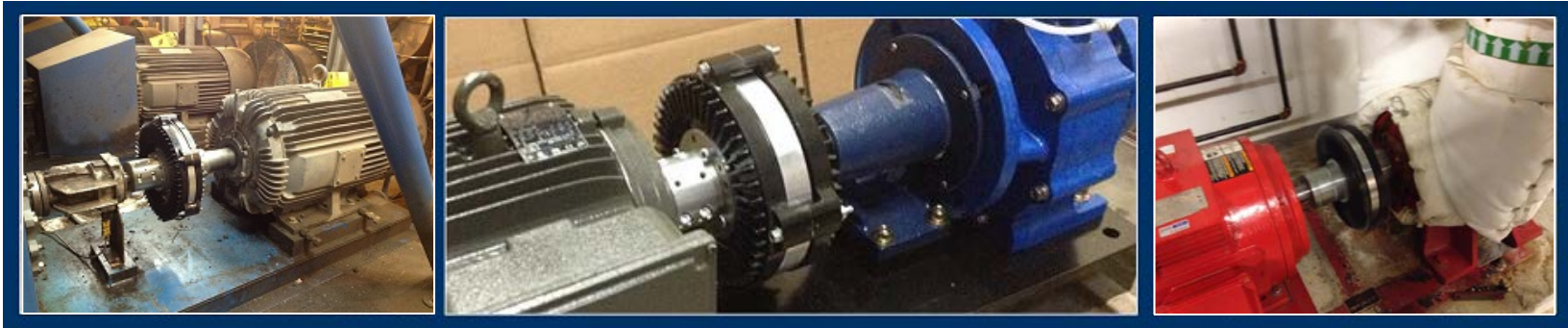
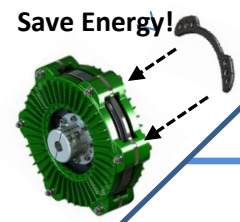


# Eliminate Misalignment and “Right-Size” Your Pumps

*Causes, Effects and New “Out-of-the-Box” Solutions*



- Participants are in a listen-only mode.
  - To ask a question during the event, use the chat feature at the bottom left of your screen. Technical questions will be answered by ReadyTalk. Questions for our speakers can be asked at any time and will be answered during the Q&A at the end of the session.
  - Visit [pumpsandsystems.com](http://pumpsandsystems.com) in the coming days to access the recording of the webinar.
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# Eliminate Misalignment and “Right-Size” Your Pumps

*Causes, Effects and New “Out-of-the-Box” Solutions*



# AGENDA

- **Introduction**
- **Misalignment Overview**
  - What is misalignment, and how is it measured?
  - Causes & effects of misalignment
- **Getting and Staying Aligned**
  - Technologies used to set alignment
  - Common reasons alignment is ignored
  - Existing flexible couplings and their limitations
  - Example of vibration at various levels of misalignment
- **Flux Drive SmartCOUPLING**
  - Magnetic coupling description and history
  - Flux Drive technology
  - Alignment benefits
  - Energy benefits
  - Case study: Veolia Environnement, Stickney, IL WWTP

## Flux Drive founded by Chip Corbin – Marine Engineer



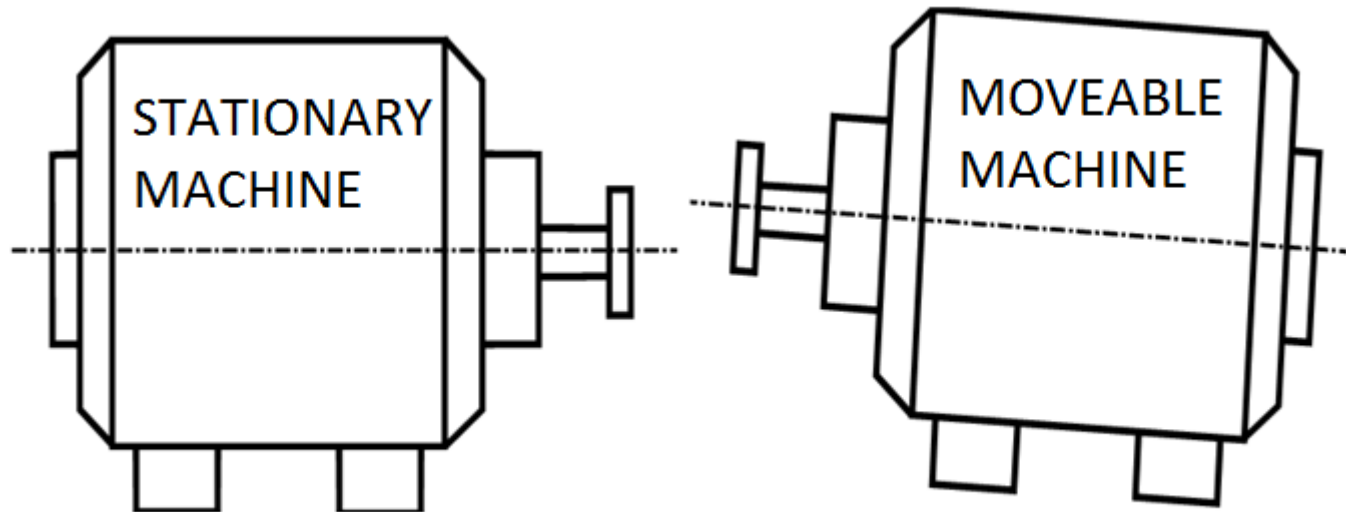
- SUNY Maritime College
- US Naval Officer - 1980s
- 1988: Founds Impact Engineering Inc.
  - Vibration mitigation and preventive maintenance services on ocean-going vessels
  - Expert alignment and balancing services
  - Chip (and team) still provides vibration services to the U.S. Navy, including highly classified vessels and global shipping lines
- 2007: Flux Drive founded.
  - Products designed to:
    1. Save energy
    2. Provide alignment and vibration mitigation benefits
    3. Survive and be serviceable at sea



# Brief Misalignment Overview

## What is Shaft Alignment?

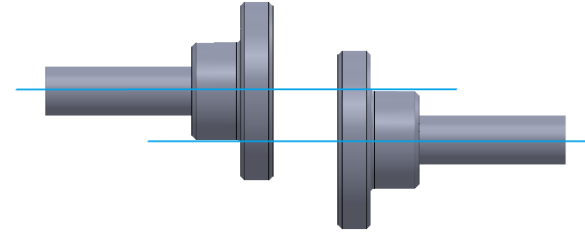
Positioning of two or more machines so that their rotating shaft center lines are collinear at the coupling under operating conditions



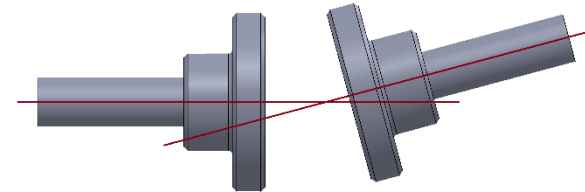
## Types of Misalignment

# OVERVIEW

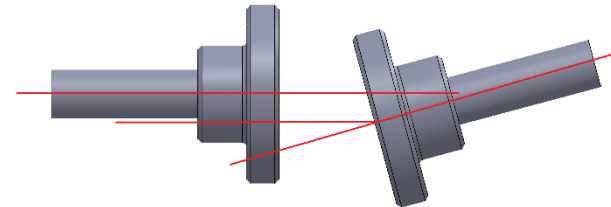
**Parallel Offset**



**Angular**



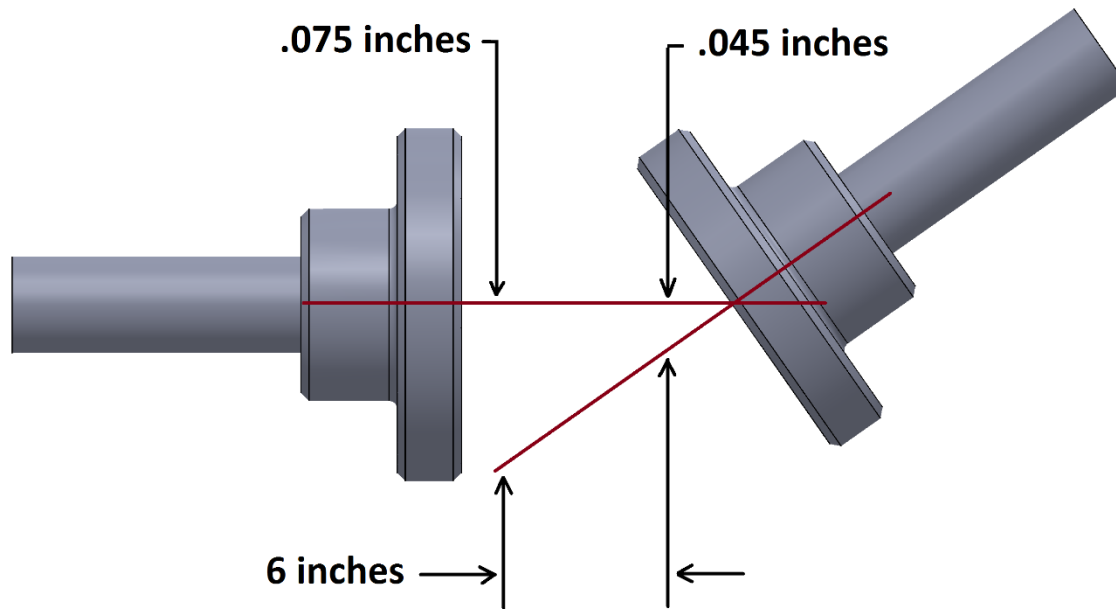
**Compound**





## Angularity Calculations

OVERVIEW



$$(.075 - .045) / 6 = 5 \text{ mils/inch of angularity}$$

## Typical Alignment Standards

RPM	Offset (mils)		Angle (mils)	
	Excellent	Good	Excellent	Good
600	5.0	9.0	10.0	15.0
900	3.0	6.0	7.0	10.0
1200	2.5	4.0	5.0	8.0
1800	2.0	3.0	3.0	5.0
3600	1.0	1.5	2.0	3.0
7200	0.5	1.0	1.0	2.0

