

Pipe Strain - *Pump Case Distortion*

Case Study:

Induced pump case distortion due to excessive misalignment of the suction piping flange connection.

Can result in a rotor rub and bearing failure...or worse.

Chuck Lyons – IMI Technologist

Perception:

Massive high pressure pump case castings will not be effected by forcing misaligned piping connections during installation.

6 Stage - 8 x 13

10"- 900# RF Suction

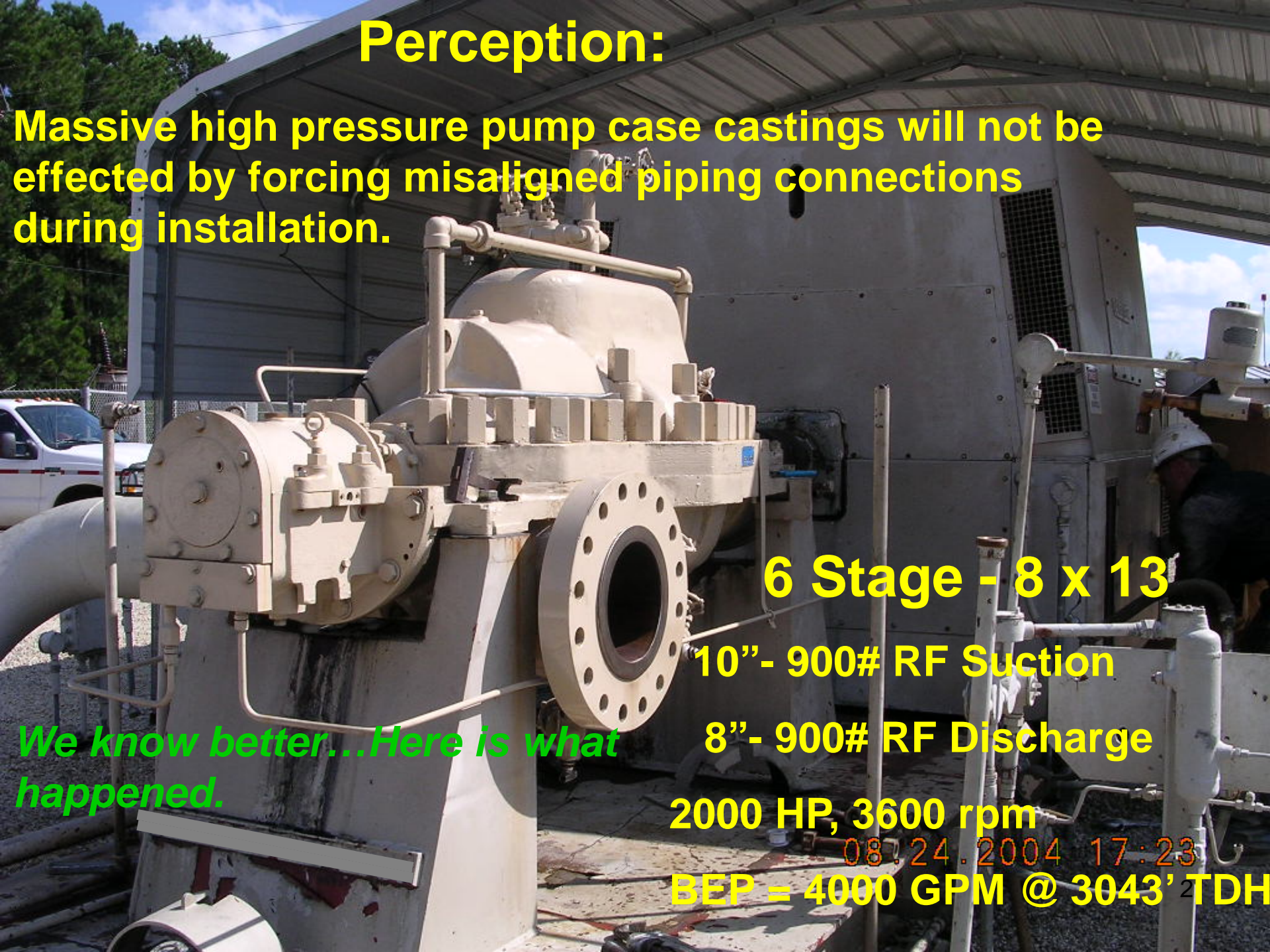
8"- 900# RF Discharge

2000 HP, 3600 rpm

08.24.2004 17:23

BEP = 4000 GPM @ 3043' TDH

We know better...Here is what happened.

