



47TH TURBOMACHINERY & 34TH PUMP SYMPOSIA
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GEORGE R. BROWN CONVENTION CENTER

Up-thrust and Seal Failures on a Vertical Can Pump

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Pine Bend, MN, 12x10, 9 stage vertical can pump, 600 hp, 1780 rpm

A new smaller, higher efficiency motor was installed to replace the old motor and shortly after numerous mechanical seal failures occurred. The motor is a solid shaft motor that is connected to the pump with a rigid coupling.

The motor hub is connected to the motor shaft with a split ring. On startup it was observed that the pump shaft would move about 3/8 inch upward and the mechanical seal would leak.



600 hp, 2300 volt, 1780 rpm

Old Motor



New Motor



- During a normal pipeline startup the refinery starts up a tank booster pump which feeds the vertical can pump. When pressure is received from the tank pump the vertical can pump is started.
- First the pump suction valve (MOV) is opened and after it is fully open the unit is given a start.
- When the suction valve was opened it was noticed that the pump shaft moved about 3/8 inch upward before the pump was started since flow through the pump pushed the impellers and shaft upward.



- It was noticed that when the pump shaft moved upward the motor shaft did not move upward so the motor was not providing any force to stop the upward movement of the pump shaft.
- The pump was started and shortly after the pump shaft went back down and stayed down. It was noticed that the seal was dripping product after the start up.
- After further investigation it was determined that the set screws had slid on the pump shaft even when properly tightened.





Upward
Movement



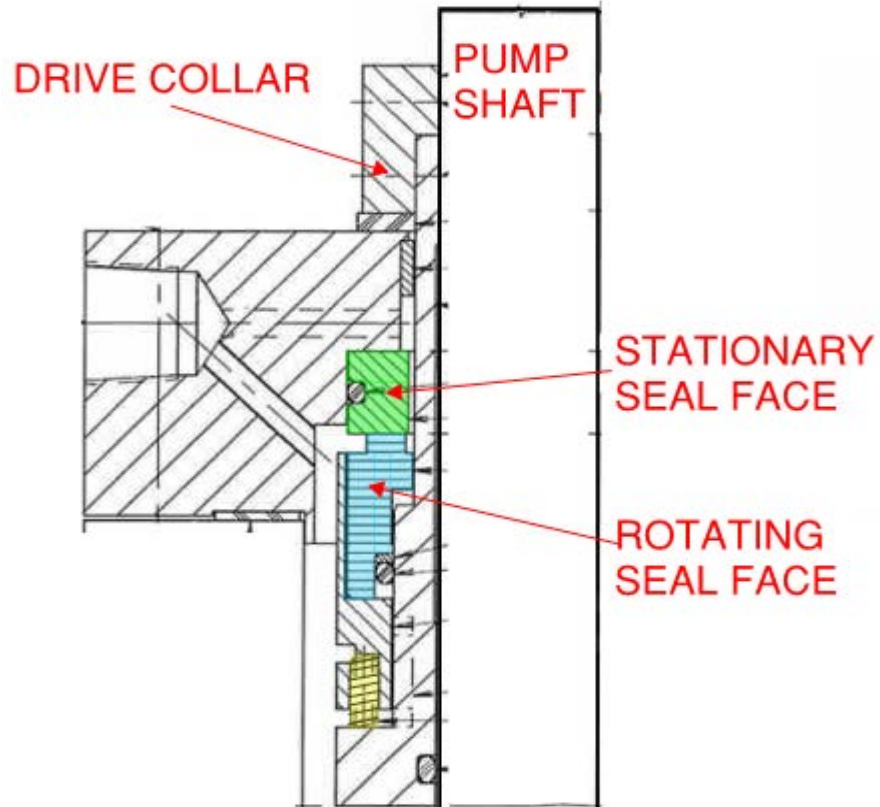
When the suction valve was opened it was noticed that the pump shaft and 4 piece rigid coupling moved about $3/8$ inch upward before the pump was started since flow through the pump pushed the components upward.