This table Copyright © LUDECA, INC., 1990

# CAUSES

## Causes of Misalignment

- Inaccurate assembly or installation of components
  - Improper shimming
  - Post-installation torque on system from pipefitting, etc.
- Thermal growth from hot processes
- Distortion of supports due to torque
- Other equipment or base anomalies
  - Soft foot



Improper shimming



Thermal growth in hot processes

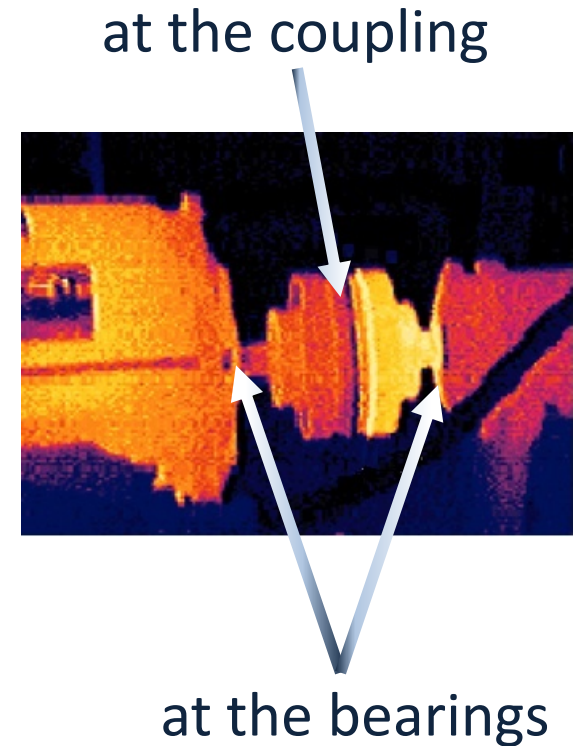


Soft foot

# EFFECTS

## Effects of Misalignment: HEAT

- Metal is under constant stress
  - Similar to bending a wire repeatedly
  - Flexible elements reduce, but that doesn't eliminate heat build-up
- Heat transfers into bearings
  - Damages grease and reduces bearing life



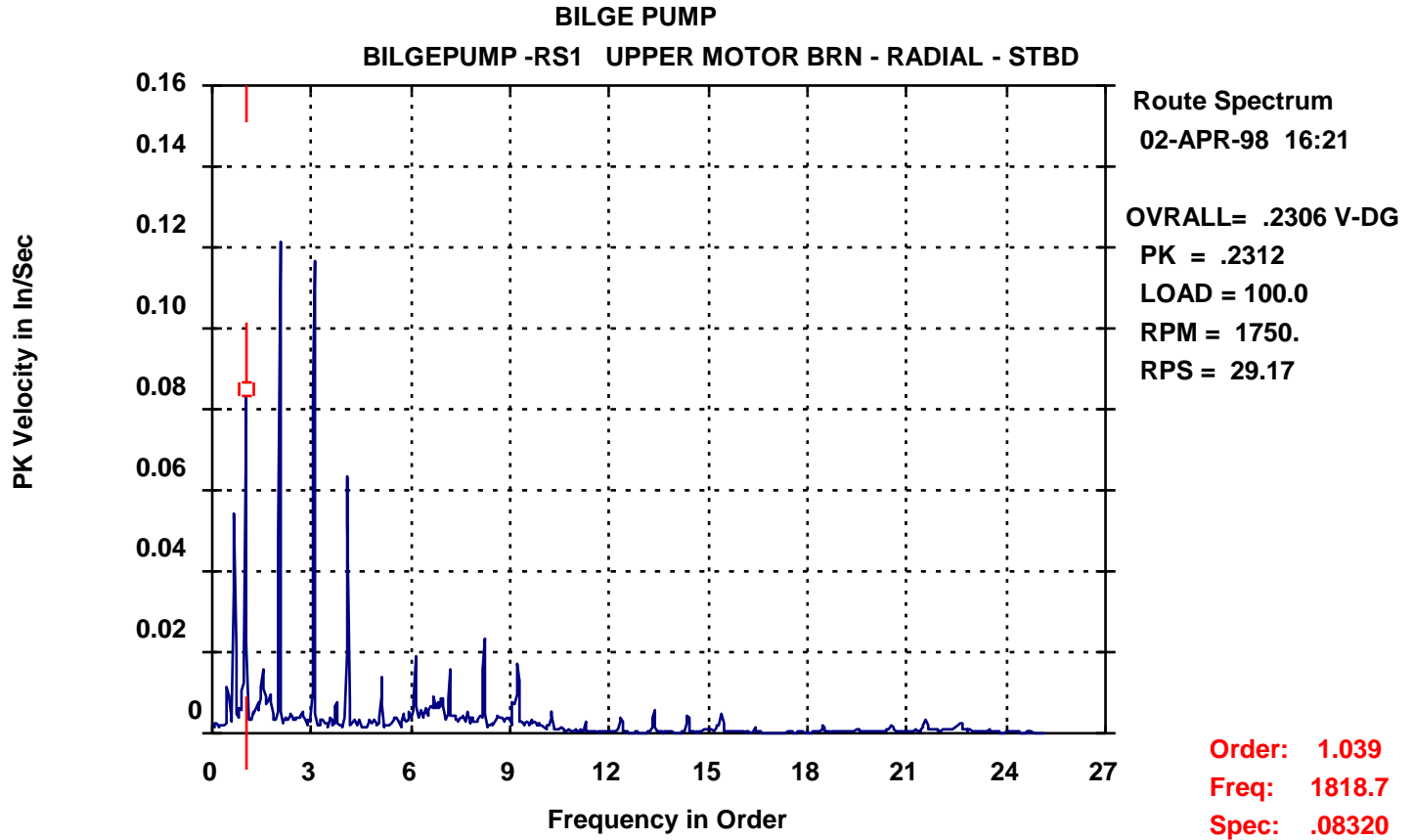
## Effects of Misalignment: VIBRATION

- Vibration damage
  - Bearings fail more rapidly
  - Seals deteriorate and leak
  - Shafts weaken over extended period
- Vibration Characteristics
  - Typical frequencies at 1x and/or 2x shaft speed (SS)
  - High vibration amplitudes in the radial and/or axial directions
  - May amplify natural frequencies in resonant structures
  - Other vibration from the coupling due to wear/lock-up conditions
  - Possible 180-degree phase shift across the coupling



# Sample Vibration Spectrum

# OVERVIEW





# Getting and Staying Aligned

## Why Perform Shaft Alignment?

Reduces:

- Vibration and noise
- Bearing, coupling and seal wear/damage
- Maintenance costs and downtime

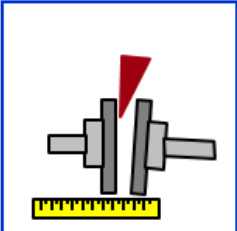
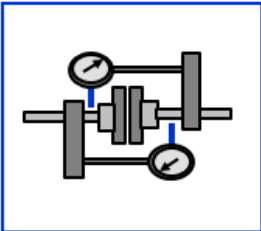
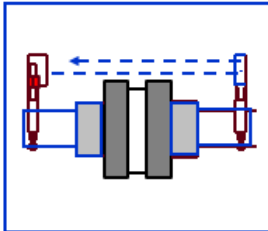
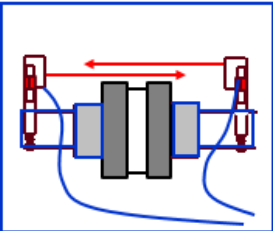
Save maintenance dollars (\$\$)

Save fuel/operating cost (\$\$)





## Alignment Alternatives

Manual Alignment	Instrumented Alignment	Invisible Laser	2nd Generation Visible Laser
<ul style="list-style-type: none"> <li>• Eyeball it</li> </ul>	<ul style="list-style-type: none"> <li>• Reverse Dial</li> <li>• Rim &amp; Face</li> <li>• Graph Paper for calculations</li> <li>• Dial Indicator to check for soft foot</li> </ul>	<ul style="list-style-type: none"> <li>• No more sag</li> <li>• Able to span longer couplings</li> <li>• Automatic Calculation/No More Graph Paper</li> </ul>	<ul style="list-style-type: none"> <li>• Visible Beam</li> <li>• Span up to 30'</li> <li>• Soft Foot Check</li> <li>• Live Move</li> </ul>
<p><b>Method:</b></p> <ul style="list-style-type: none"> <li>• Straight Edge</li> </ul>	<p><b>Method:</b></p> <ul style="list-style-type: none"> <li>• 3 or 4 points</li> </ul>	<p><b>Method:</b></p> <ul style="list-style-type: none"> <li>• 3 or 4 points</li> </ul>	<p><b>Method:</b></p> <ul style="list-style-type: none"> <li>• 3 or 4 point</li> </ul>
			

## Why is Alignment Often Ignored?

- Benefits are not known
- Present alignment methods are thought to be adequate
- Precision equipment/procedures not available
- Precision equipment too expensive
- Skilled/trained personnel not available