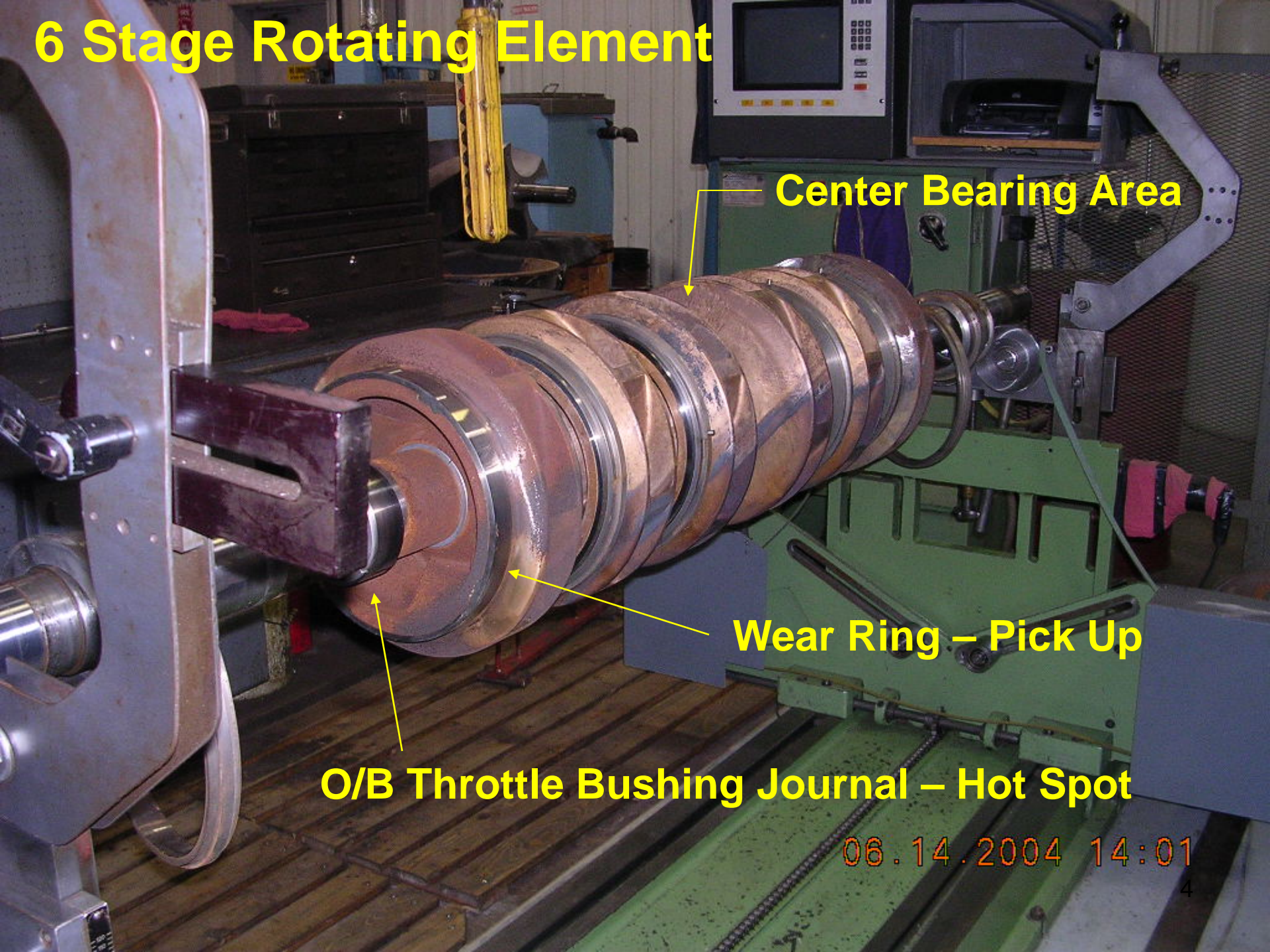


Background: *Pipeline M/L pump – LPG service*

- **Planned swap out of an existing unit with a complete unit drop-in spare.**
- **Difficulty encountered in getting bolt holes to line up on the suction flange connection...tapered pins & a come along were used.**
- **Post incident comment: *“Some resistance to rotation may have been present during motor to pump alignment”.***
- **Excessive noise and vibration, < 0.80 in./sec. on start up prompted shutdown of unit after 2 minutes of operation.**
- **Pump pulled for shop inspection and the service unit was reinstalled to re-start the pipeline...**

A long night, here is what was found...

