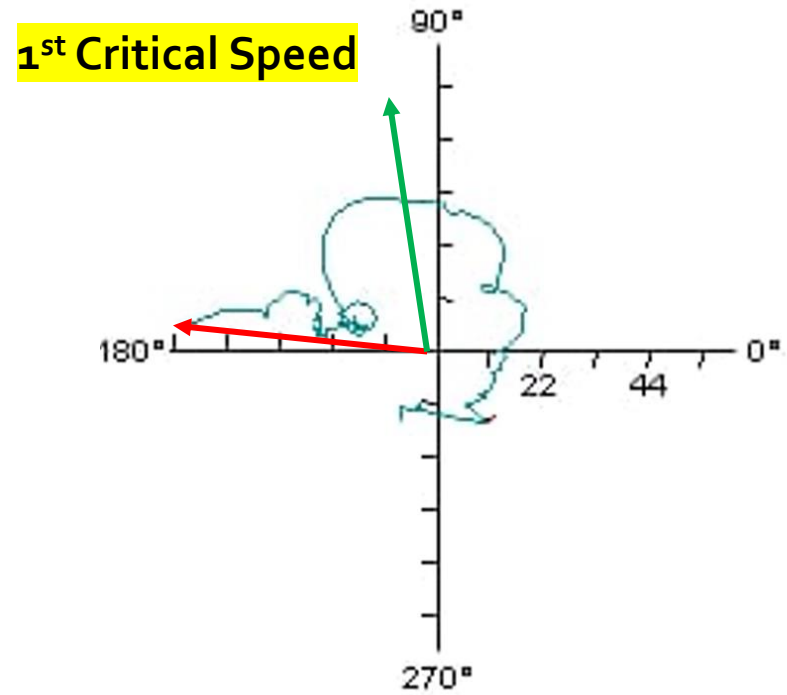
On-site Balancing – Steam Turbine Using Emerson CSI 2140

Units =
microns Pk-Pk
Filter=Cust
Order=1.000



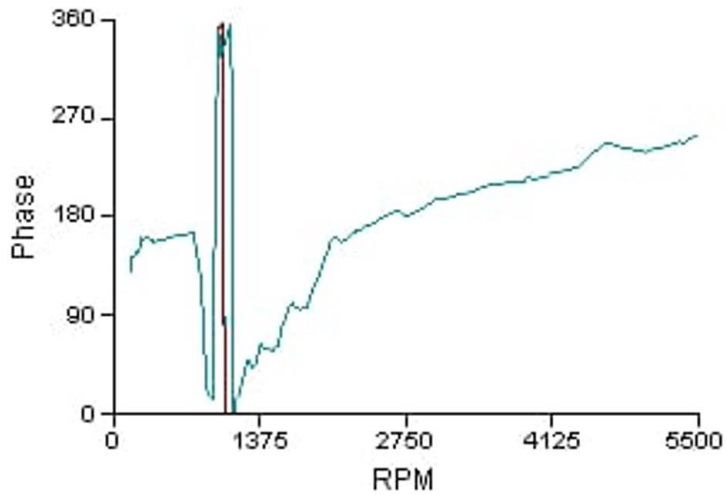
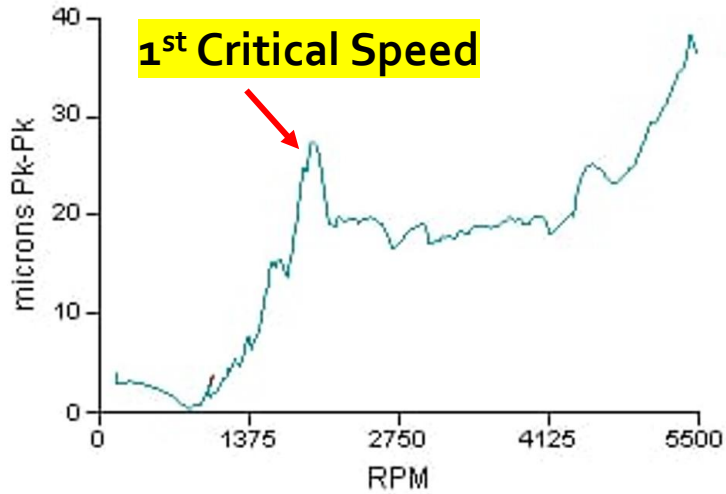
Turbine Drive End – 2X Polar Plot