## Accommodating Misalignment: Flexible Couplings and Their Function

- Transmit torque and speed (power)
- Accommodate limited misalignment between the driver and driven load
- Accommodate limited misalignment during temperature transients
- Compensate for end movement and axial growth



Toothed Elastomeric  
Insert Coupling



Gear Coupling



Grid Coupling



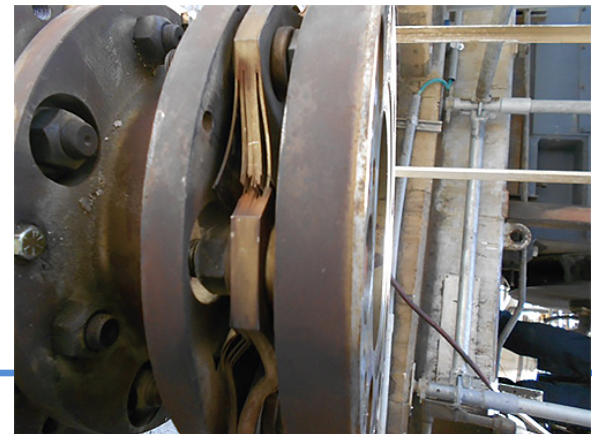
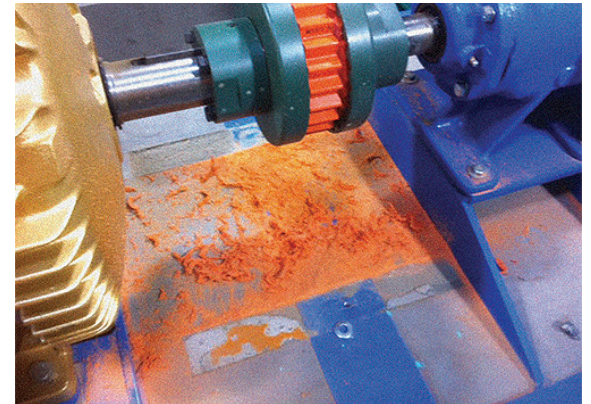
Elastomeric ring



Disc Pack Coupling

## Flex Coupling Limitations: Cause of Failures

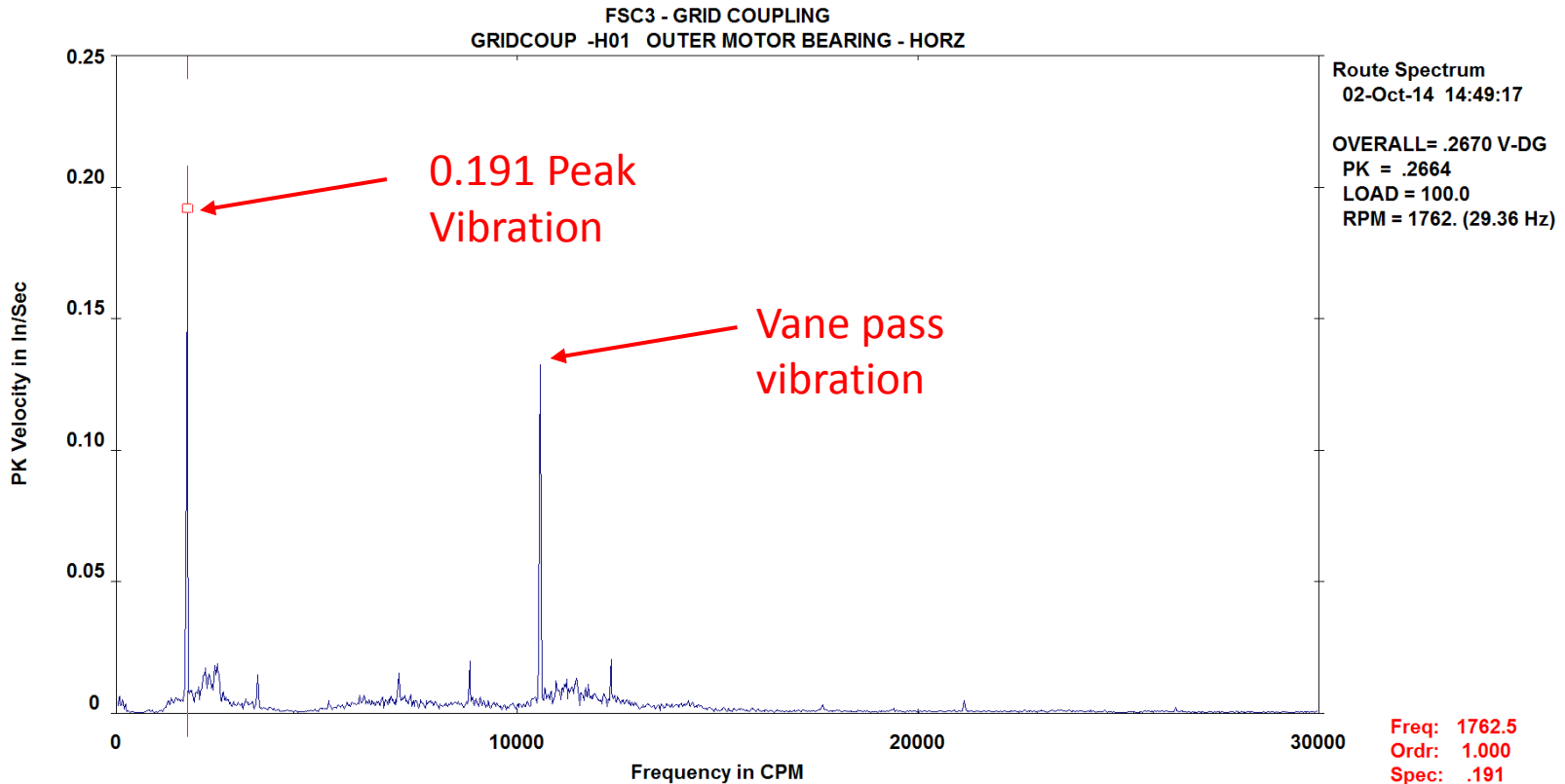
- Excessive misalignment/improper assembly
- Improper coupling selection or installation
  - Undersizing coupling for torque requirement
  - Not laser-aligning or thinking coupling doesn't require it
- Lack of PM (lubrication) or wrong type
  - Grid/gear type couplings require regular maintenance
- Age
  - Inserts are designed for obsolescence





# Flexible Coupling Performance Example: Grid Coupling on 40hp 1800 rpm Pump

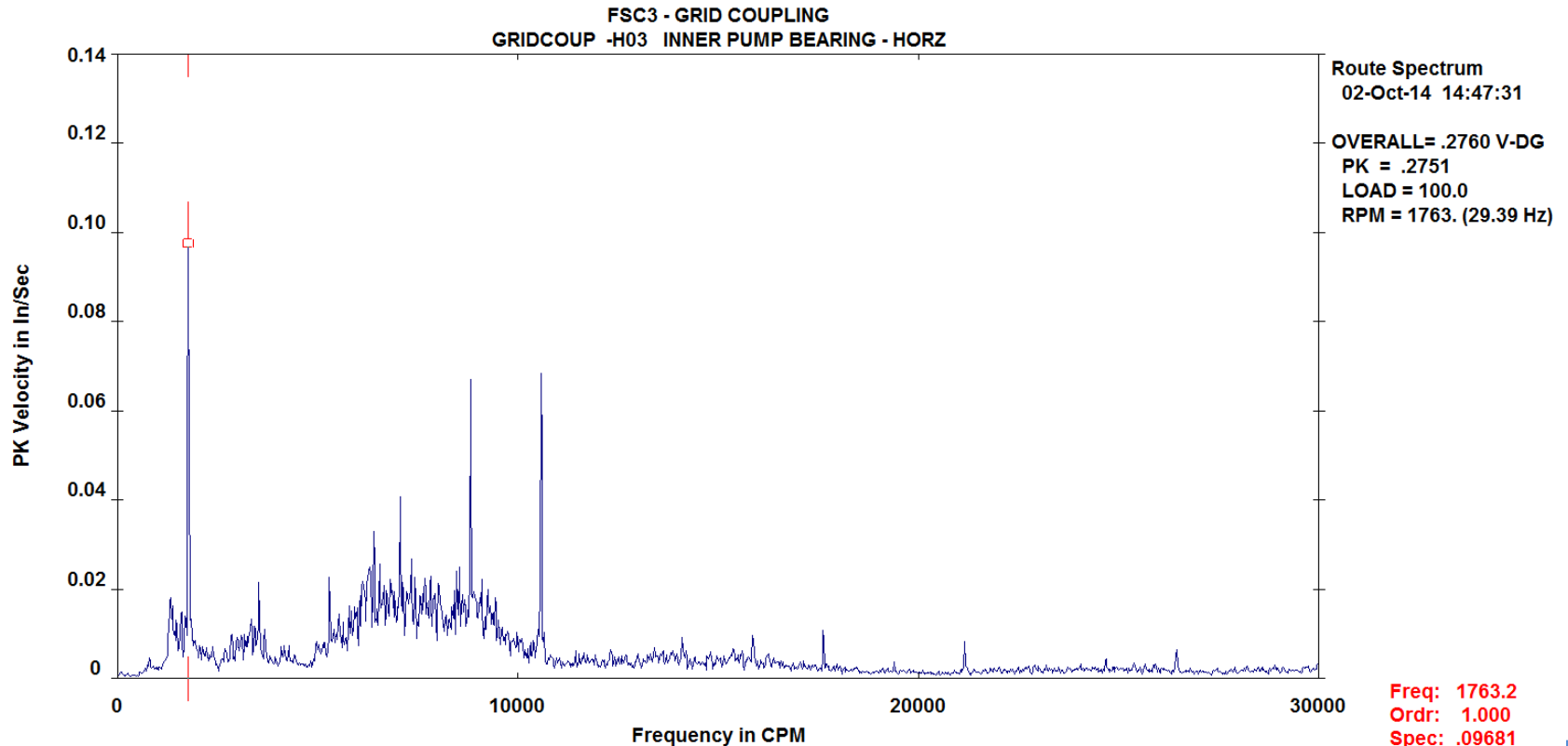
**Motor:** Laser-aligned to coupling tolerance



