



47TH TURBOMACHINERY & 34TH PUMP SYMPOSIA
HOUSTON, TEXAS | SEPTEMBER 17-20, 2018
GEORGE R. BROWN CONVENTION CENTER

BB1 LATERAL DYNAMIC ANALYSIS

LANDON COOPER

SULZER



TEXAS A&M
UNIVERSITY



TURBOMACHINERY LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

Presenter/Author bios

Landon Cooper is a Field Engineer at Sulzer Pumps Services. He has 10 years of experience working with end user's to help improve pump life.



Abstract

Customer has four 4x8x13 BB1 booster pumps for produced water injection. One pump was recently repaired and ran for only 4 months. Typically these pumps run about 16-18 months.

Before shutting down the pump it had a high 1x vibration. It was discovered that the pump clearances had increased to 5x running clearances. The customer wanted to increase the mean time between repairs. A solution was derived doing a lateral dynamic analysis.



Outline

- Problem
- Work Scope
- Options and Solution
- Results
- Lateral harmonic Response
- Additional Changes
- Field Results
- Lesson Learned



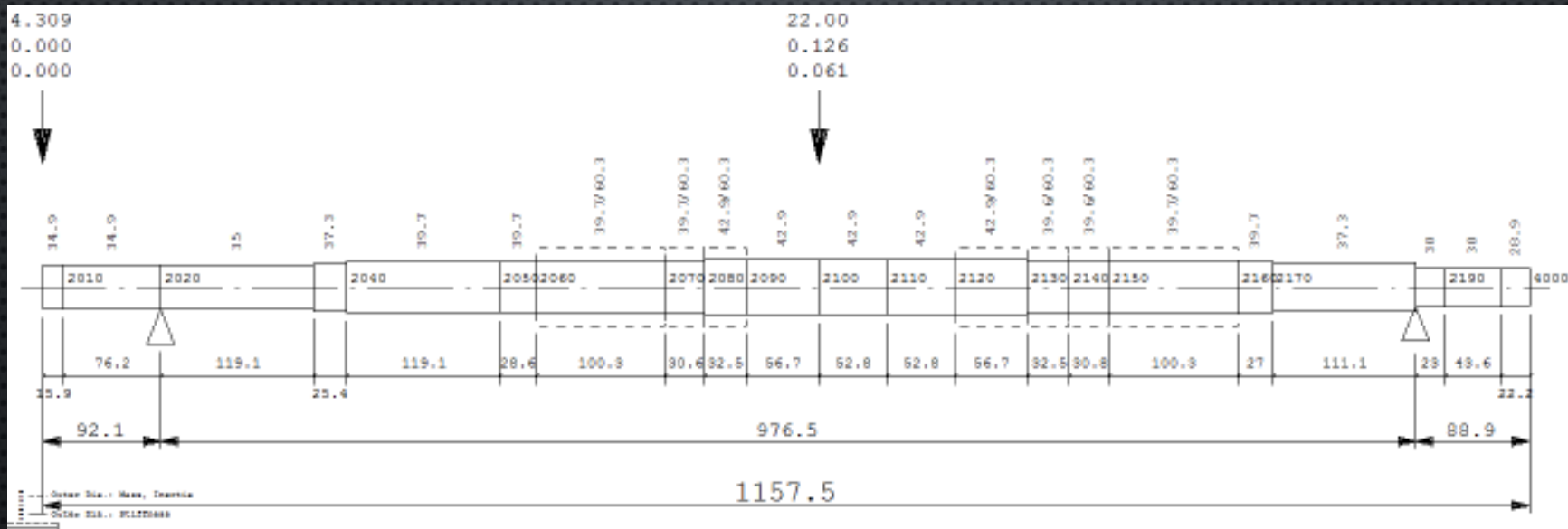
Problem

- Customer has four 4x8x13 BB1 pump and are only getting 16-18 months of runtime.
- Produced Water Injection
- Upon a recent repair one only last 4 months.
- High abrasive services
- As the pumps wear clearances increased the customers pump would see a high 1X vibration.



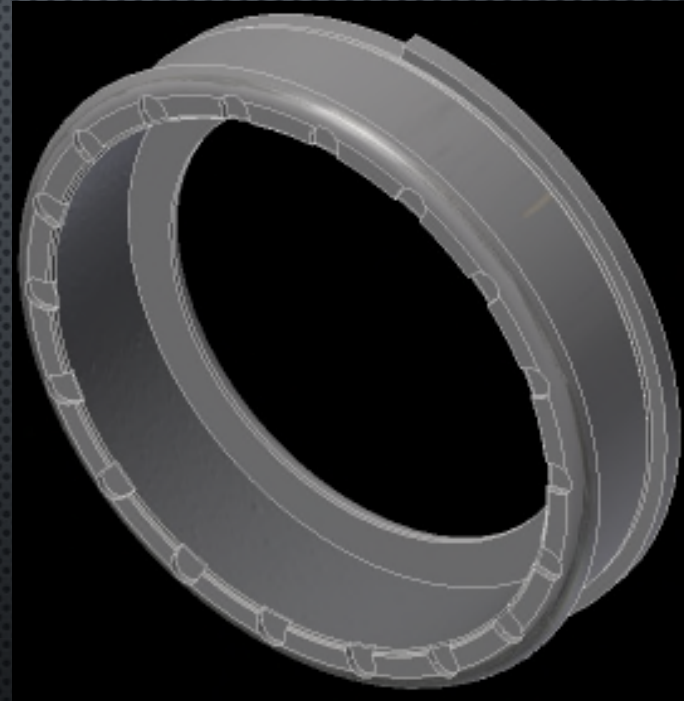
Work Scope

- A lateral dynamic analysis to determine best possible solution.



Option 1 - Swirl brakes

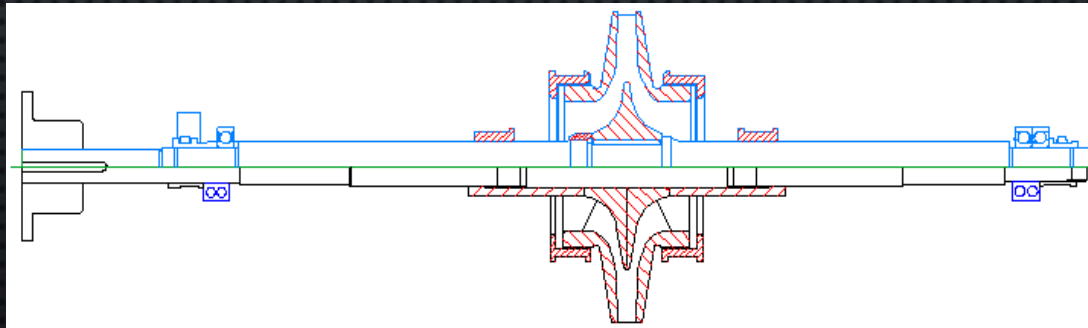
- Benefits
 - Reduces inlet swirl
 - Increase rotor stability



Larger Shaft Continued

Shaft @	New Design (in)	Old Design (in)
Impeller Bore	Ø2.125	Ø1.688
Mech. Seal Area	Ø2.00	Ø1.563
Bearings	Ø1.575	Ø1.468/1.181

New design



Old design



Results – Larger Shaft

- Lateral dynamic analysis

Clearance	New Pump Clearance		2x Pump Clearance		5X Clearance	
	damping	hz	damping	hz	damping	hz
As Designed	34%	93	26%	73	19%	53
Larger Shaft	31%	101	24%	84	18%	69



Results – Swirl Brakes

Clearance	New Pump Clearance		2x Pump Clearance		5X Clearance	
	damping	hz	damping	hz	damping	hz
As Designed	34%	93	26%	73	19%	53
Swirl brakes – Wear rings	48%	90	43%	71	41%	51