6 Stage Rotating Element



Center Bearing Area

Wear Ring – Pick Up

O/B Throttle Bushing Journal – Hot Spot

06.14.2004 14:01

Center Bushing – Hot Spot



Pump Case – O/B End

06.14.2004 12:18

Center Bearing



2 Minutes of Run Time

Thrust End Bearing Housing



Babbitt Flakes &
Minor Shaft Rubbing

06.14.2004 10:40

Thrust End Radial Bearing – Bottom Half

Some
Babbitt
Removal



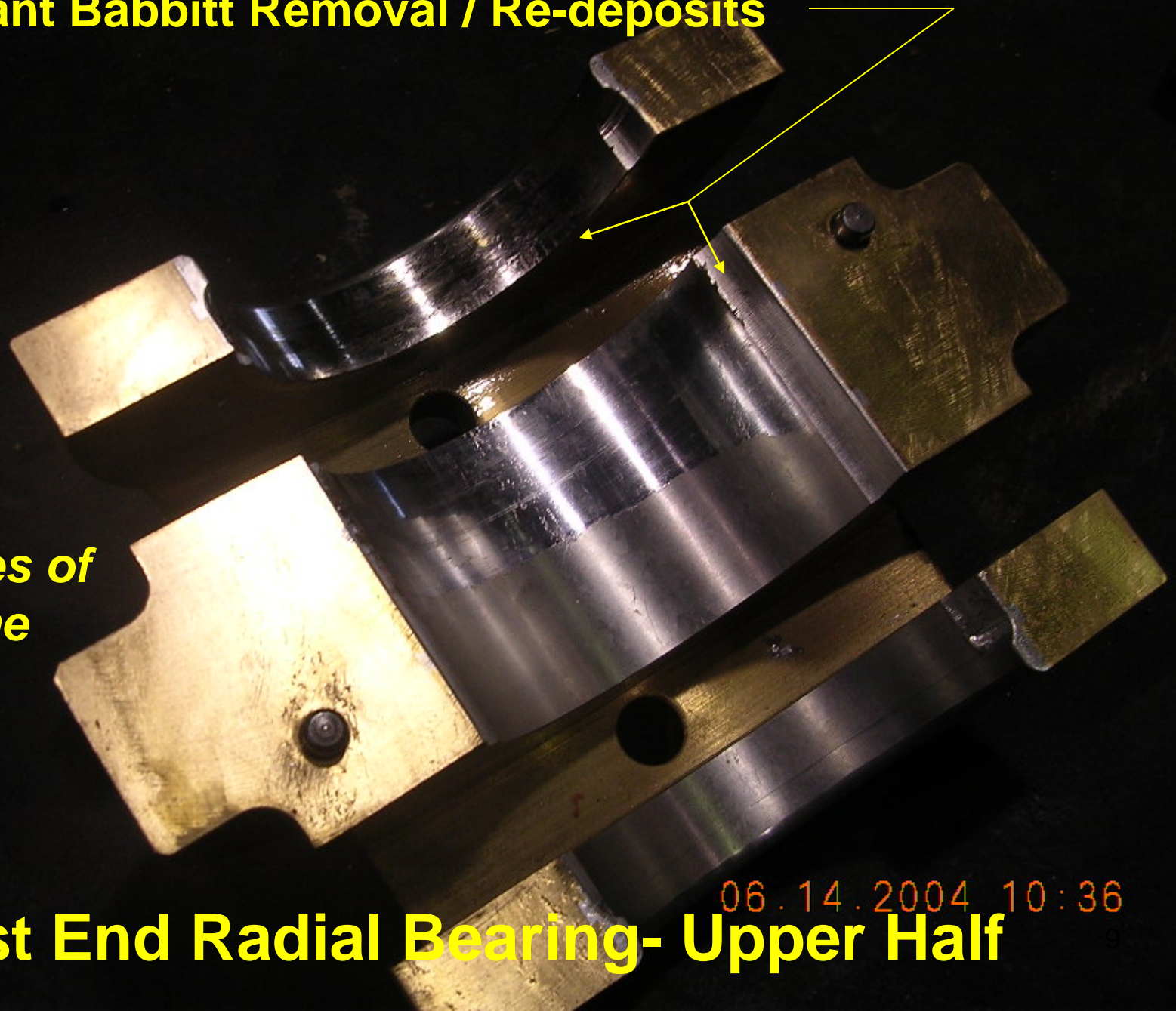
06.14.2004 10:48

Significant Babbitt Removal / Re-deposits

***2 Minutes of
Run Time***

Thrust End Radial Bearing- Upper Half

06.14.2004 10:36



Inspection Findings

- **Case distortion / rotor damage limited from the O/B suction end of pump to center bearing area. I/B bearing had a small shiny area.**
- **Rotor checked OK for run out and straightness.**
- **Case / bearing housings assembled and boring mill checked. All surfaces concentric and perpendicular to shaft centerline.**

Shop Repairs

- Pump case required no repairs.
- Center bearing bushing skim cut to remove high spots – reused.
- Rotor – Center bearing journal and throttle bushing journal skim cut and polished. Radial bearing journals and wear rings polished – Rotor reused.
- O/B radial bearing, thrust bearings and O/B throttle bushing replaced. I/B radial bearing and throttle bushing reused.
- Mechanical seals were replaced.

Prior to setting the seals, the pump turned easily by hand after assembly – *The pump was rotated by hand in an as received condition prior to disassembly and inspection.*

Issues

- The subject pump is one of three complete case/rotor units to provide installed units and a spare unit for two pump stations. Two pumps are always in service.
- The suction flange on the subject pump was changed from a 600# to a 900# rating in year 2000 to allow for installation at both intended locations.
- The flange rating change was done to utilize a surplus pump case as an available drop in spare.
- Like rated suction and discharge flanges are used on pipeline pumps to maintain DOT regulated MAOP of pipeline systems .
- Normal suction pressure range is 400 – 600 psig.

Issues – cont.

- **This was the first time an attempt was made to install this pump at this location.**
- **Available resources and the planned maintenance window were made without consideration of possible piping modification work.**
- **The pipeline system was down for reasons other than this pump swap out.**
- **The job was started because an outage window existed.**
- **Mechanics were under some pressure to have a pump installed before the planned pipeline start up.**

