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.

We know better...Here is what happened.

6 Stage - 8 x 13
10” - 900# RF Suction
8” - 900# RF Discharge
2000 HP, 3600 rpm
BEP = 4000 GPM @ 3043’ TDH
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
Center Bushing – Hot Spot

Pump Case – O/B End
Center Bearing

Bushing

Journal

2 Minutes of Run Time
Thrust End Bearing Housing

Babbitt Flakes & Minor Shaft Rubbing
Thrust End Radial Bearing – Bottom Half

Some Babbitt Removal
Significant Babbitt Removal / Re-deposits

2 Minutes of Run Time

Thrust End Radial Bearing - Upper Half
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
10” - 900# RF Suction Flange

2-3/4” Flange Thickness

16 Stud Bolts 1-3/8” dia.

18.50” dia. Bolt Circle

Approx. Bolt Hole Deviation

21.50” OD
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.
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 ~ ¼” 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