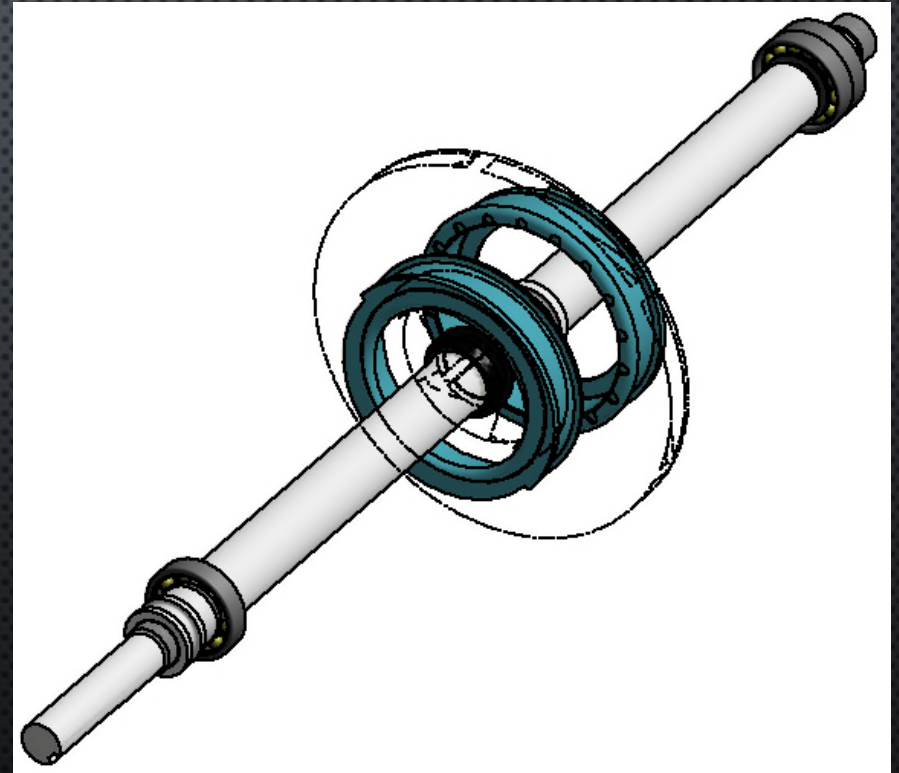
Results – Both Options

Clearance	New Pump Clearance		2x Pump Clearance		5X Clearance	
	damping	hz	damping	hz	damping	hz
As Designed	34%	93	26%	73	19%	53
Both (Shaft - Swirl brakes)	43%	99	36%	83	31%	69



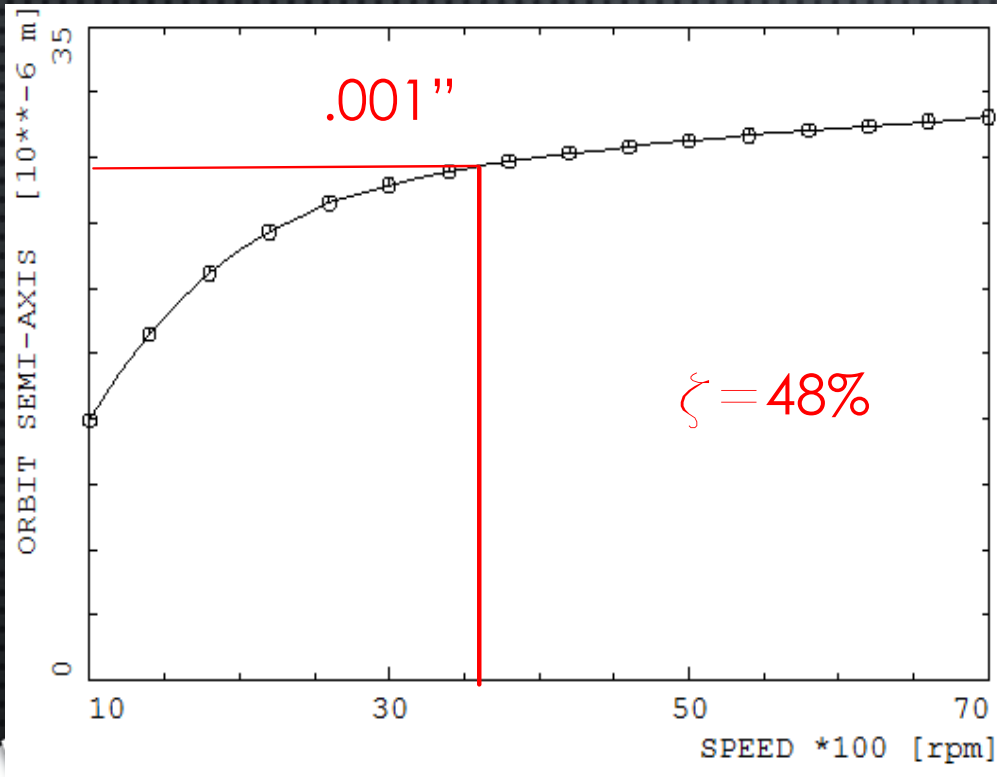
Solution

- Larger shaft, and swirl brakes.
 - Larger bearings
 - Rotor stiffness increased
 - Reduce cross-coupling stiffness (increased damping)

