

W248 N5550 EXECUTIVE DRIVE, SUSSEX, WI 53089

# 2016 FSRUG

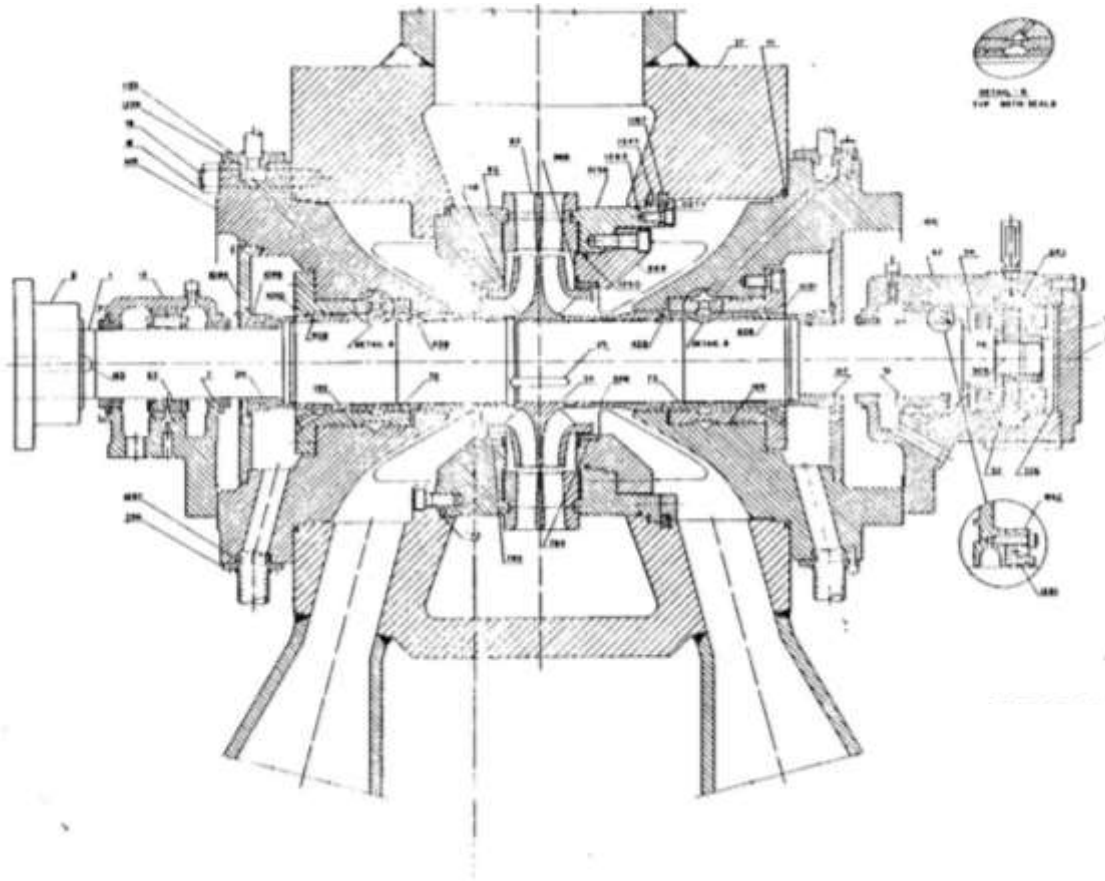
Austin, TX

Rotating Equipment Repair  
Mark Barber

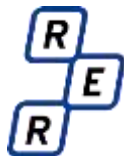
Steam Generator  
Feed Pump  
Cyclic Vibration