# Flexible Coupling Performance Example: Grid Coupling



**Pump:** Laser-aligned to coupling tolerance



## ISO 10816 Chart

Vibration Severity Range Limits (Velocity)		Vibration Severity Ranges for Machines Belonging to:			
From ISO 2372		Class I	Class II	Class III	Class IV
In/Sec (PK)	MM/Sec (RMS)	< 15 KW	15 – 75 KW	>75 KW	>75 KW
0.015	0.28	A	A	A	A
0.025	0.45				(Good)
0.039	0.71	B			
0.062	1.12		B		
0.099	1.8	C		B	
0.154	2.8		C		B
0.248	4.5	D		C	(Allowable)
0.392	7.1		D		C
0.617	11.2			D	(Tolerable)
0.993	18				D
1.54	28				(Not Permissible)
2.48	45				
3.94	71				

A: Good  
 B: Allowable  
 C: Tolerable  
 D: Not Permissible

Suggested Classifications:  
 Class I: Small (up to 15kW) machines and subassemblies of larger machines.  
 Class II: Medium size (15kW to 75kW) machines without special foundations, or machines up to 300kW rigidly mounted on special foundations.  
 Class III: Large rotating machines rigidly mounted on foundations which are stiff in the direction of vibration measurement.  
 Class IV: Large rotating machines mounted on foundations which are flexible in the direction of vibration measurement.

**Legend:**  
 Green: Good  
 Yellow: Warning



# Flux Drive SmartCOUPLINGs (FSC)

## The Modern Magnetic Alignment Solution



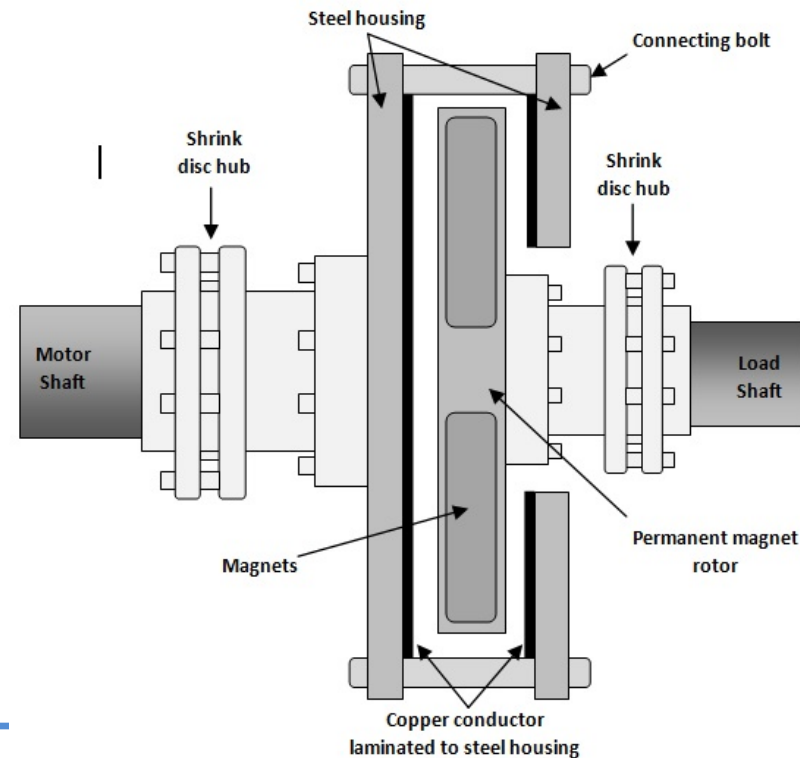
## Magnetic Couplings – The Modern Alternative

All magnetic couplings provide benefits that no other technology can:

- 100 percent isolation of motor from load via air gap
  - Eliminates all potential for vibration transfer
  - Provides load seizure protection (no broken shafts)
- Misalignment accommodation
  - 0.100” or more due to wide air gap
- Cushioned start

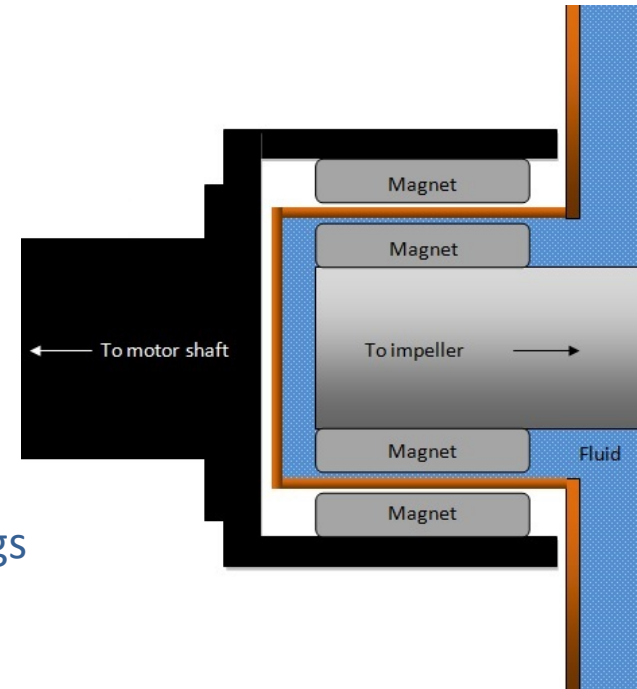
## Magnetic Coupling Background

- “Eddy current” couplings debuted in late 1990s
  - Rare earth permanent magnet advances made them feasible
- Limitations relegated Eddy current couplings to niche markets
  - Eddy current design is relatively weak, requiring coupling oversizing
  - Oversized coupling larger in diameter than motor
  - Expensive due to use of copper bonding technique
  - No inherent ability to reduced load speed
  - Load seizures lead to overheating and coupling damage



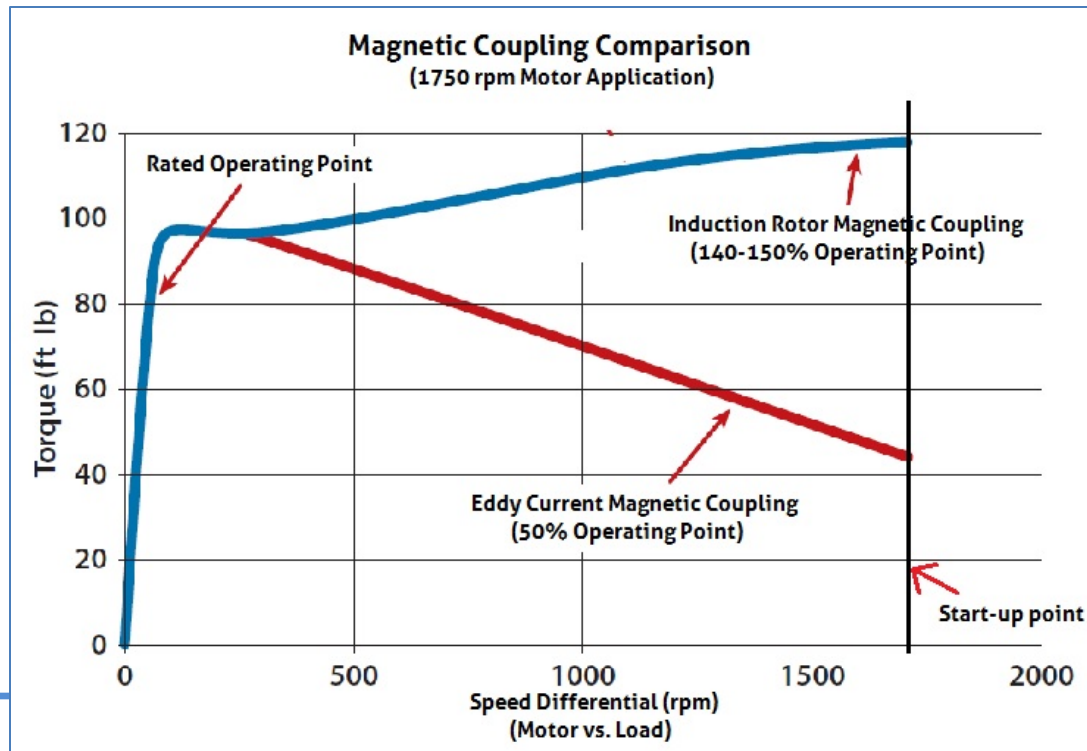
## Magnetic *Sealing* Technology

- Not the same as a magnetic coupling
- “Mag drive” pumps utilize opposing magnets for synchronous torque transfer
- Benefits
  - Excellent sealing technology – no leaks!
  - Breaks away on load seizure to protect shafts/impellers
- Limitations
  - No cushioned starting
  - Not intended for alignment correction between motor/load
  - No load speed control for energy savings