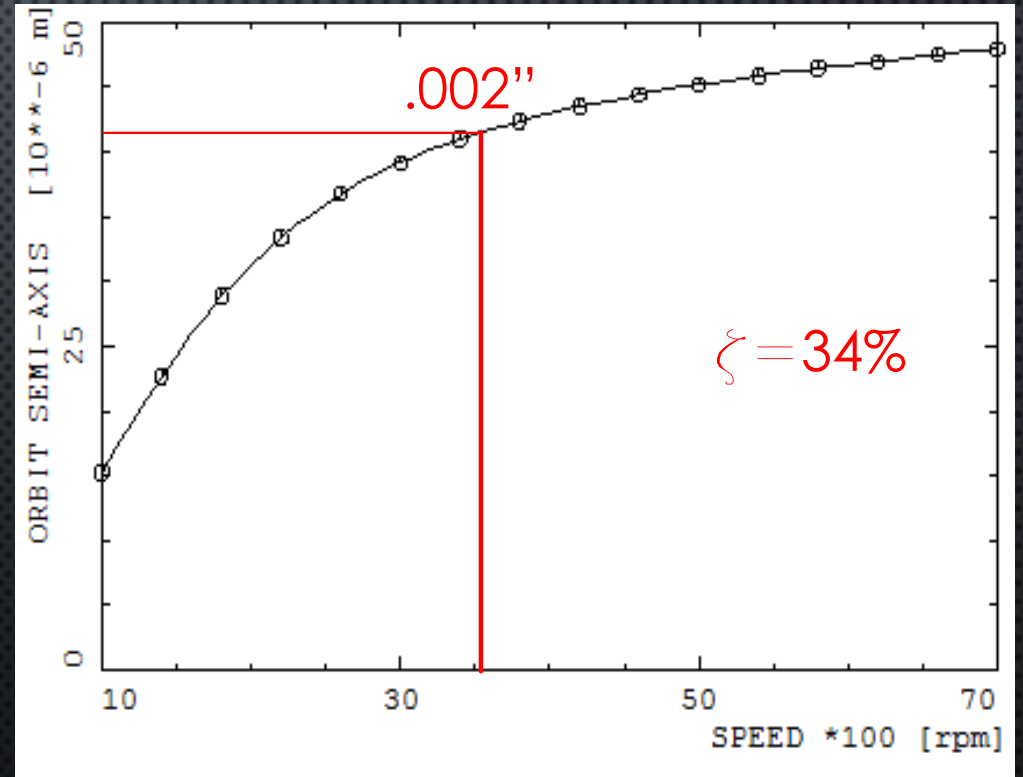


New Clearance

Swirl Brake Design



Original Design

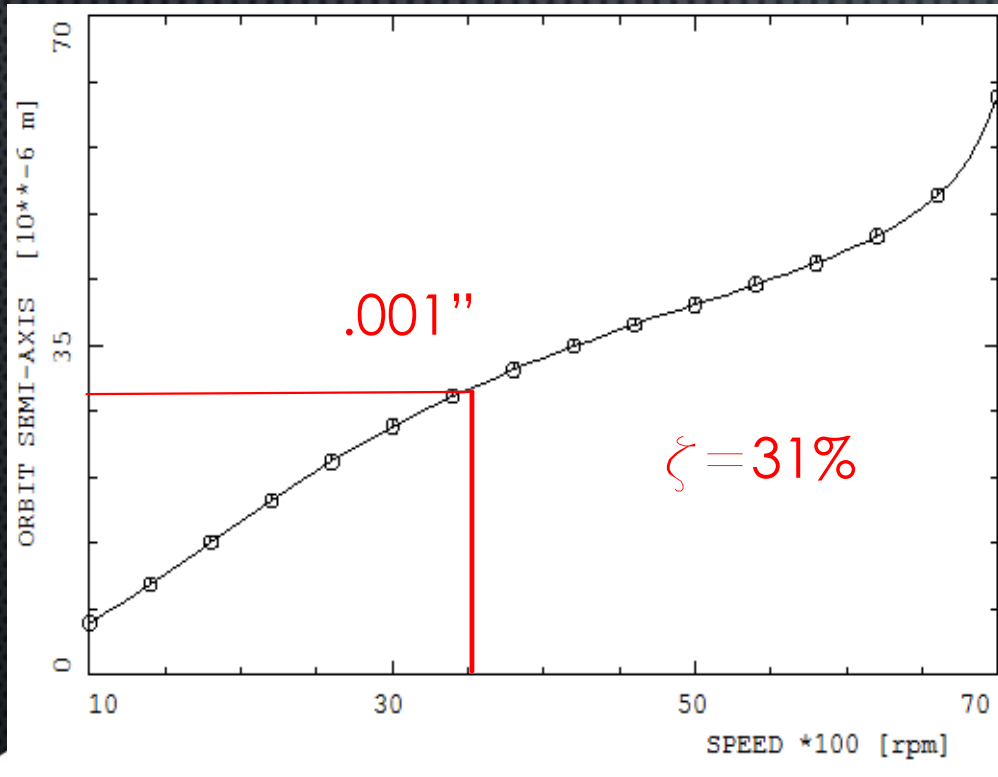


Lateral Harmonic Response @ Impeller

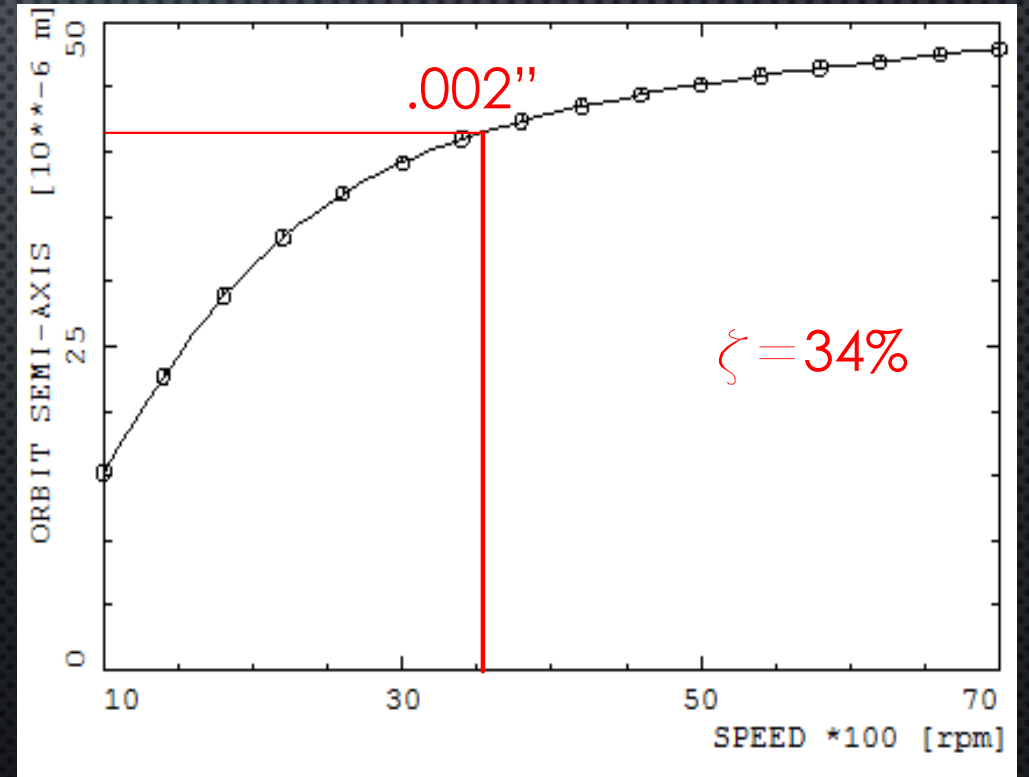


New Clearance

Larger Shaft Design



Original Design

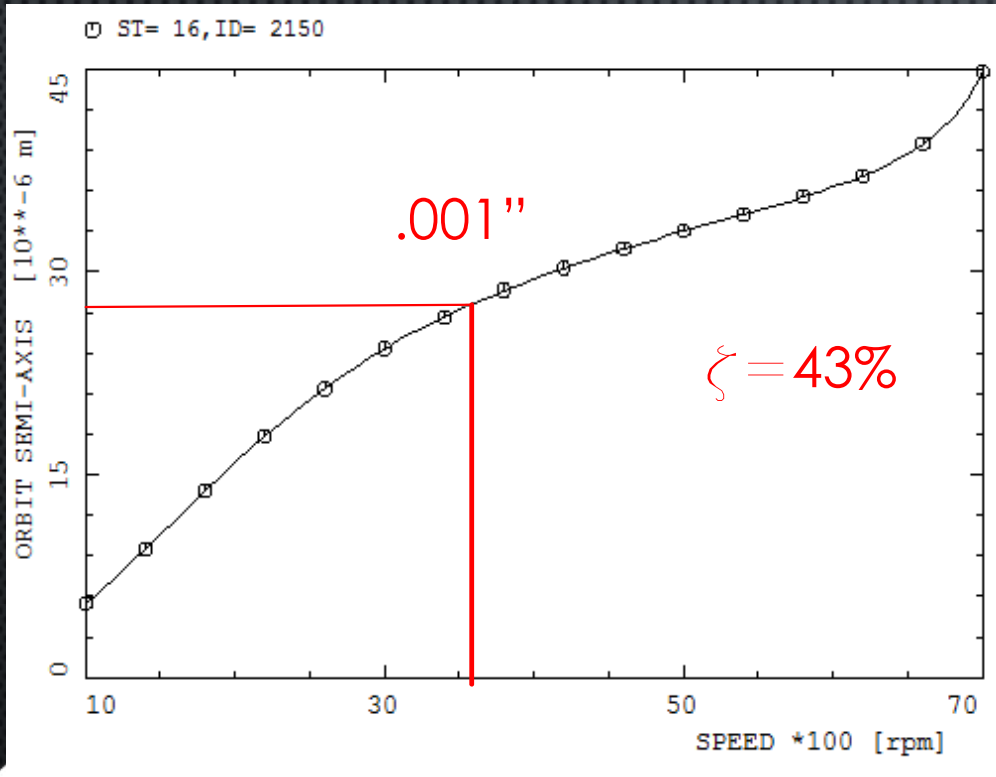