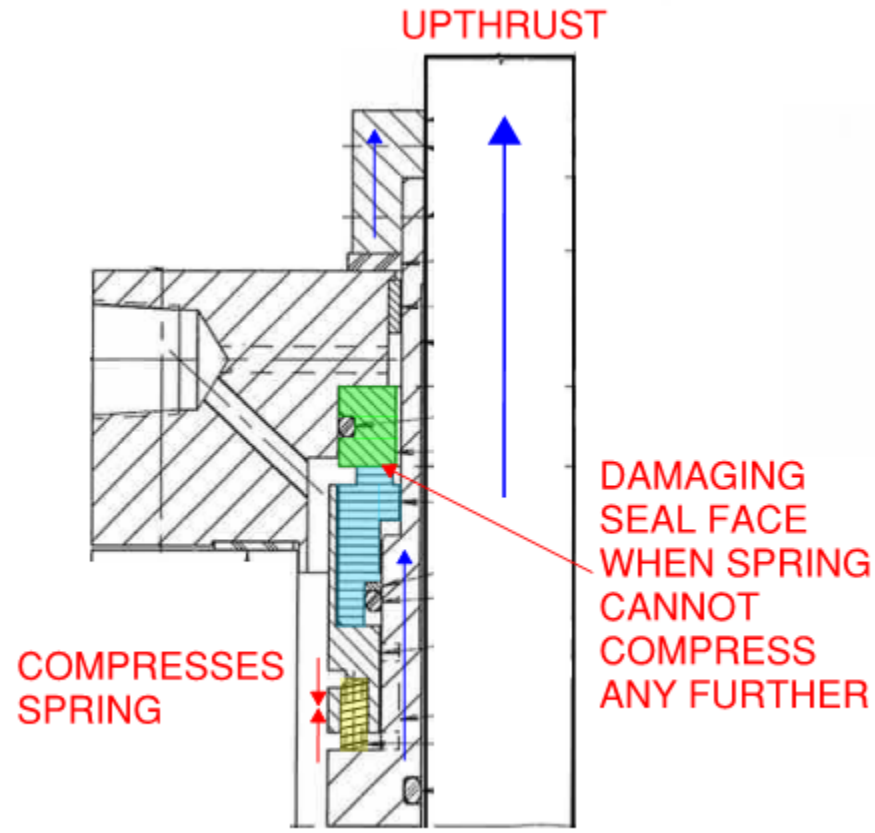
It was difficult to determine that the motor shaft did not move so it was difficult to trouble shoot and resolve the problem.

After the pump was started and flow was established the components moved back down to the normal position and the pump was in down thrust.