Units =
microns Pk-Pk
Filter=Cust
Order=1.000

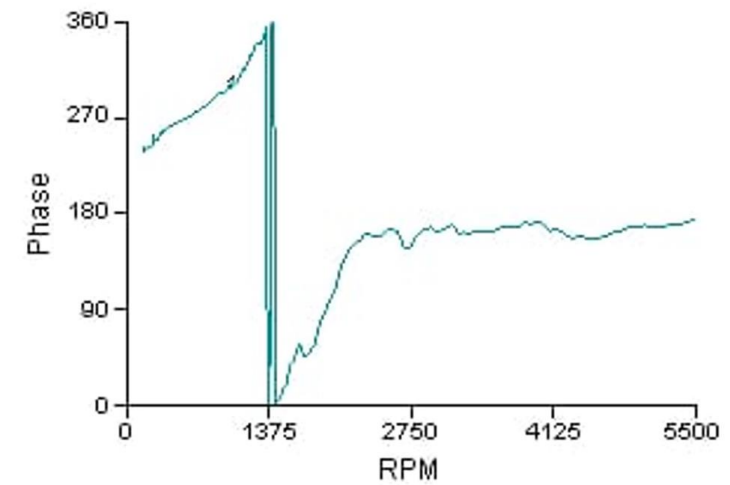
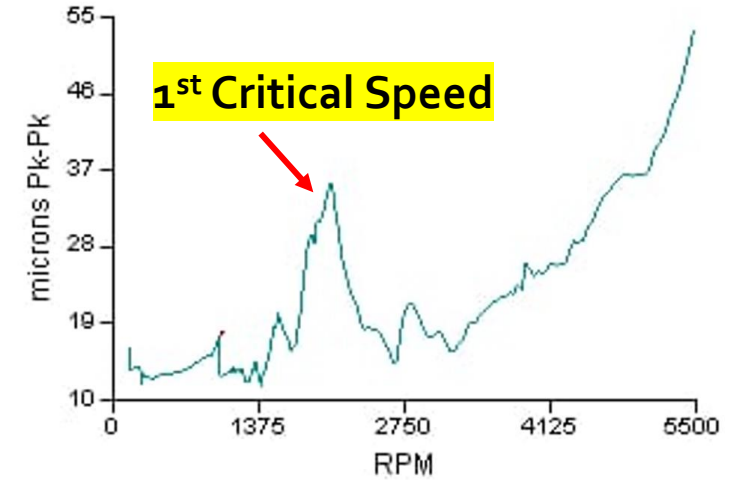


Turbine Non - Drive End – 1X Polar Plot

On-site Balancing – Steam Turbine Using Emerson CSI 2140



Turbine Drive End – Bode Plot



Turbine Non - Drive End – Bode Plot

On-site Balancing – Steam Turbine Using Emerson CSI 2140

Initial Vibration readings

Location	1X Vibration	Phase	Speed
TNDE – 1X	65 um PP	173°	5480 rpm
TNDE – 1Y	87 um PP	299°	5480 rpm
TDE – 2X	42 um PP	261°	5480 rpm
TDE – 2Y	75 um PP	166°	5480 rpm



Turbine Non - Drive End

1st Trail Weight Readings on the right side (100 gm @ 202.5 deg)