Lateral Harmonic Response @ Impeller

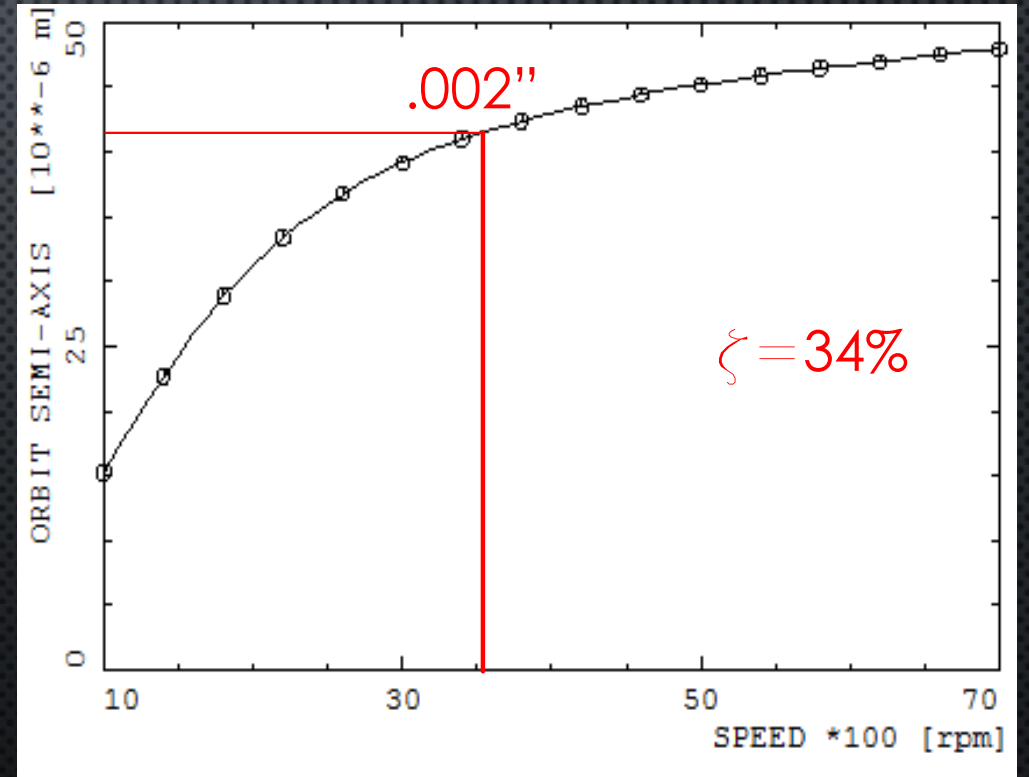


New Clearance

Upgrade Design



Original Design

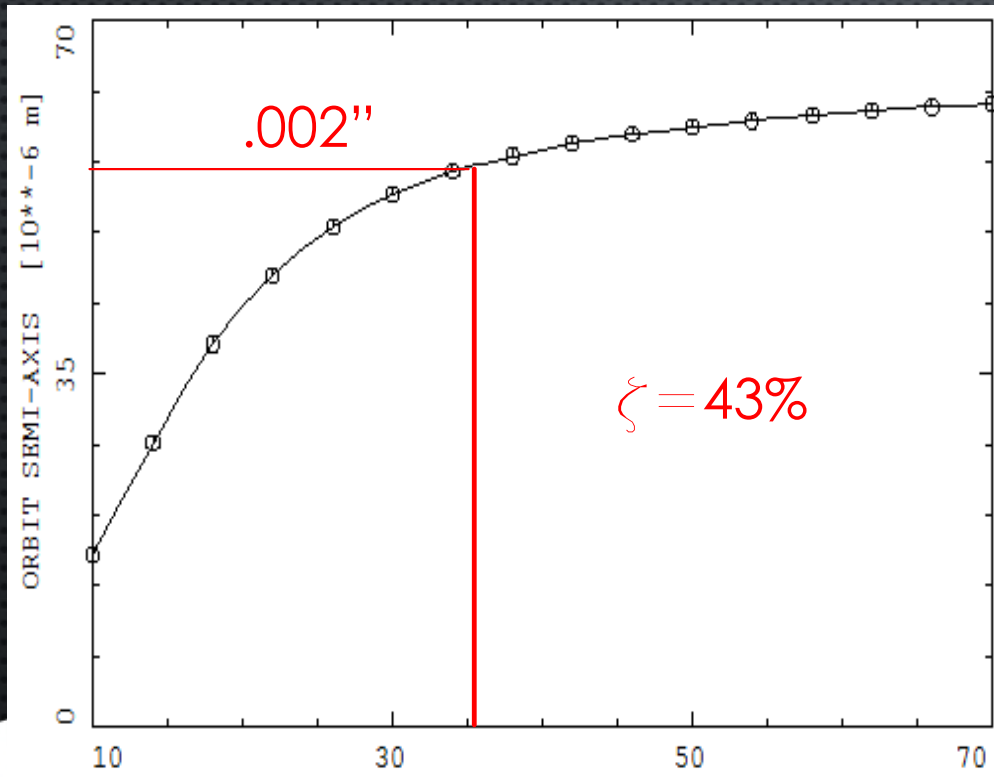


Lateral Harmonic Response @ Impeller

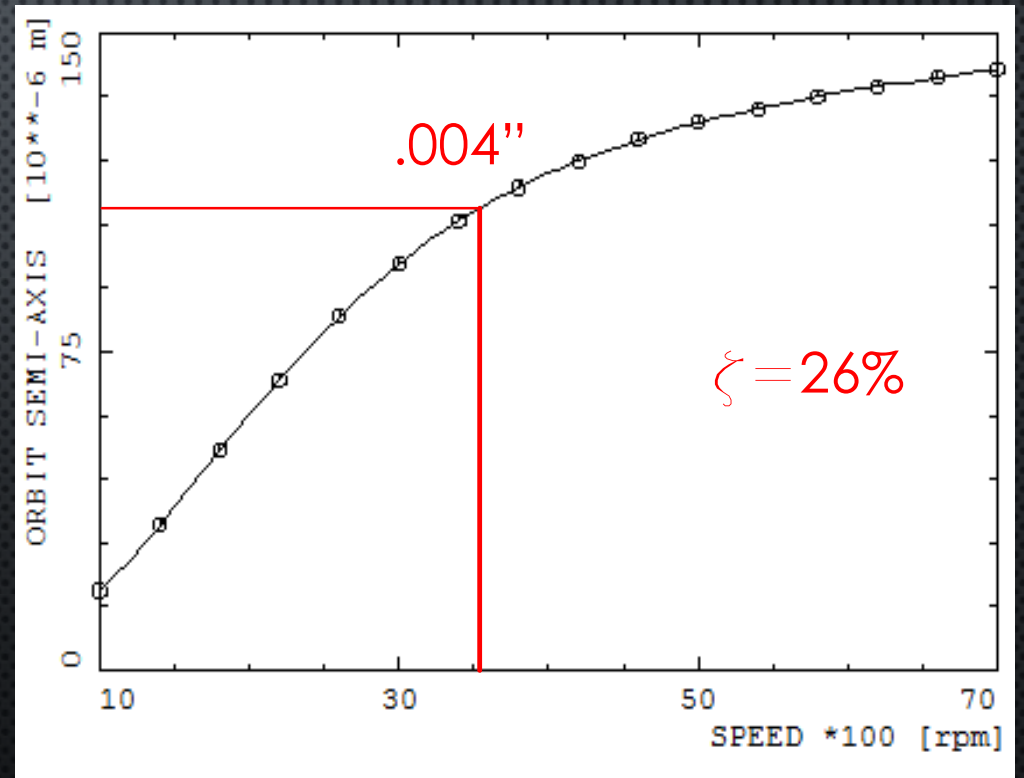


2X Clearance

Swirl Brake Design



Original Design