Mechanical Seal

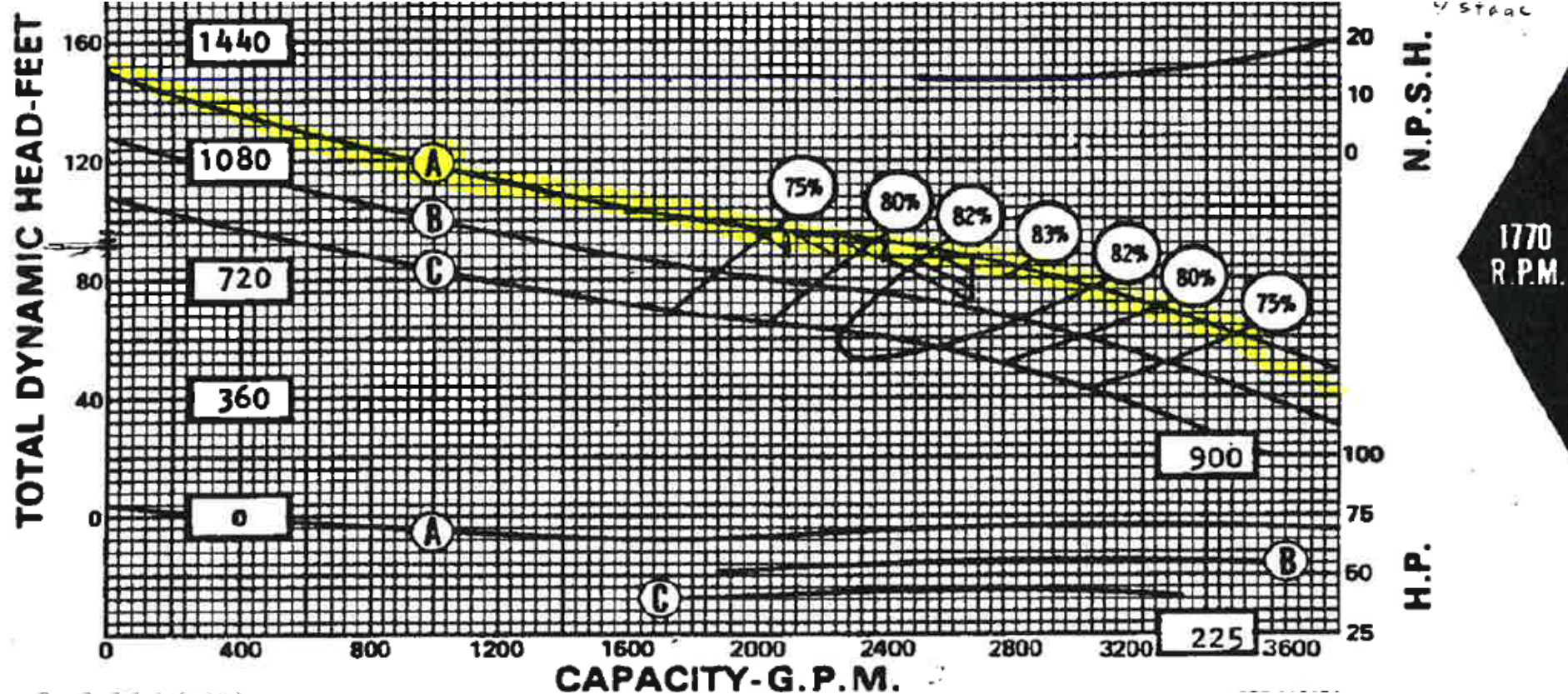




Impeller A is installed: diameter = 12.188 inch

Impeller B diameter = 11.250

Impeller C diameter = 10.625



Additional Details:

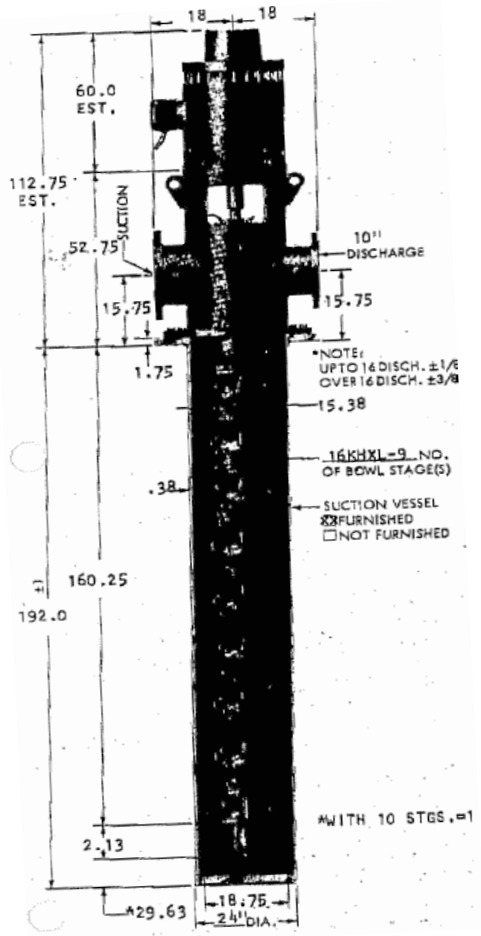
- Pump downthrust rating 19,000 lb
- Old motor downthrust rating 19,000 lb
- New motor downthrust rating 22,000 lb
- Total motor weight 3,850 lb
- The new motor had a longer shaft and was smaller diameter so a new motor hub and coupling spacer were manufactured



Additional Details:

- 300 hp vertical motor
- Old motor shaft diameter: 3.125 inches
- New motor shaft diameter: 2.625 inches