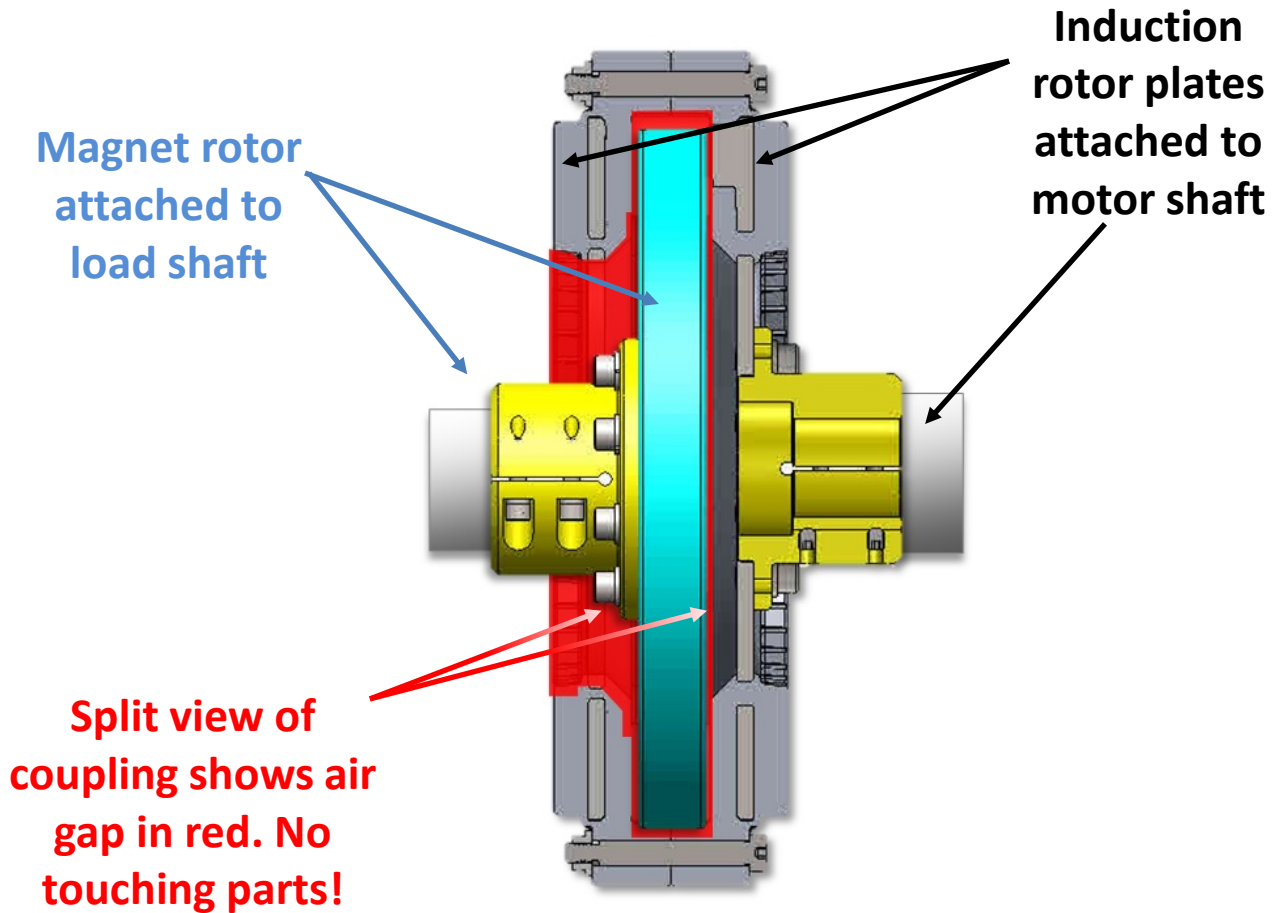
# Flux Drive SmartCOUPLING Technology

- Second-generation magnetic coupling design
- Based on proven induction rotor/motor principles
- Cushioned start and energy savings (a Flux Drive exclusive)
- Rising torque curve for wide range of applications



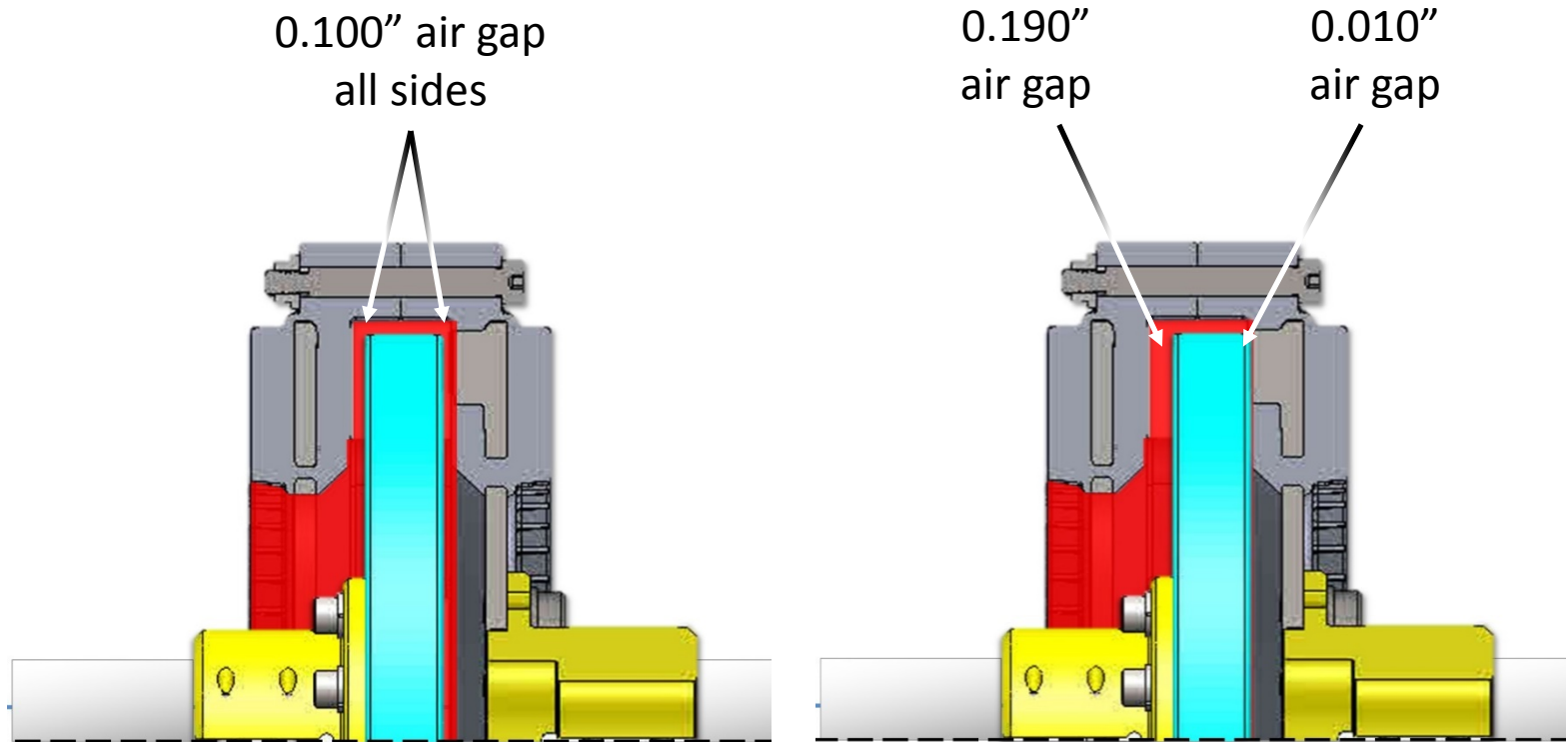
# Inline Flux Drive SmartCOUPLING

TECHNOLOGY



## Alignment Benefits

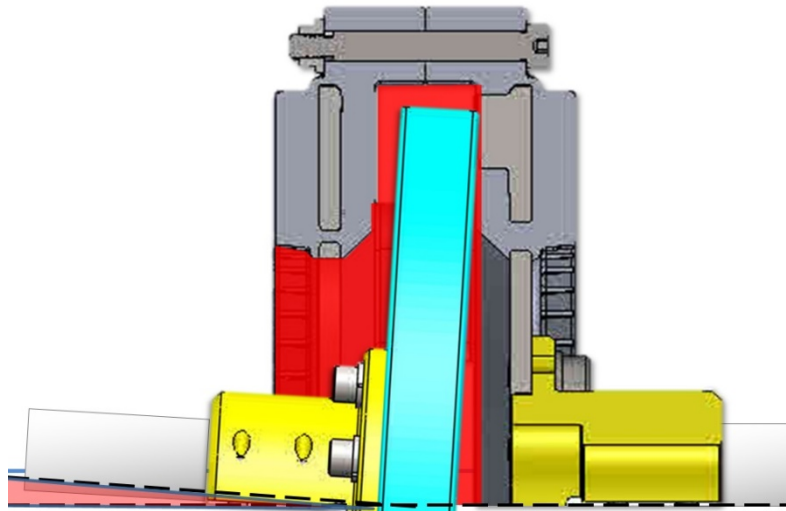
- Allows axial elongation (thermal growth)