# Subject Pump



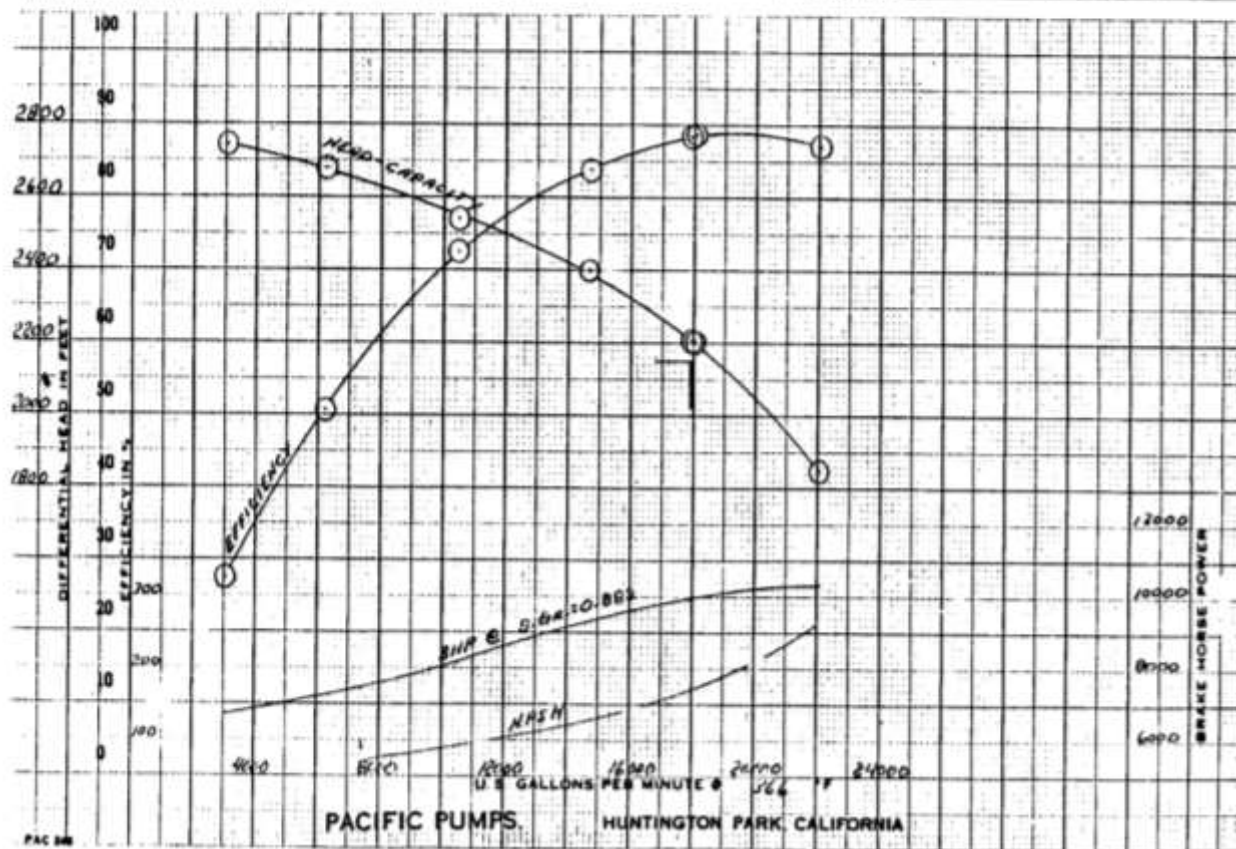
Pacific 20x17 HVF

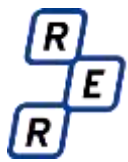


# Pump Curve

ITEM NO. 1. d P.O. NY-403434  
 IMPELLER PATTERN 0-3130  
 MAXIMUM DIAMETER 17 1/2  
 RATED DIAMETER 17 1/2  
 MINIMUM DIAMETER 16 1/2

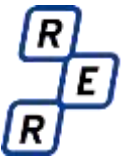
SIZE 20x17 TYPE HVF STAGES 1  
 R.P.M. 5200 DATE 1-16-78  
 PUMP NUMBER \*49077  
 PERFORMANCE ALSO APPLIES TO PUMP  
 NUMBER \_\_\_\_\_





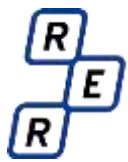
## Problem Statement

Pump exhibits increased vibration periodically for no apparent reason. Vibration appears, lasts for a time, then disappears. Sister pump exhibits NO similar vibration characteristics.