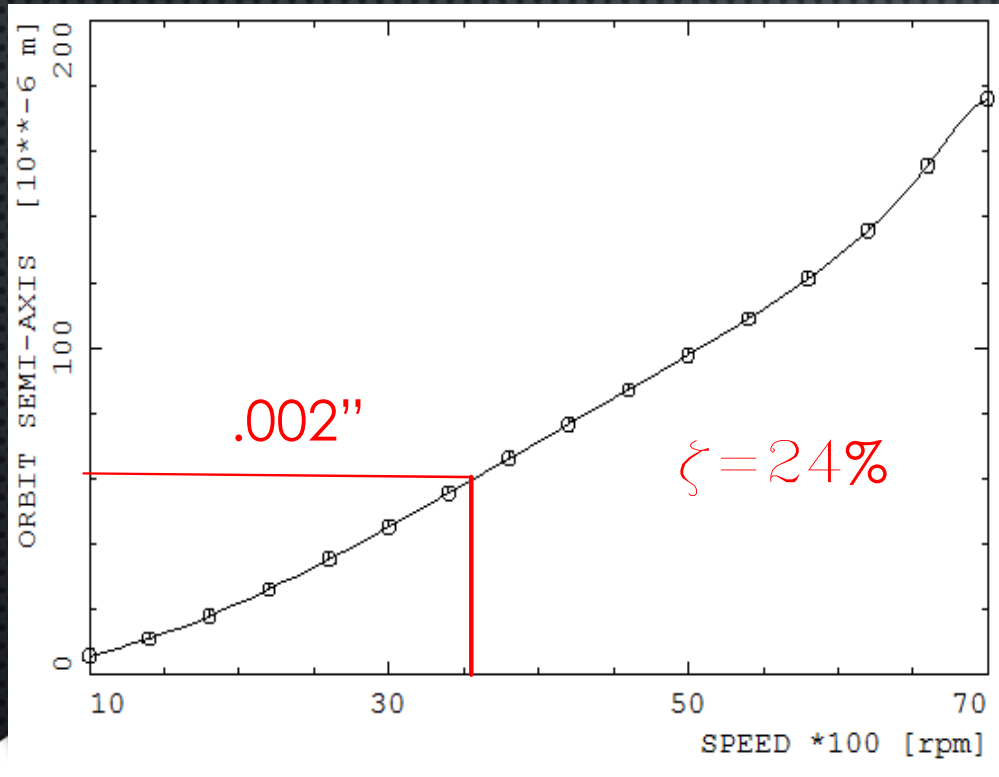


Lateral Harmonic Response @ Impeller

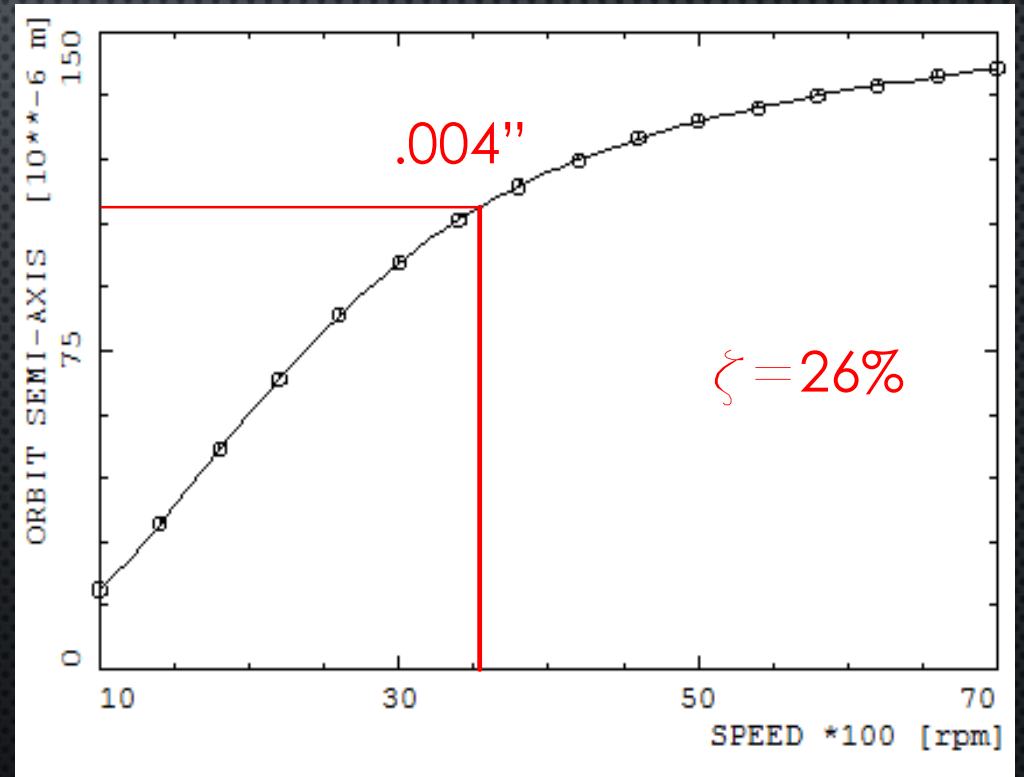


2X Clearance

Larger Shaft Design



Original Design

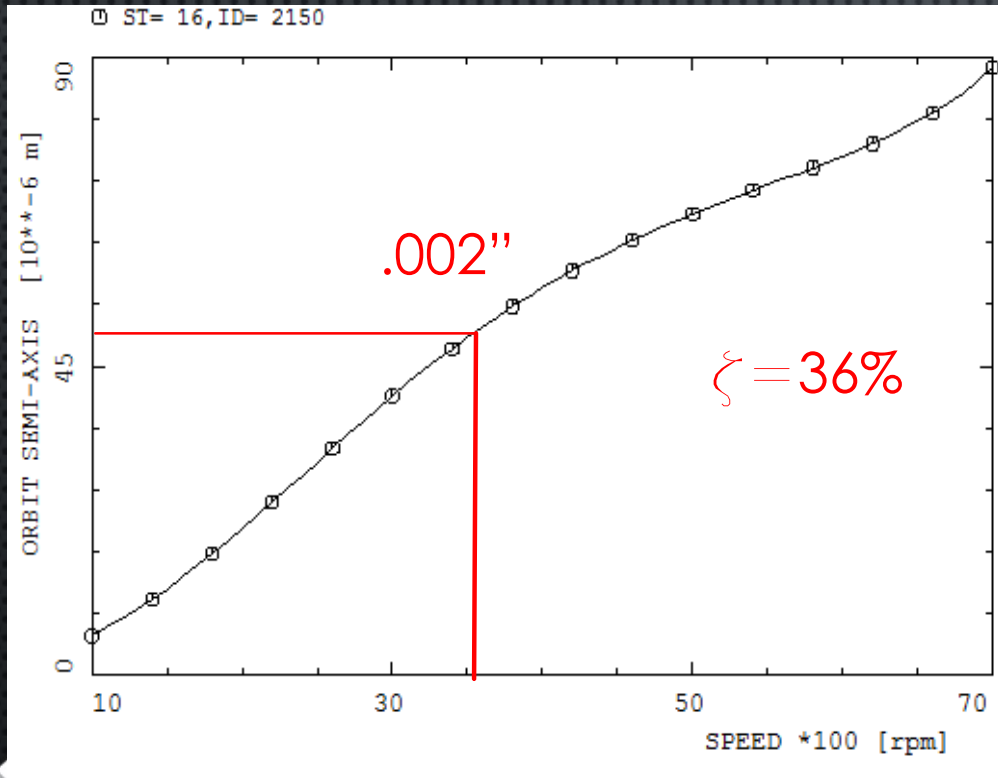


Lateral Harmonic Response @ Impeller

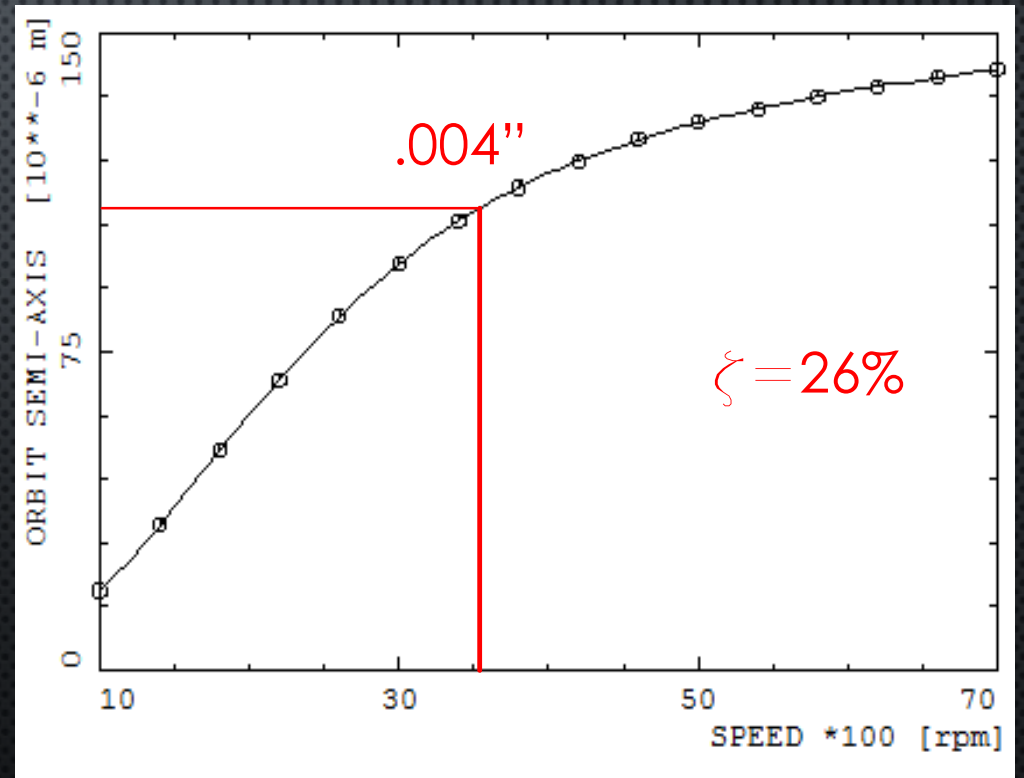


2X Clearance

Upgrade Design



Original Design