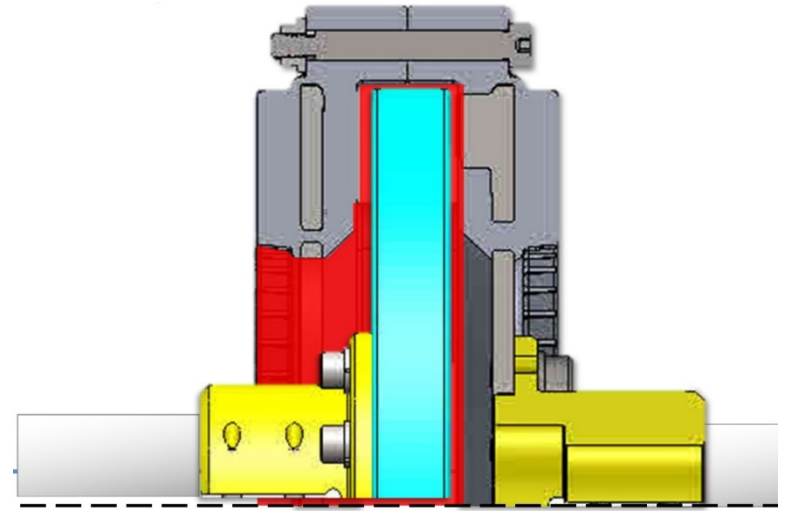
## Alignment Benefits

- Accepts angular and parallel misalignment

Magnetism balances  
for consistent torque  
transfer

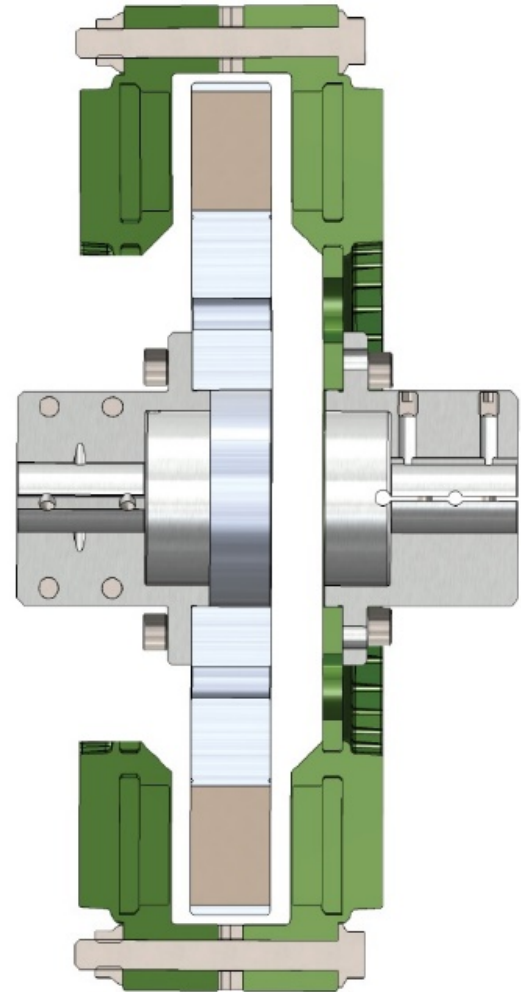


Parallel offset in any  
direction up to  
0.090"



## Alignment Benefits

- No touching parts
  - No transmission of vibration
  - No laser alignment needed
  - **Never wears out!**