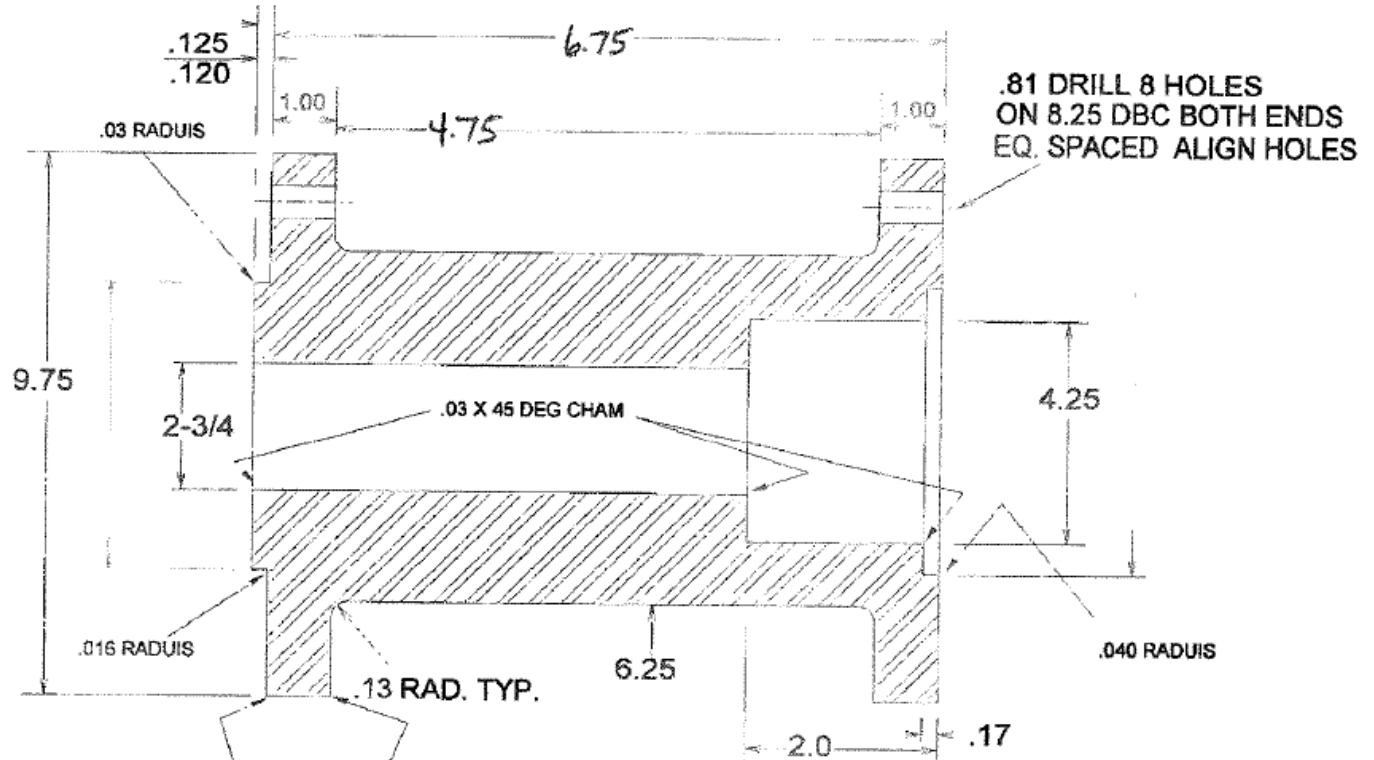
Pump Outline Drawing
 12x10, 9 stage pump
 600 hp, 1780 rpm, solid shaft motor

4 piece rigid coupling, spacer, nut,
 motor hub and pump hub

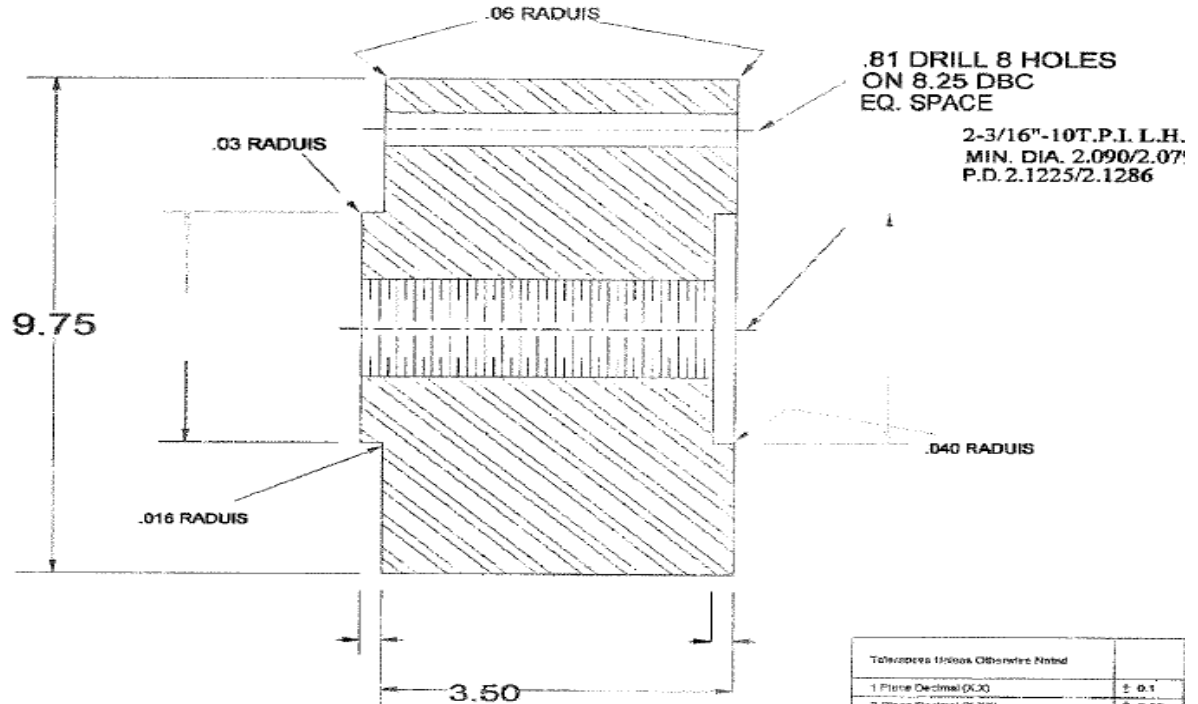
791 ft at 2660 gpm
 Suction Vessel 24" OD & 192" Length
 Suction 12" 150#
 Discharge 10" 300#