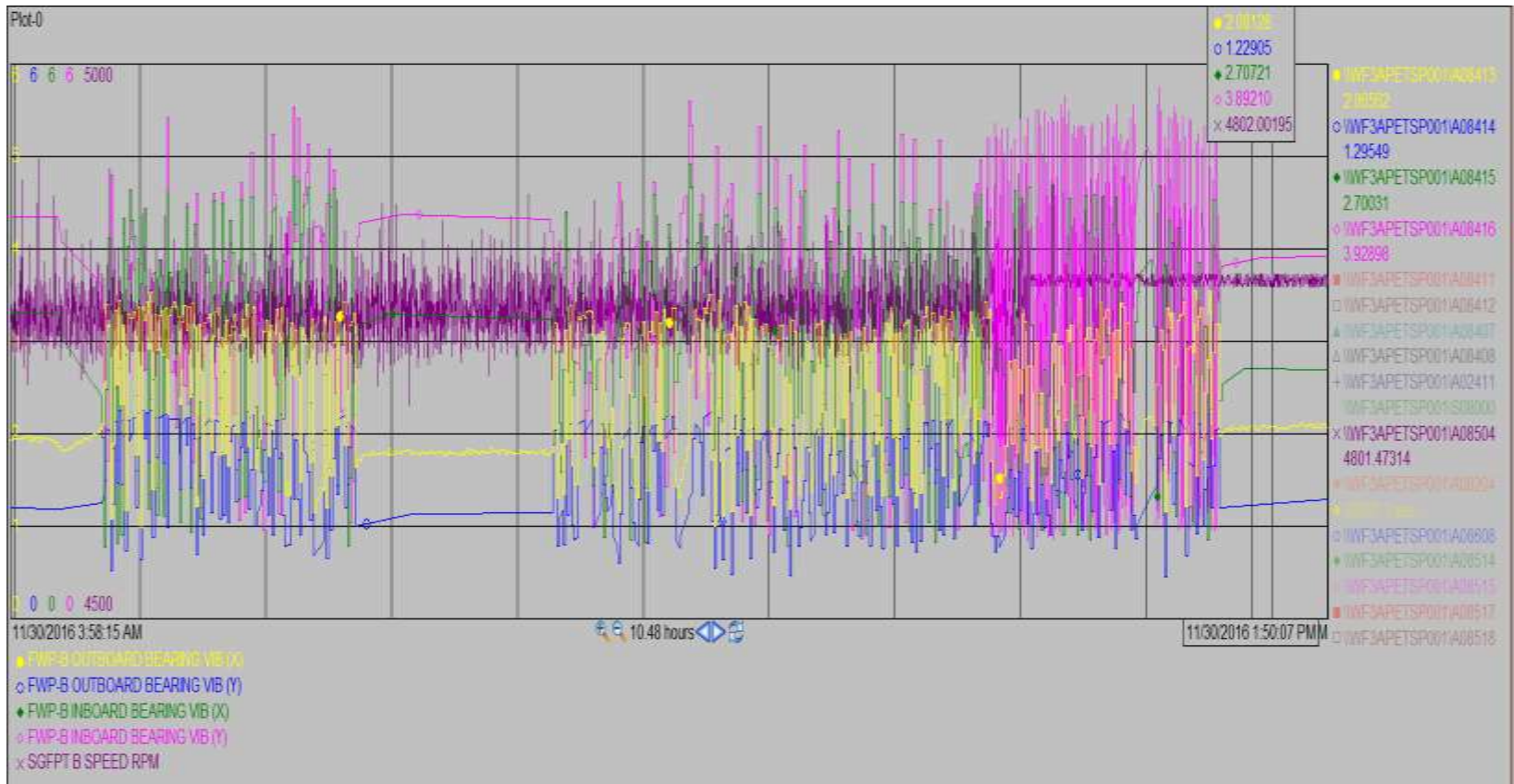
# History

- Pump ran without issues for over 20 years.
- In early 2000's, during a rebuild, a piece of FME passed through the pump after restart.
- Pump initially exhibited no problems.

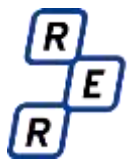


# History (continued)

- Vibrations began to intermittently appear; highest on IB end.