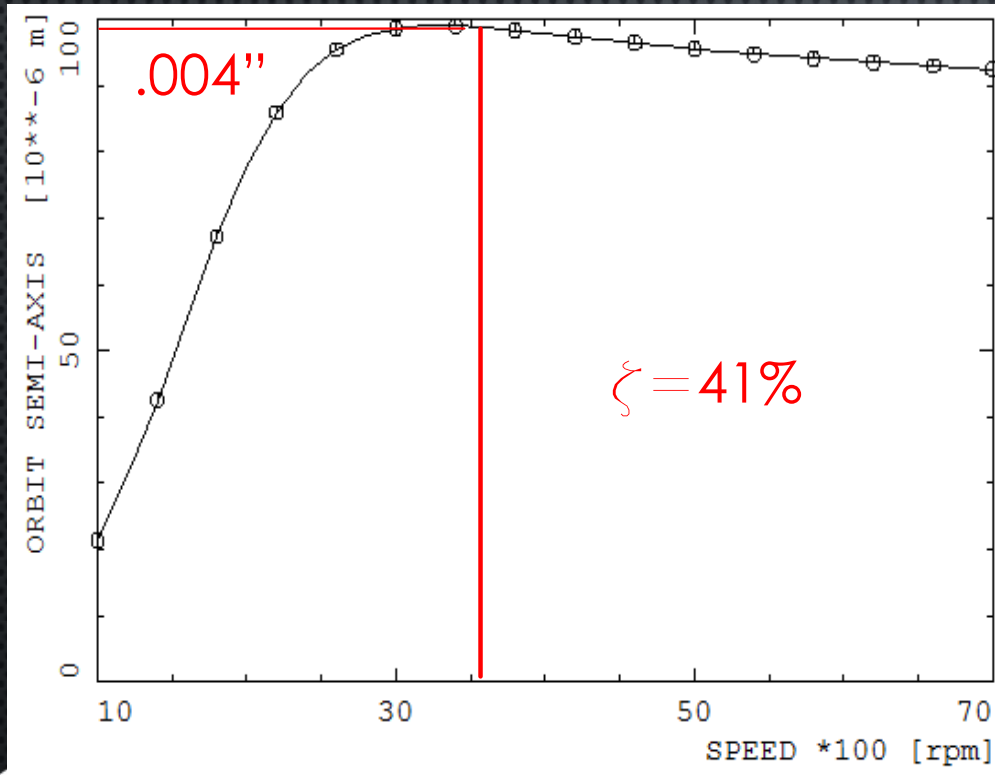


Lateral Harmonic Response @ Impeller

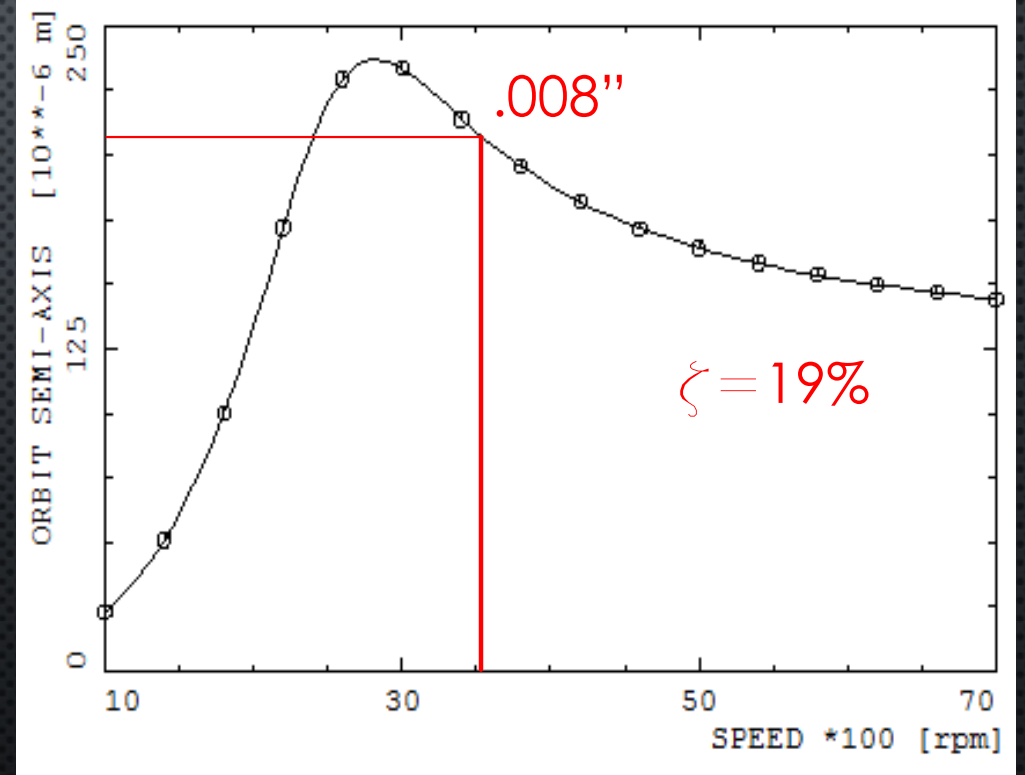


As Received

Swirl Break Design



Original Design

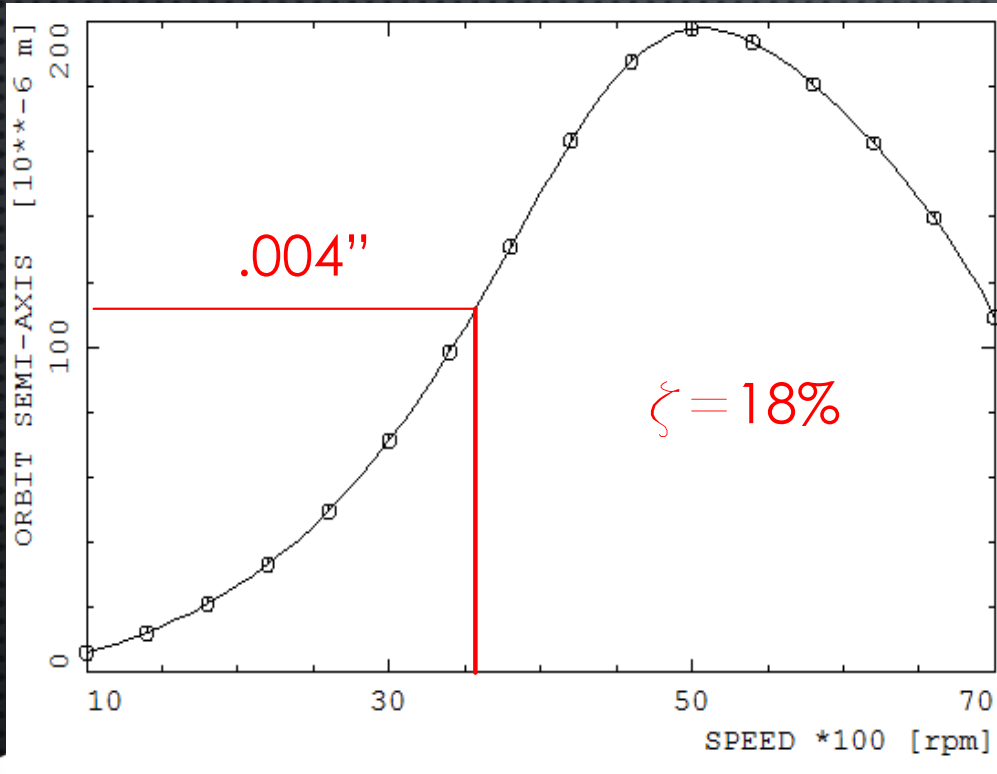


Lateral Harmonic Response @ Impeller

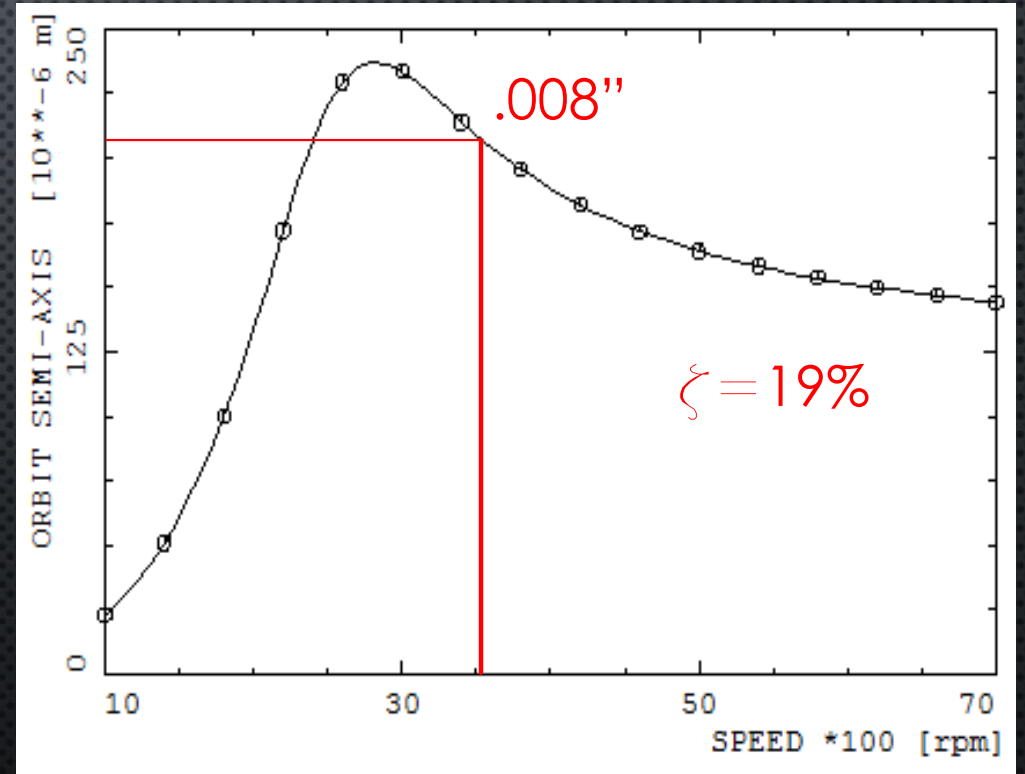


As Received