Location	1X Vibration	Phase	Speed
TNDE – 1X	26 um PP	166°	5480 rpm
TNDE – 1Y	72 um PP	292°	5480 rpm
TDE – 2X	40 um PP	244°	5480 rpm
TDE – 2Y	26 um PP	3°	5480 rpm

On-site Balancing – Steam Turbine Using Emerson CSI 2140

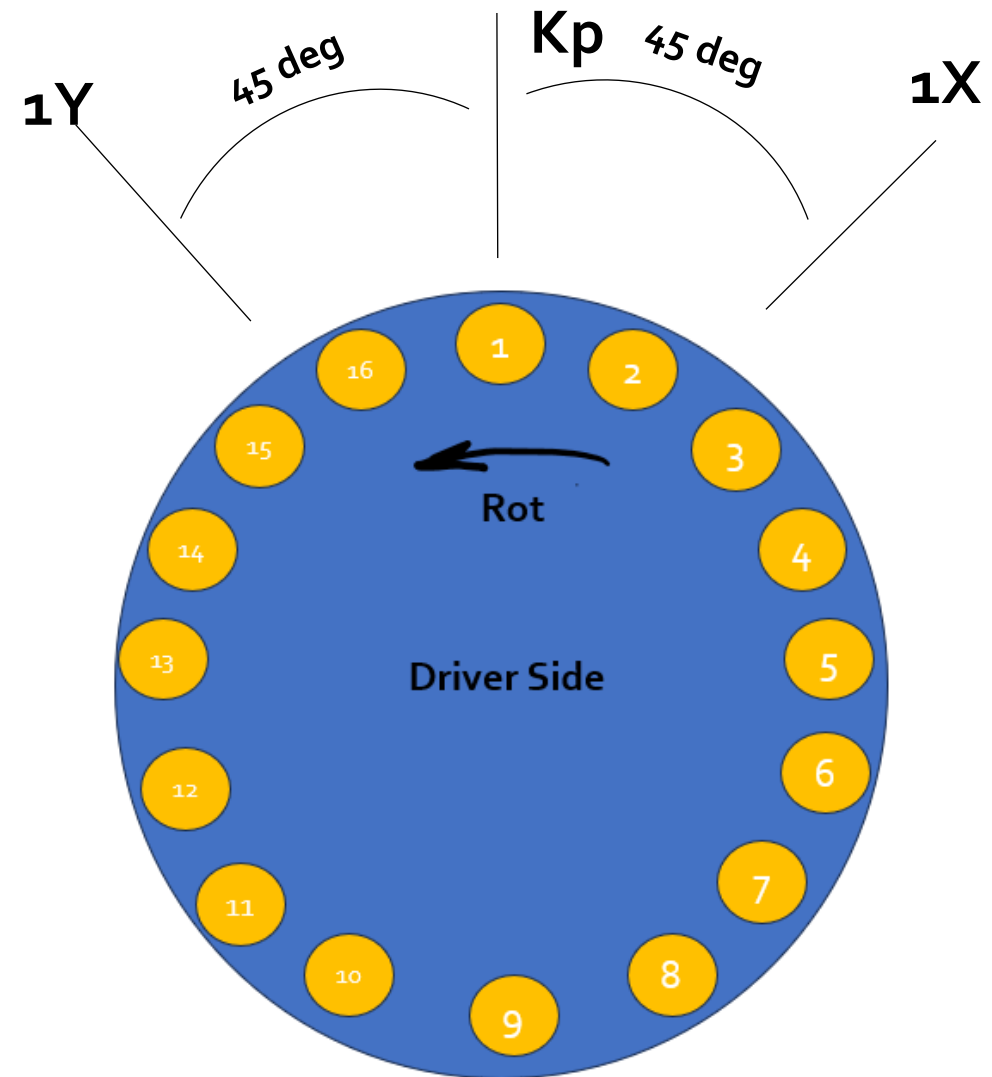
1st Trail Weight Location

Location	1X Vibration	Phase	Speed
TNDE – 1X	55 um PP	173°	5480 rpm

1st Trail Weight Readings on the right side (80gm @ 202.5 deg)

Rotate the 1X probe 45° to the left, in the same direction as the shaft rotation, to compensate for the angle difference by adding 45° to the measured phase value.