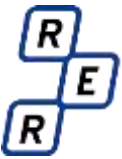
- Worse on IB bearing housing



## More Info...

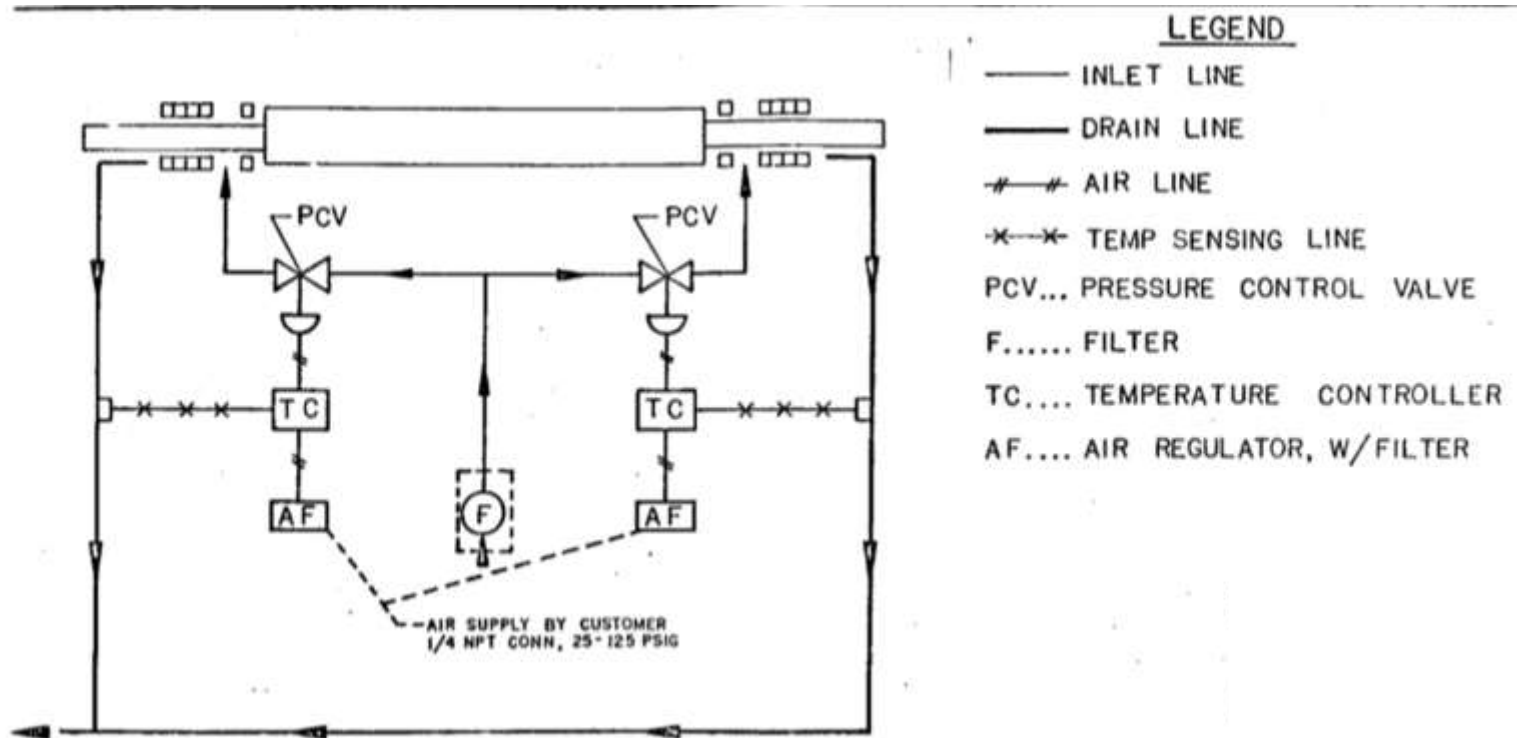
- Pump utilizes tilt-pad journal bearings
  - 5 shoes
  - Designed to minimize oil whirl problems associated with high speed machines



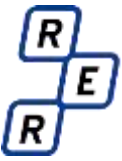


## More Info...

- Typical seal water injection system
  - Same temp water from condensate injected into both IB & OB stuffing box bushings
  - Seal drain temp is controlled