Larger Shaft Design



Original Design

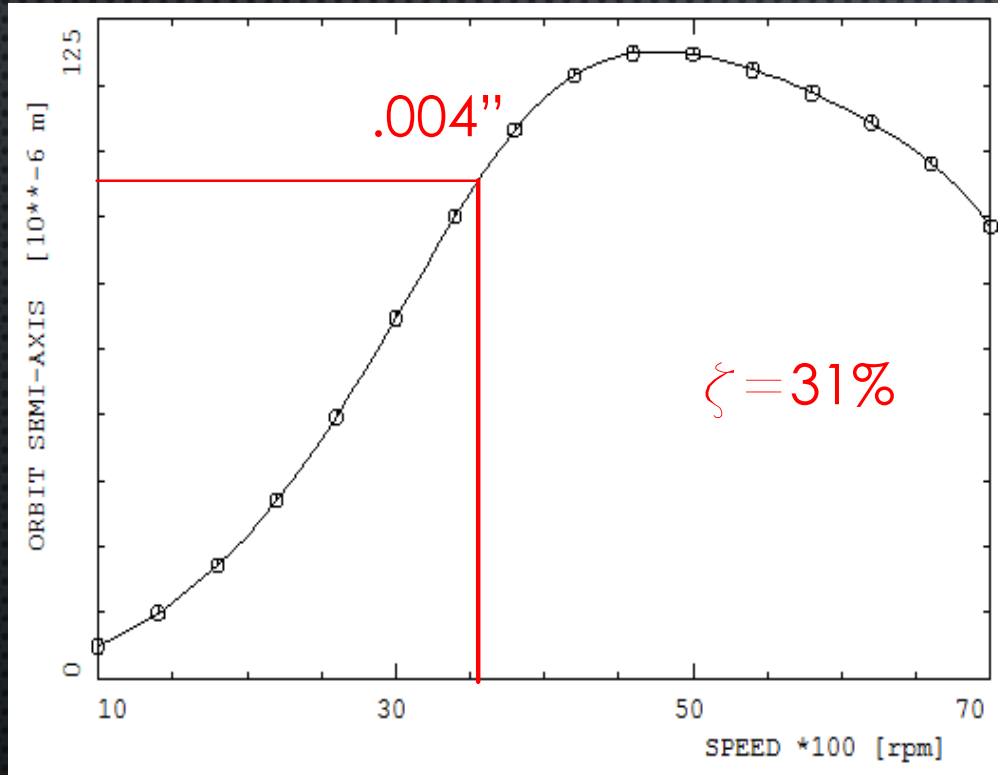


Lateral Harmonic Response @ Impeller

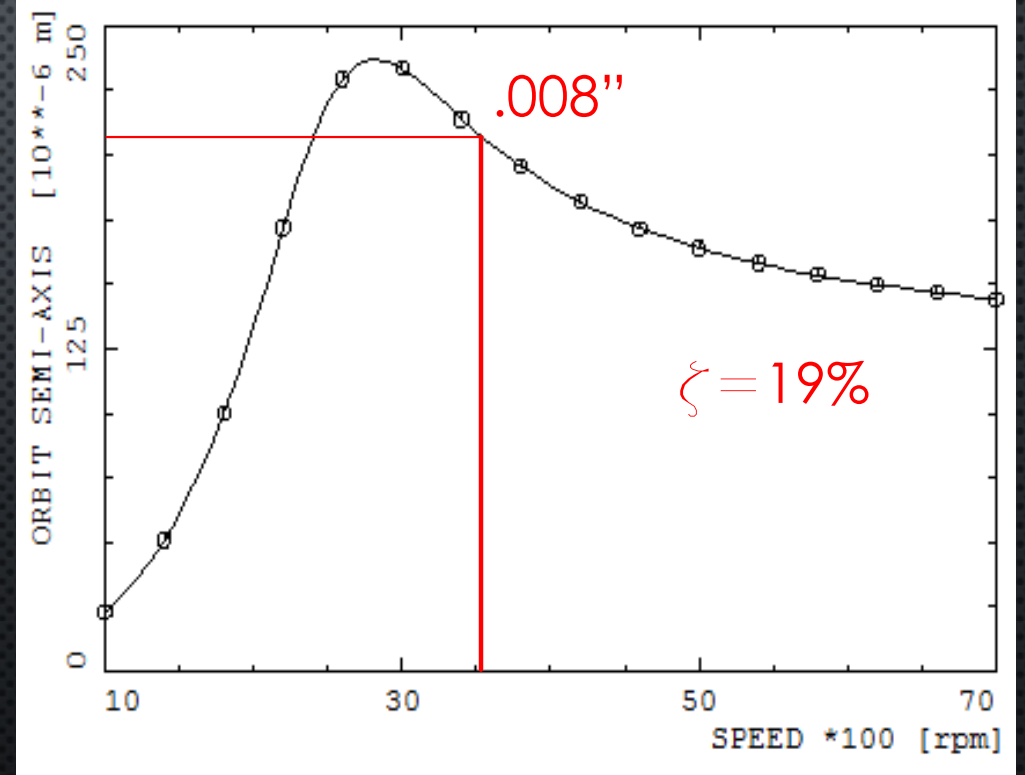


As Received

Upgrade Design



Original Design



Lateral Harmonic Response @ Impeller

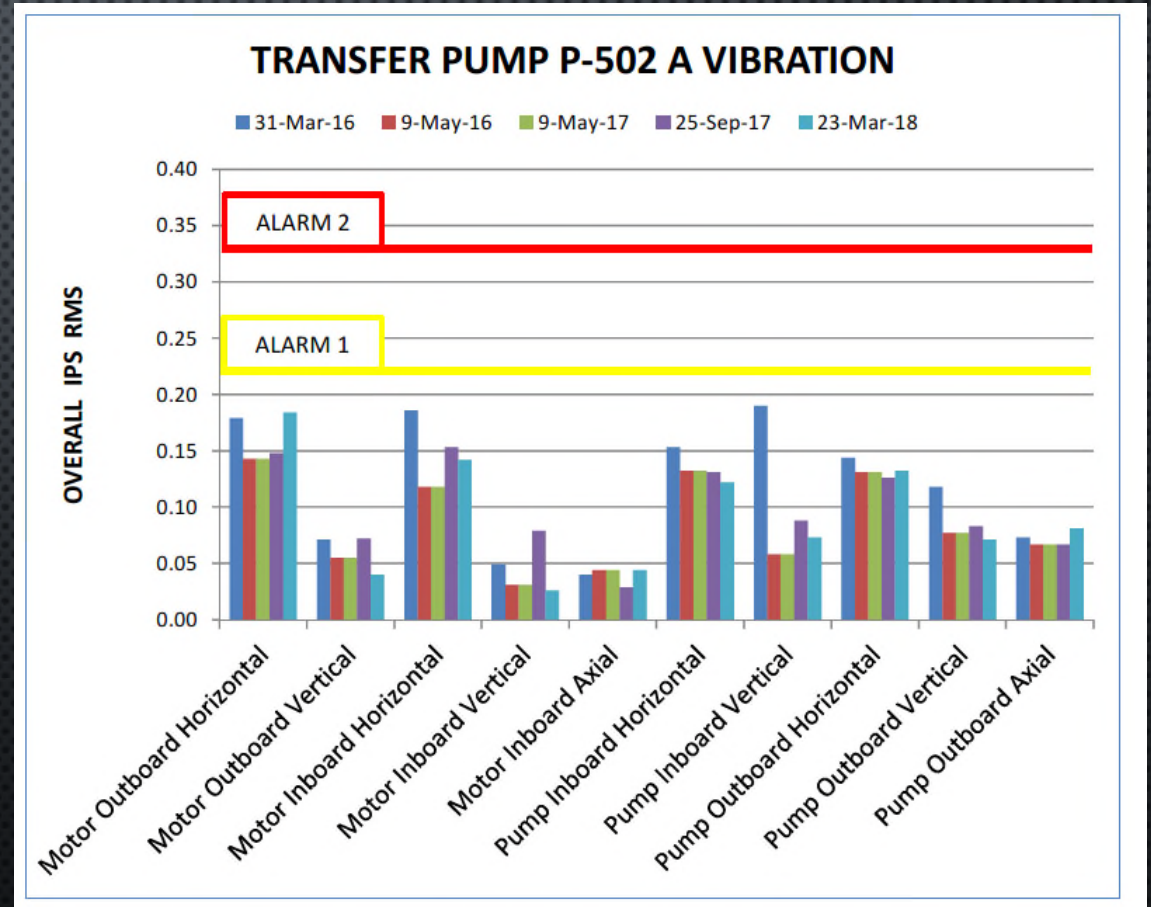
Additional Changes