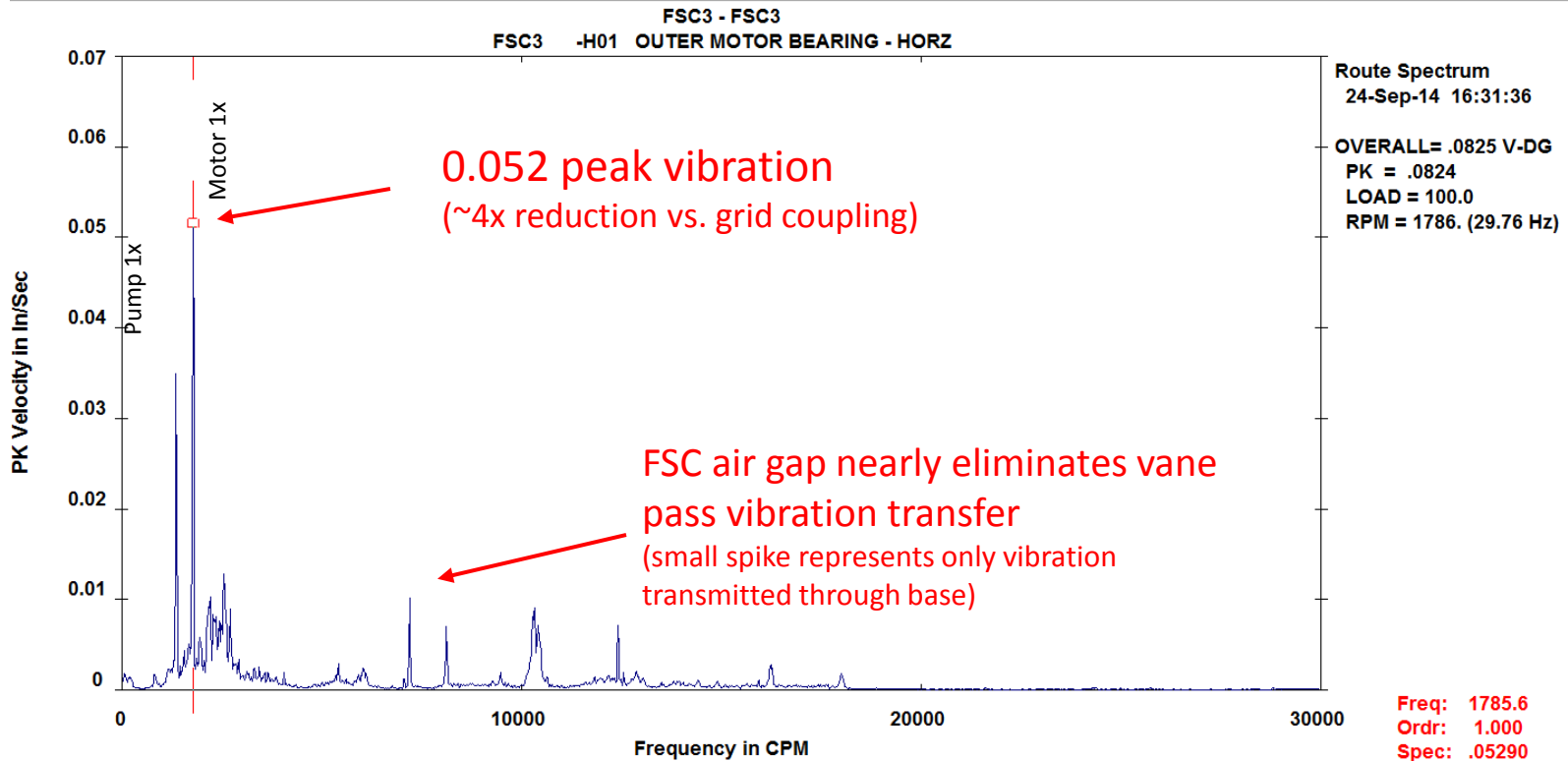




# Flexible Coupling Performance Example

## SmartCOUPLING on 40hp pump @ 1800rpm

**Motor:** Laser-aligned for comparison purposes

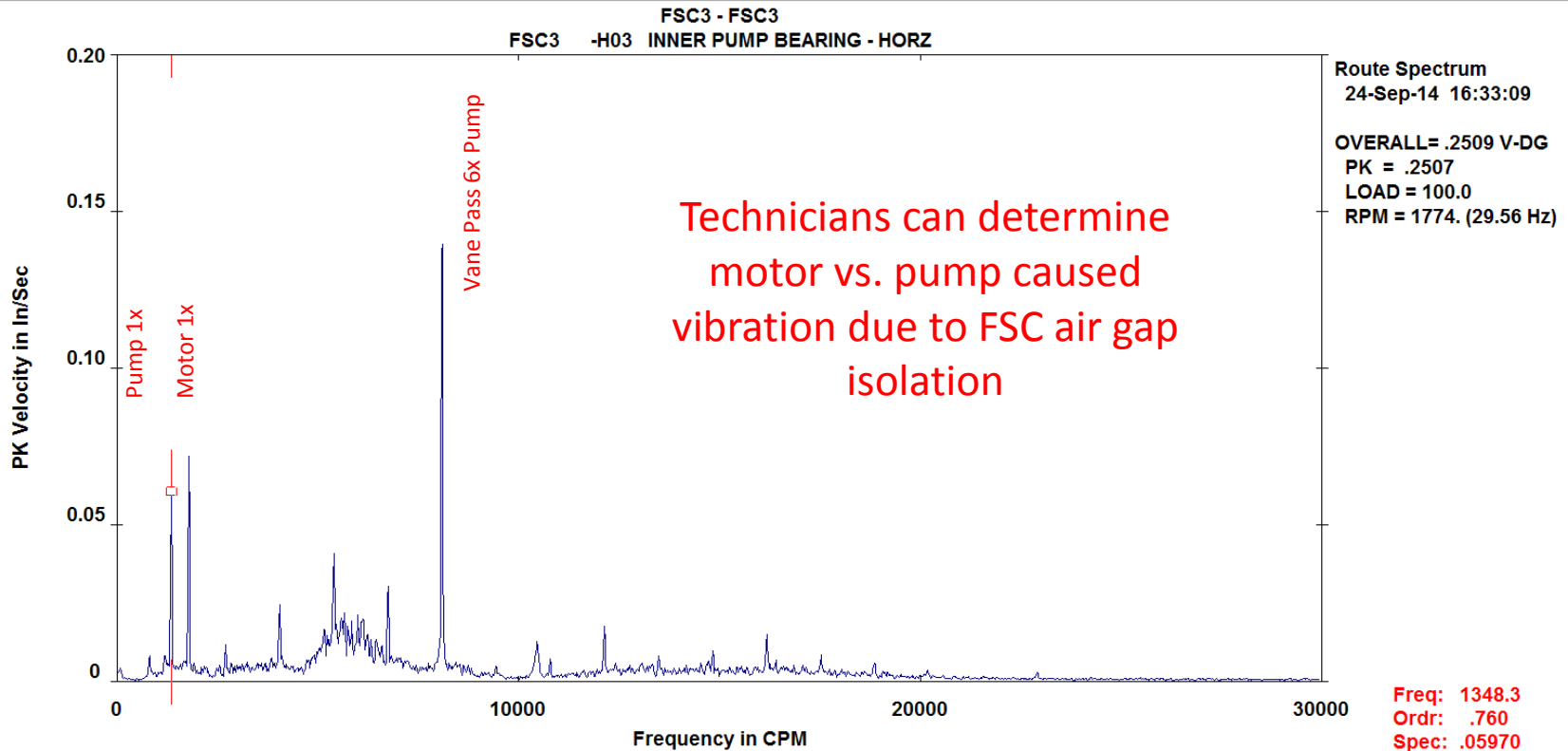




# Flexible Coupling Performance Example

## SmartCOUPLING:

**Pump:** Laser-aligned for comparison purposes

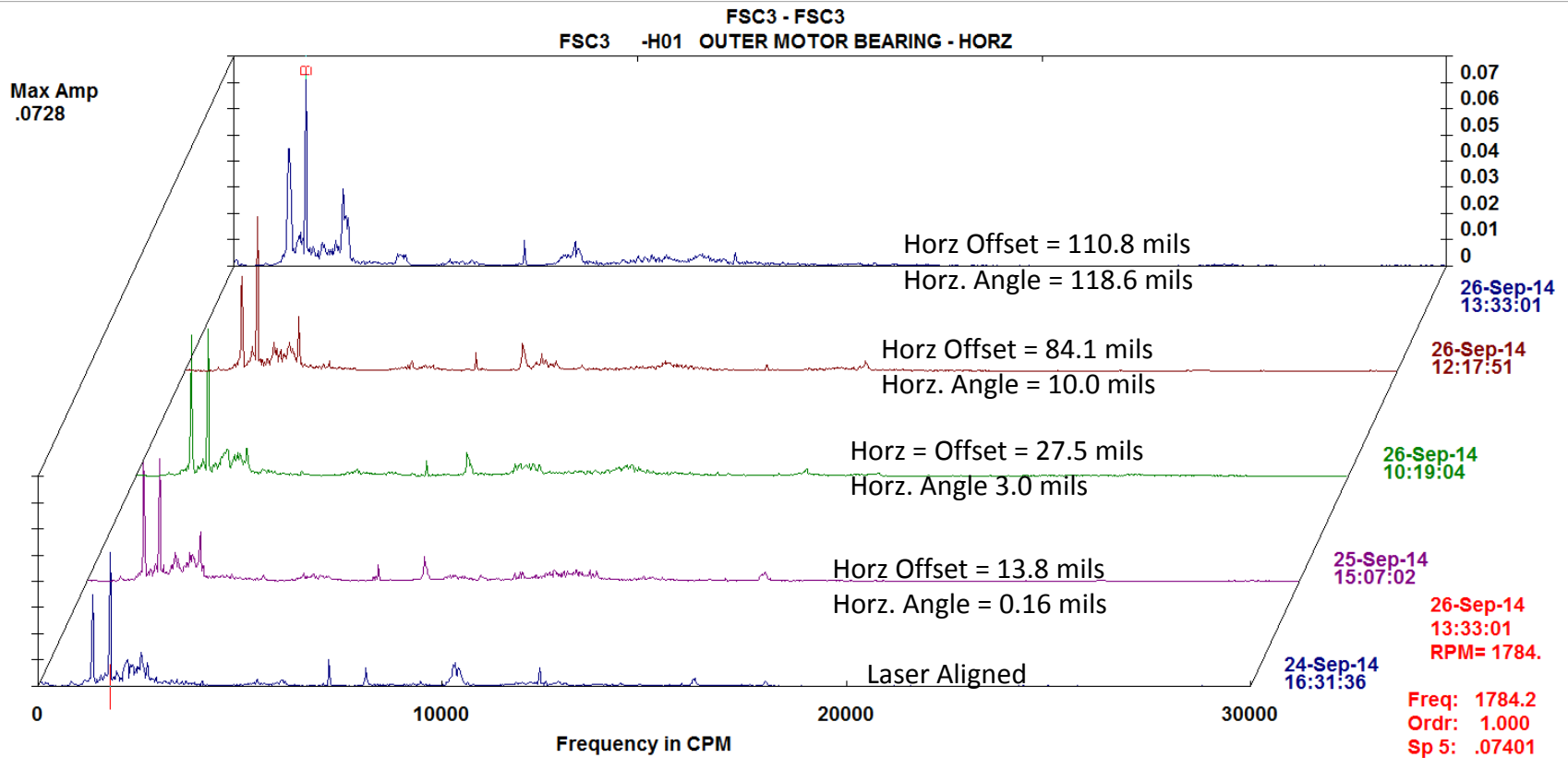




# Flexible Coupling Performance Example

## SmartCOUPLING:

**Motor:** Multiple spectrums at various levels of misalignment

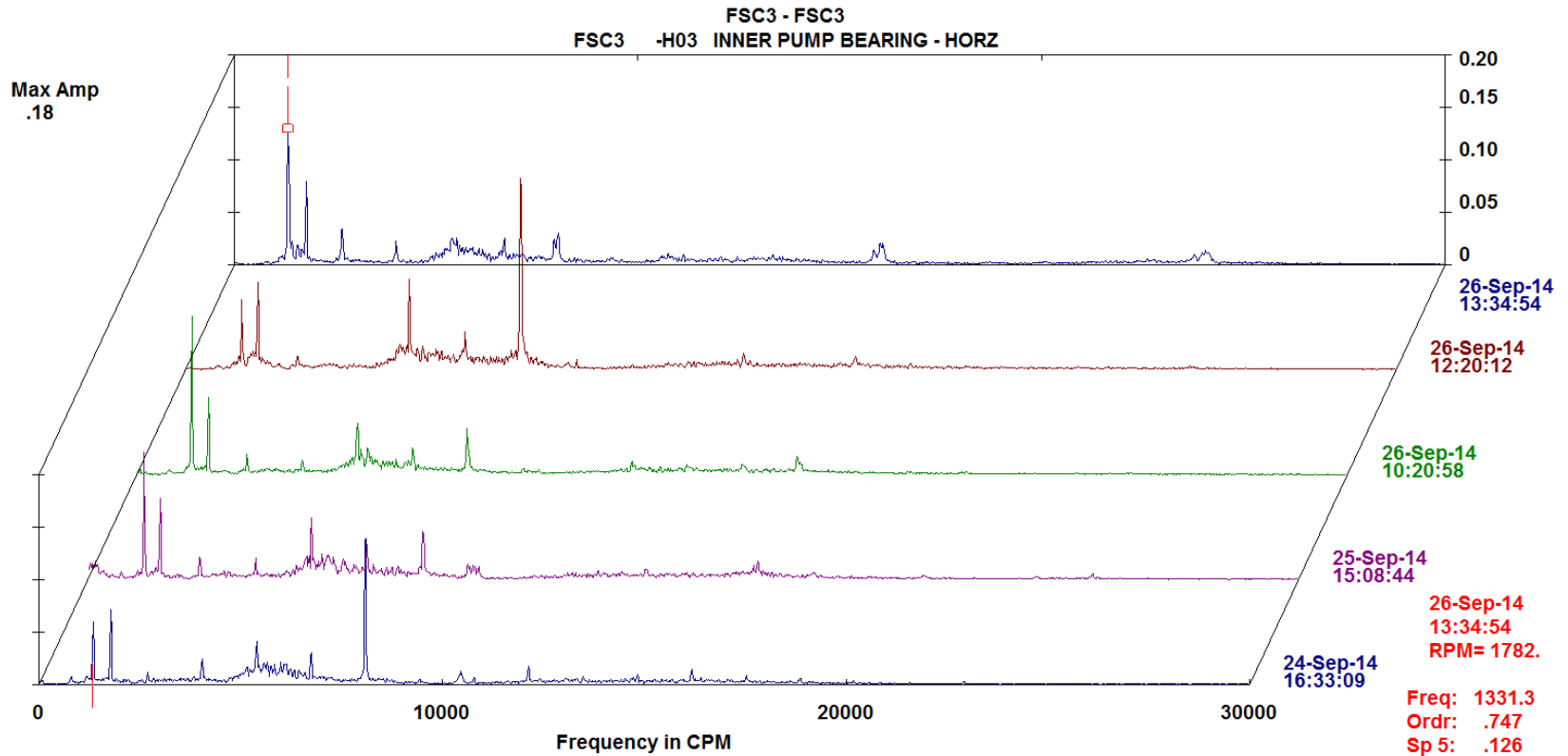




# Flexible Coupling Performance Example

## SmartCOUPLING:

**Pump:** Multiple spectrums at various levels of misalignment





# Flux Drive SmartCOUPLINGs (FSC)

## Energy-Saving Benefits!



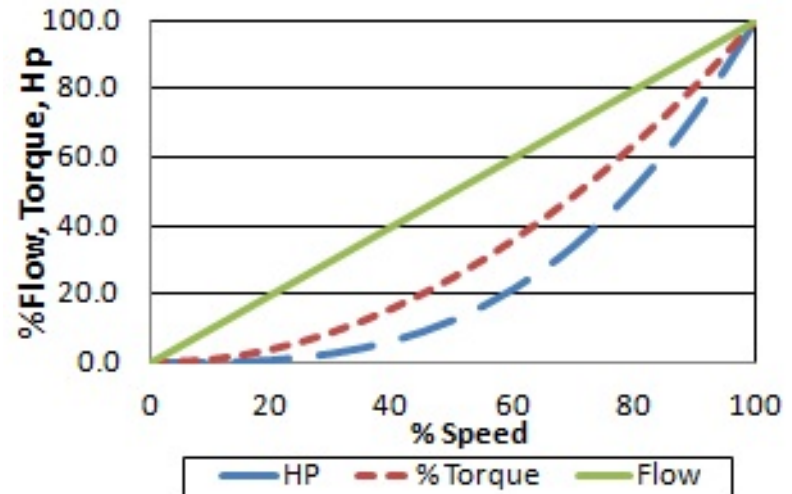
**An optimist will tell you the glass is half-full;  
the pessimist, half-empty.**