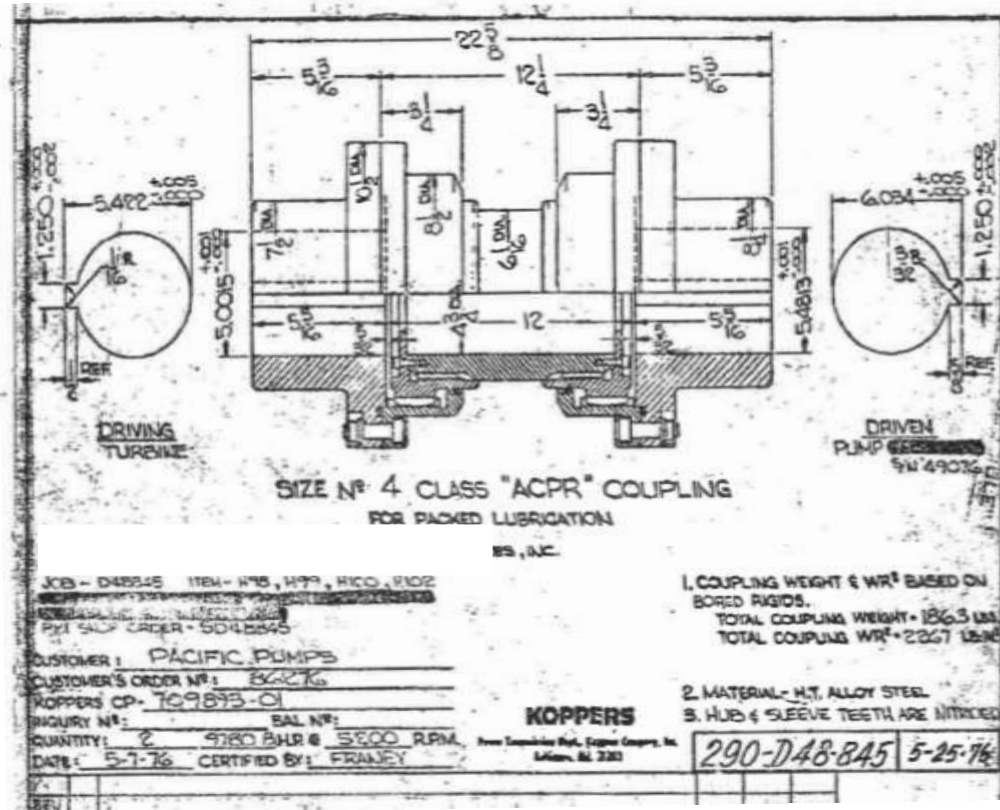


## More Info...

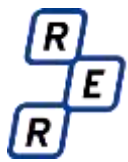
- As the Alpha pump does NOT exhibit these problems, other installation-specific possibilities considered
  - Piping; are hangers appropriate? Plant verified all are freely operating.
  - Casing “gib” arrangement. Plant made upgrades to gib-way under casing.

# More Info...

- The coupling was found to have loose fits. It was also assembled NOT per match marks.

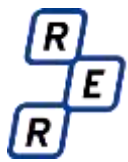


- A new, balanced coupling was installed. No noticeable improvement. Vibration sporadically existed for no apparent reason.