- Hard face wear surfaces (Tungsten-carbide)
 - Increases wear ring clearance life.



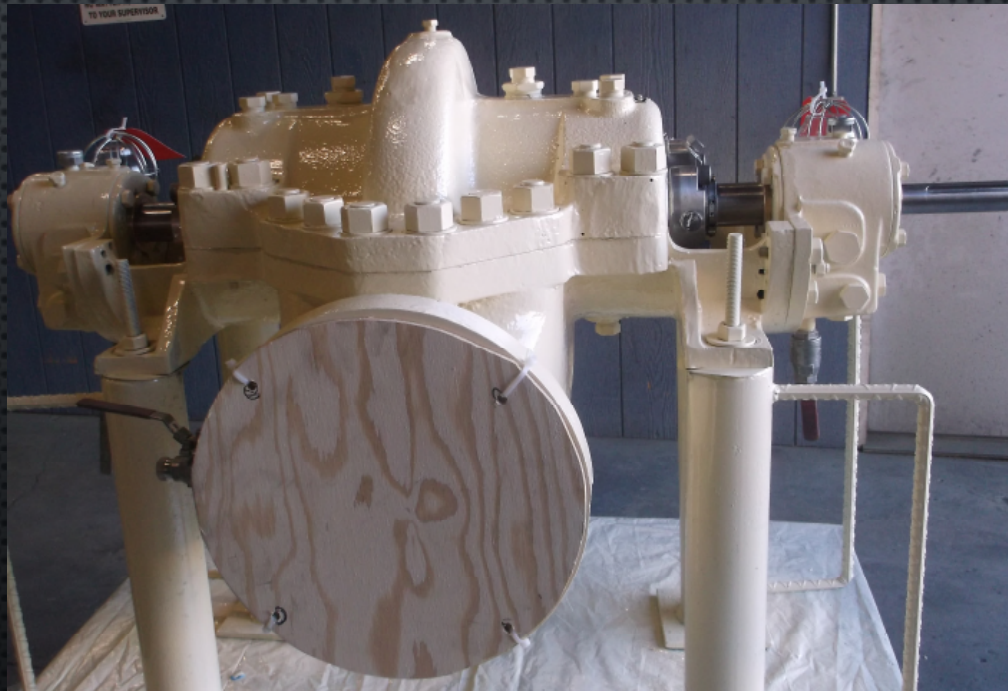
Field Results

- As of March 2018
 - Horizontal .13 IPS RMS
 - Vertical .07 IPS RMS



Lesson Learned

- Being my first lateral it was interesting to see how much damping the swirl brakes provide.



Questions?