As we run above the critical speed, so the heavy spot and high spot are out of phase approximately 180 deg, and the location of our trail weight should be very close to high spot location.



Turbine Non - Drive End

On-site Balancing – Steam Turbine Using Emerson CSI 2140

Initial Vibration readings

Location	1X Vibration	Phase	Speed
TNDE – 1X	65 um PP	173°	5480 rpm
TNDE – 1Y	87 um PP	299°	5480 rpm
TDE – 2X	42 um PP	261°	5480 rpm
TDE – 2Y	75 um PP	166°	5480 rpm

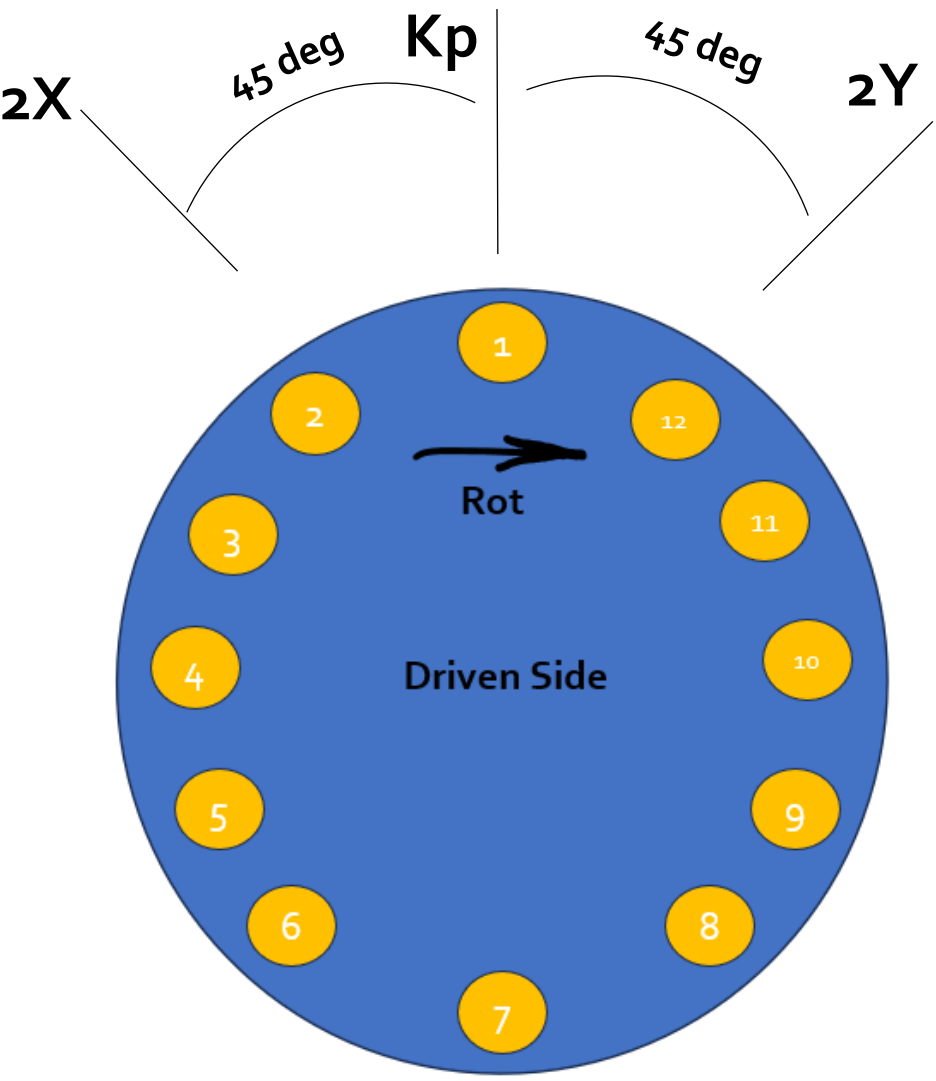
2nd Trial Weight Readings on the left side (50gm @ 300 deg)