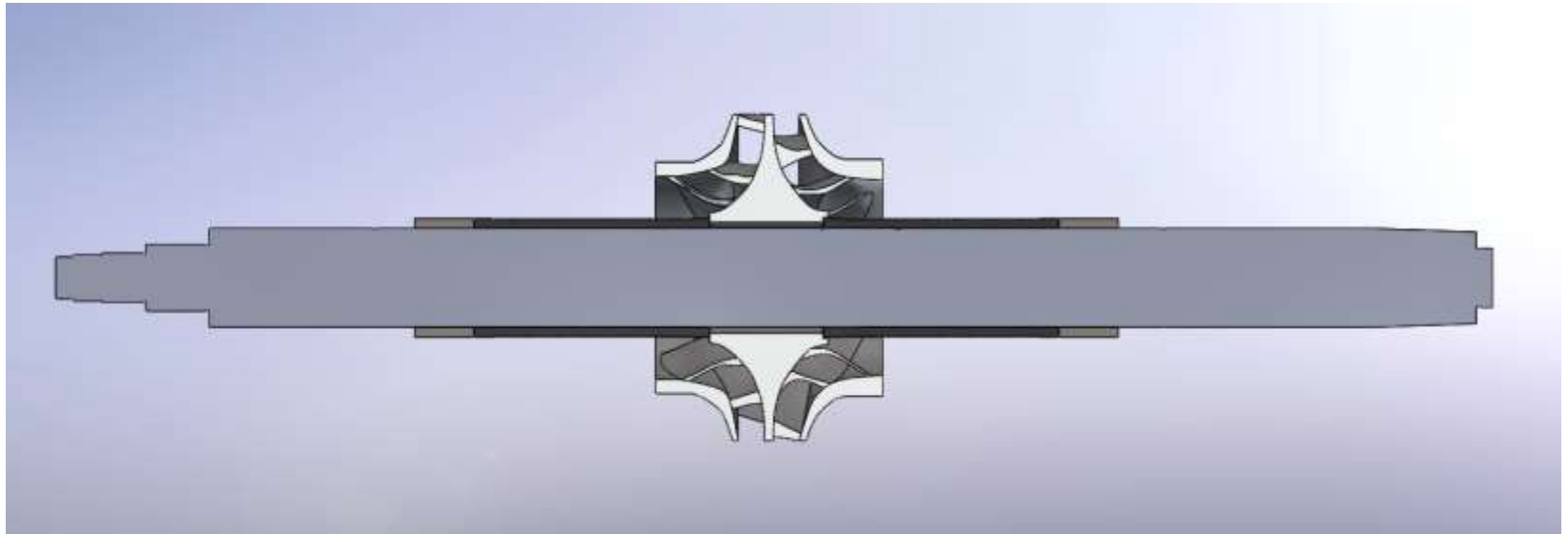


## What could be causing the vibration?

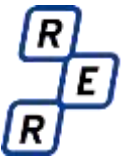
1. Seal injection temperature/flowrates
2. Pipe strain
3. Thermal growth
  - a. Alignment to turbine (verified to be properly accounted for)
  - b. Rotor components' variations in thermal growth rates



## Rotor Thermal Growth Considerations

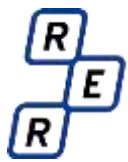


- Rotor stack is restrained via nuts.
- Sleeves have 0.001-0.0025" loose fit re the shaft.



## Rotor Thermal Growth Considerations

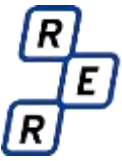
- The sleeves, being less massive than the shaft, tend to grow in length relative to the shaft.
  - Not a problem if sleeve fit to shaft is “perfect.” If shaft and sleeve are at tolerance limits, can cause bending moment.
- Moment of inertia equation suggests that shaft deflection at impeller can easily be close to 0.003”. Sufficient to cause vibration.



Why vibrations only on bravo pump?

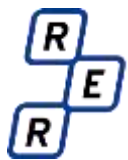
Why vibration worse on IB end?

- Sleeve fits? Sleeve with more loose fits would make for a larger bending moment on the rotor.
- Bearing fit to housing? Fits checked with “plastigage?” Prefer micrometer measurements whenever possible.
- Seal area geometry; one side worn worse than other?



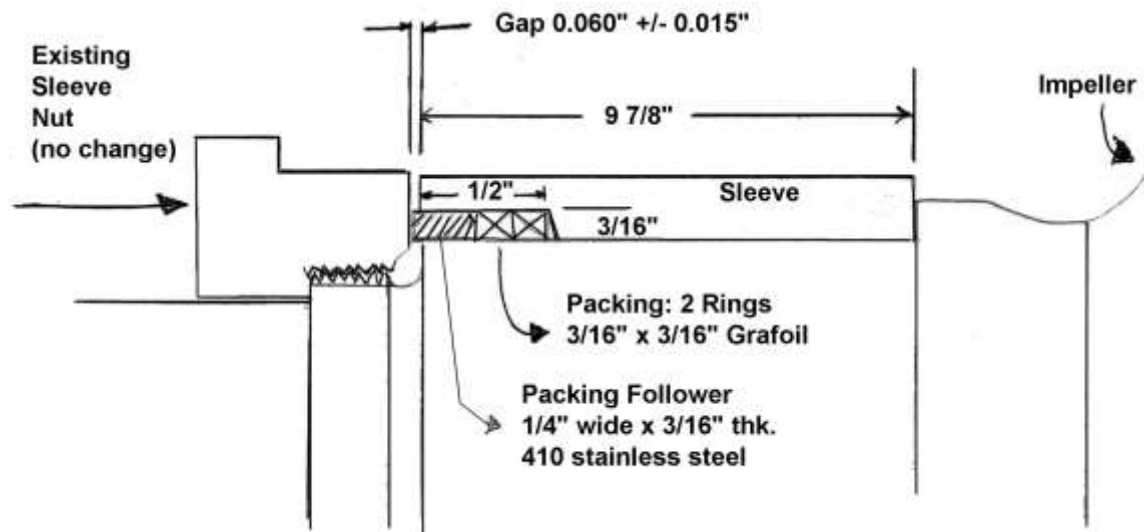
What can be done to correct the issue?