Post Repair Installation



No problem on the
Discharge Bolt Up

08.24.2004 17:23

**10" - 900#
RF Suction Flange**

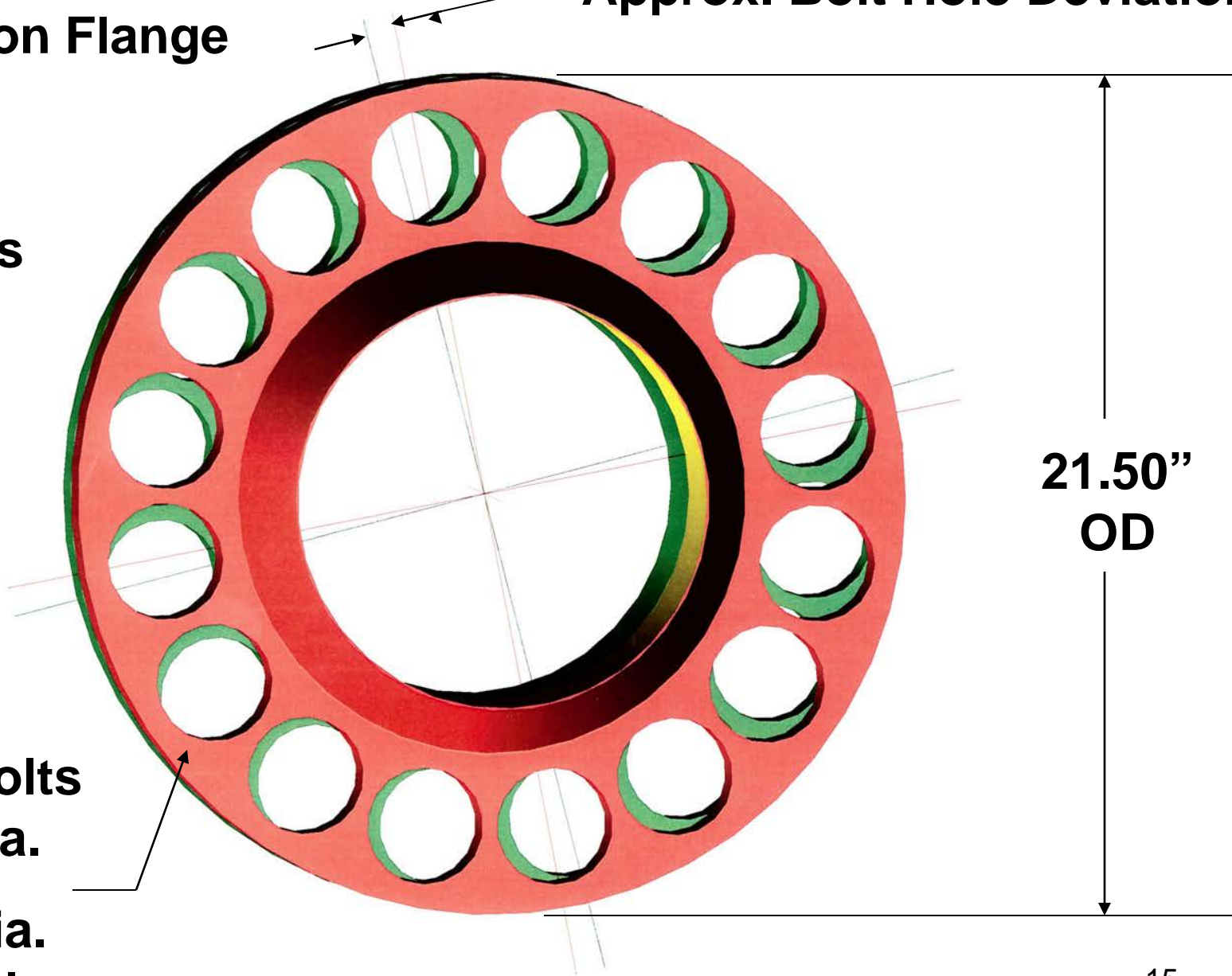
**2-3/4"
Flange
Thickness**

Approx. Bolt Hole Deviation

**21.50"
OD**

**16 Stud Bolts
1-3/8" dia.**

**18.50" dia.
Bolt Circle**



Post Repair Installation & Corrective Actions

- Pump drive coupling hub was monitored for movement with dial indicators, top and side, during piping bolt up – 0.002” allowable.
- Decision made to fabricate a new suction spool to correct center line and bolt hole timing misalignment before attempting a bolt up.
- New suction spool was fitted and reworked until no coupling hub movement was present during flange bolt up.
- Unique suction spools are identified and stored at the facility for use with individual pumps.
- Soft Foot and Pipe Strain checks are understood to be key elements in the machinery shaft alignment procedure.

Suction Side



Supports

08.24.2004 17:23

Final Installation



New Paint Job and New Suction Spool

Conclusions, Opinions, & Thoughts

- **Failure to maintain dimensional uniformity when the suction flange was changed on the pump case was a key contributing factor.**
- **Discussions indicated that bolt hole timing may have been more of an issue than flange center line deviation.**
- **A prompt decision to shut down the unit limited damage to minor machining, polishing and replacement of wear parts.**
- **Continued operation would have resulted in a more severe wreck up to a rotor lock up or worse.**
- **Pump has been in service since re-installation in August, 2004.**

How much force is required to distort a pump case? *Not Much*

- It is difficult to say how much force was required to make this bolt up. Mechanics indicated it was very difficult.
- On a 2006 installation of an identical pump at the sister pump station, a gasket gap approximately double that of the required (1/8") was observed ~ 1/4" total.
- When the joint was made up, 0.005" movement was observed at the pump coupling hub. Allowable movement is 0.002".
- This problem was corrected by loosening two adjacent flange joints and shifting the spool within the bolt hole clearance until less than 0.002" movement was observed.

Any Questions...and Thanks