Location	1X Vibration	Phase	Speed
TNDE – 1X	25 um PP	274°	5480 rpm
TNDE – 1Y	13 um PP	40°	5480 rpm
TDE – 2X	12 um PP	229°	5480 rpm
TDE – 2Y	73 um PP	141°	5480 rpm



Turbine Drive End

On-site Balancing – Steam Turbine Using Emerson CSI 2140



2nd Trail Weight Location

Location	1X Vibration	Phase	Speed
TDE – 2X	42 um PP	261°	5480 rpm

2nd Trail Weight Readings on the left side (50gm @ 300 deg)

Rotate the 2X probe 45° to the right, in the same direction as the shaft rotation, to compensate for the angle difference by adding 45° to the measured phase value.

As we run above the critical speed, so the heavy spot and high spot are out of phase approximately 180 deg, and the location of our trail weight should be very close to high spot location.

On-site Balancing – Steam Turbine Using Emerson CSI 2140

Initial Vibration readings

Location	1X Vibration	Phase	Speed
TNDE – 1X	65 um PP	173°	5480 rpm
TNDE – 1Y	87 um PP	299°	5480 rpm
TDE – 2X	42 um PP	261°	5480 rpm
TDE – 2Y	75 um PP	166°	5480 rpm



Correction weights Readings

(217 gm @ 352 deg on Right Side) – (99 gm @ 300 deg on Left Side)

Location	1X Vibration	Phase	Speed
TNDE – 1X	14 um PP	48°	5480 rpm
TNDE – 1Y	18 um PP	192°	5480 rpm
TDE – 2X	12 um PP	139°	5480 rpm
TDE – 2Y	16 um PP	264°	5480 rpm



On-site Balancing – Steam Turbine Using Emerson CSI 2140

Metric Units	Vertical Y-Axis Probe Calculations					
	Probe # 1VD			Probe # 2VD		
	Mag.*	°	Angle	Mag.*	°	Angle
INPUT:						
Slow Roll	E1=	0.00	°	0	E2=	0.00 ° 0
Initial Vibration	A1=	42.00	°	261	A2=	65.00 ° 173
Calib. Wt. @ Plane	B11=	12.00	°	229	B21=	25.00 ° 274
Calib. Wt. @ Plane	B12=	40.00	°	244	B22=	26.00 ° 166
Calib. Weights	W1=	50.00	°	300	W2=	100.00 ° 202
CALCULATED:						
Runout	A1c=	42.00	°	261	A2c=	65.00 ° 173
Compensated	B11c=	12.00	°	229	B21c=	25.00 ° 274
Vibration Vectors	B12c=	40.00	°	244	B22c=	26.00 ° 166
Response from	C11=	32.45	°	92	C21=	73.96 ° 334
Calibration	C12=	12.28	°	153	C22=	39.32 ° 358
Weights	W1e=	50	°	300	W2e=	100 ° 202
Equiv. Cal. Wt. Add	S11=	0.649	°	152	S21=	1.479 ° 34
Unbalance Sens.	S12=	0.123	°	311	S22=	0.393 ° 156
μMeters _{pp} /Gram	S11=	1.54	°	208	S21=	0.68 ° 326
Unbalance Sens.	S12=	8.14	°	49	S22=	2.54 ° 204
Grams/μMeters _{pp}						
INITIAL RESULTS:						
Unbalance	U1=	99	°	125	U2=	217 ° 172
Weight Add	Wa1=	99	°	305	Wa2=	217 ° 352

On-site Balancing – Steam Turbine Using Emerson CSI 2140

Balancing Weights