- Plant has contracted at least two consultants in effort to “see inside the pump.”
  - Seal water studied
  - Resonant frequencies studied
  - Alignment studied
  - Pump hold-down bolting procedure corrected to allow thermal growth axially



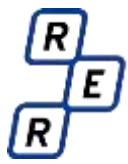
What can be done to correct the issue?

Outline Drawing for Shaft Sleeve Modification  
Pacific Model 20x17 HVF



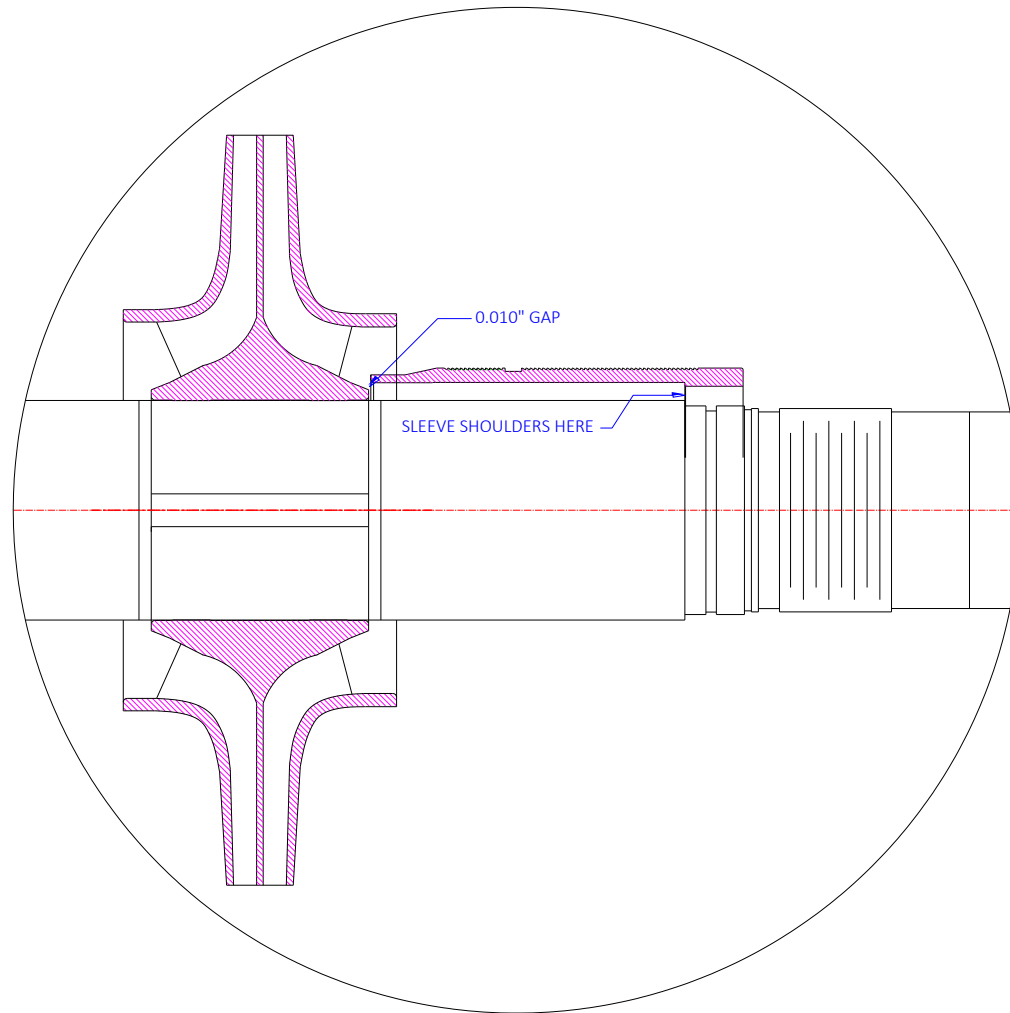


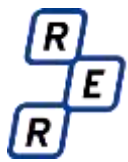




## What can be done to correct the issue?

- 0.010" gap allows for thermal growth





## Summary

1. Plant found OE on NRC website of plant w/same equipment which discussed the thermal growth bending moment caused by shaft sleeves' fit and compression.
2. Ensure procedures call for recording of all data
  - a. Would like to see shaft sleeve and bearing housing fits at this site to confirm differences between sister pumps.
3. Proof will be when pump is overhauled...



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