**The engineer will wonder why the glass was  
designed with 100 percent excess capacity!**

# THE PROBLEM

## Wasted Energy In Motor-Driven Systems

- Excess Capacity Margin (ECM) - built into most pump/fan systems
  - Engineers size systems for future demand/safety factor
  - Systems commissioned and run with some level of ECM
  - Adjustable speed devices can **RIGHT SIZE** the pump!
- Savings on centrifugal loads follows laws of affinity
  - Exponential savings with speed reduction

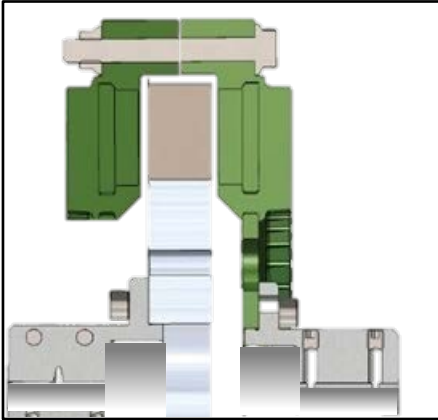


Theoretical power based on Laws of Affinity.

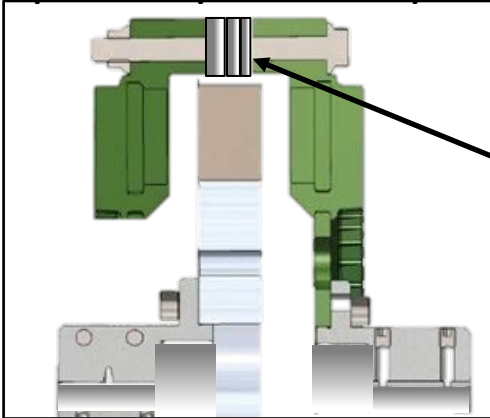
# Energy Savings on Centrifugal Loads

TECHNOLOGY

Closed Air Gap = Max Speed



Open Air Gap = Reduced Speed



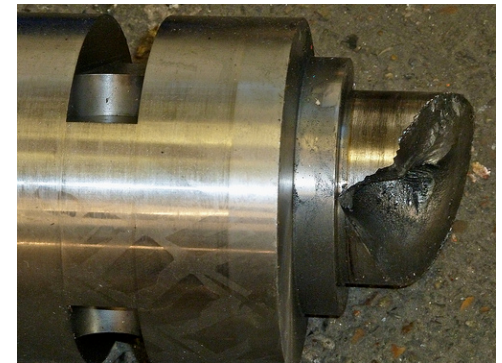
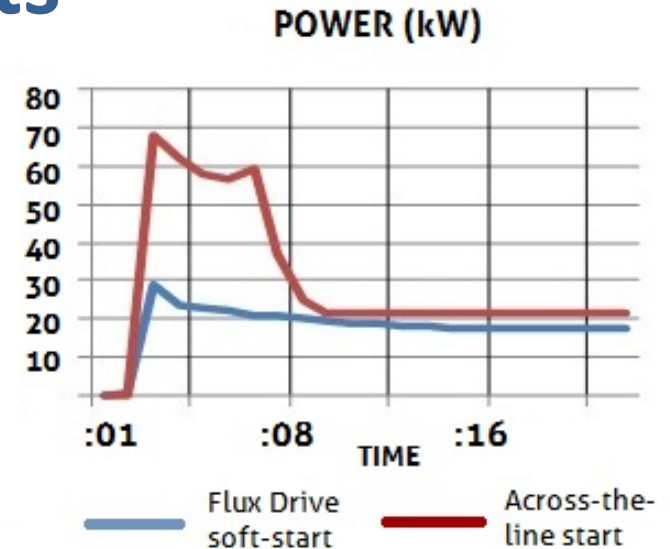
- Savings achieved by adjusting air gap (*'SmartPOWER'* reduction)
  - Benefits from Affinity Laws
    - 5% less speed = ~10% less power
    - 10% less speed = ~20% less power
  - Example: 100kW Electric Motor, \$0.10 cents/kWh, full time operation = \$87,600 per year in energy cost
    - **Gap 1: \$8,760 Savings**
    - **Gap 2: \$17,520 savings**
    - **Max Gap: Up to \$65,000 savings!**
  - Payback ROI often less than 2 years



# BENEFITS

## Cushioned Start Benefits

- Motor disconnected from load at start-up
- Magnetism is created by speed differential coupling sides
- Locked rotor amps dramatically reduced
  - Typically current spikes to 6-7x running amps
  - Flux Drive limits to 1.5x running amps
  - May reduce utility demand charges
- Torsional shock decreased
  - Reduces shaft/coupling damage
  - Protects gearboxes from lash



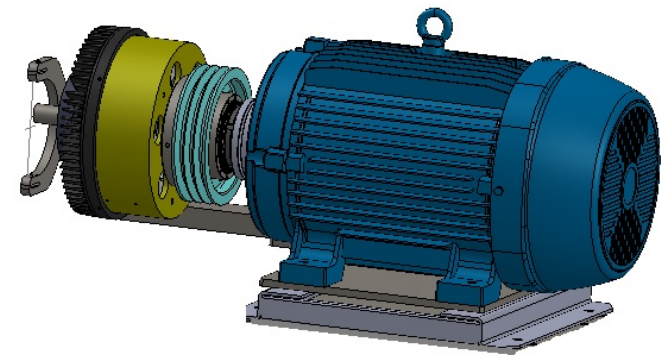
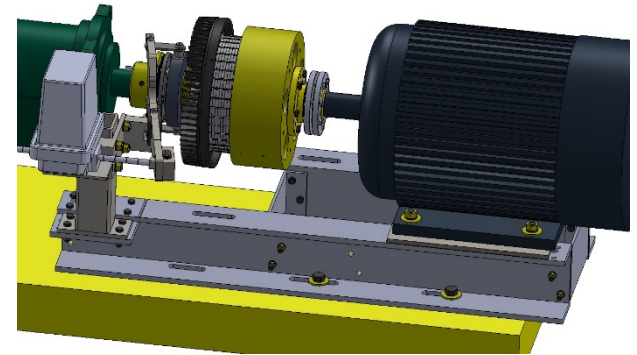
## Other SmartCOUPLING Benefits

- Out of the box “drop in” replacement of existing flexible couplings
  - Shaft spacers available for wide DBSE
- No laser alignment required – “eyeball” install
  - Minimum 100-mil air gap on all sides – up to 310 mil with air gap spacers
- Installation in less than 1 hour
  - Simple split hubs – pre-bored to customer specs
- Easy switch between full and reduced speed operation as needed
  - Never permanently trim an impeller again!
- Available in belt-pulley model as well!



# Flux Drive Adjustable Speed Drives

- Mechanical soft start
- Dynamic speed control for changing processes
  - Linear actuator connects to facility control system
  - Control between 30 percent & full speed
- Load seizure protection
- Reliability in difficult environments
- Not susceptible to power quality issues
- Extremely durable
  - Outlast connected equipment
- Available in inline and belt-pulley models





Stickney WWTP,  
Chicago, IL

## Hot Oil Pumps – Sludge Drying Problem:

- Four 125hp KSB hot oil pumps
- Pumps aligned when cold but grew out of alignment when hot
  - ~35 mils vertical growth
  - ~40 mils axial growth
- Seals failing approximately every six months due to vibration from misalignment
- High maintenance expense plus hazardous conditions from leaking oil





Stickney WWTP,  
Chicago, IL

**Solution:**

- 125hp SmartCOUPLING (FSC-5)
- Drop-in solution replaces existing coupling
  - 1" shaft spacer used to span DBSE

**Results:**

- Significant reduction in vibration
  - Below 0.05 in/sec compared to 0.25 in/sec prior to installation
- FSC insulates motor from pump heat
- \$1,500 annual energy savings per pump



## After the webinar ...

## WHITEPAPERS

- “IDENTIFYING AND CORRECTING MISALIGNMENT WITH THE FLUX DRIVE *SmartCOUPLING*”

<http://www.fluxdrive.com/docs/VibrationWhitepaper.pdf>

- “ELIMINATING EXCESS CAPACITY MARGIN FOR ENERGY AND COST SAVINGS”

<http://www.fluxdrive.com/docs/ECMWhitepaper.pdf>

## VIDEOS

- <http://www.fluxdrive.com/videos>



# Q&A



**To contact our speaker after this webinar:**  
**Matt Carlson | VP Sales & Marketing | Flux Drive Inc.**  
**[mcarlson@fluxdrive.com](mailto:mcarlson@fluxdrive.com) | 1-800-236-3581**



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**Visit the webinar page on [pumpsandsystems.com](http://pumpsandsystems.com)  
in the coming days to access the recording of the webinar.**

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