Coupling Spacer



Coupling Nut



ALL SURFACES TO A 125 FINISH UNLESS OTHER WISE NOTED

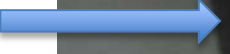
Tolerances Unless Otherwise Noted	
1 Place Decimal (X.X)	± 0.1
2 Place Decimal (X.XX)	± 0.02
3 Place Decimal (X.XXX)	± 0.005
Fractions	± 1/16
Angles	± 5°
All Dimensions In Inches Break All Unthreaded Corners	



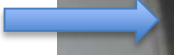
Motor Hub



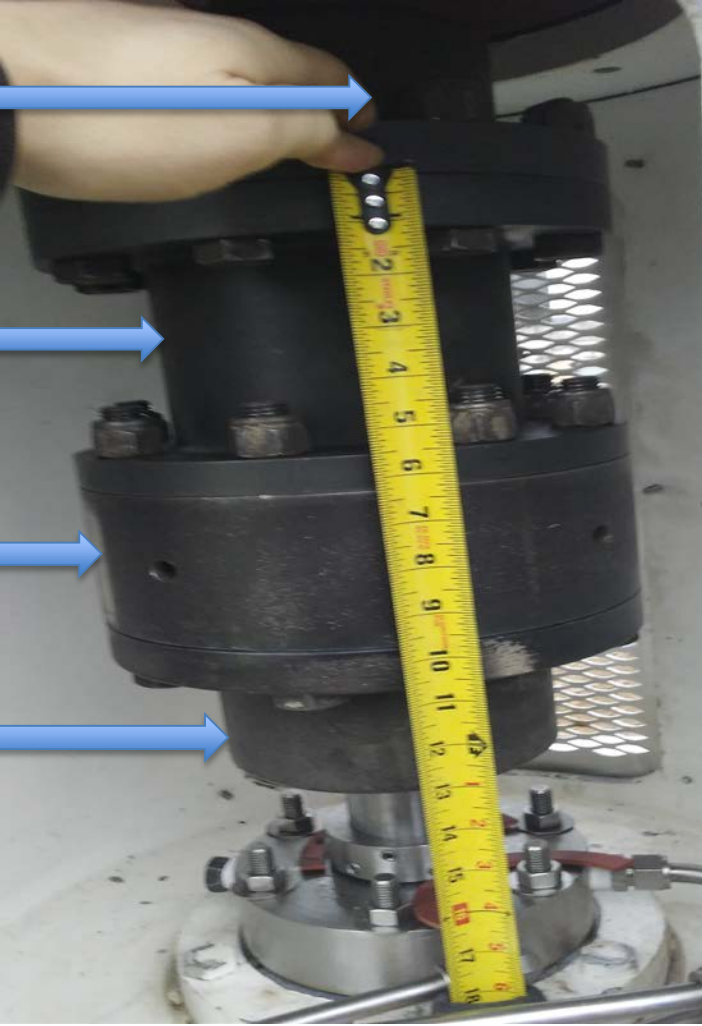
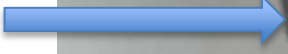
Coupling
Spacer



Coupling
Nut

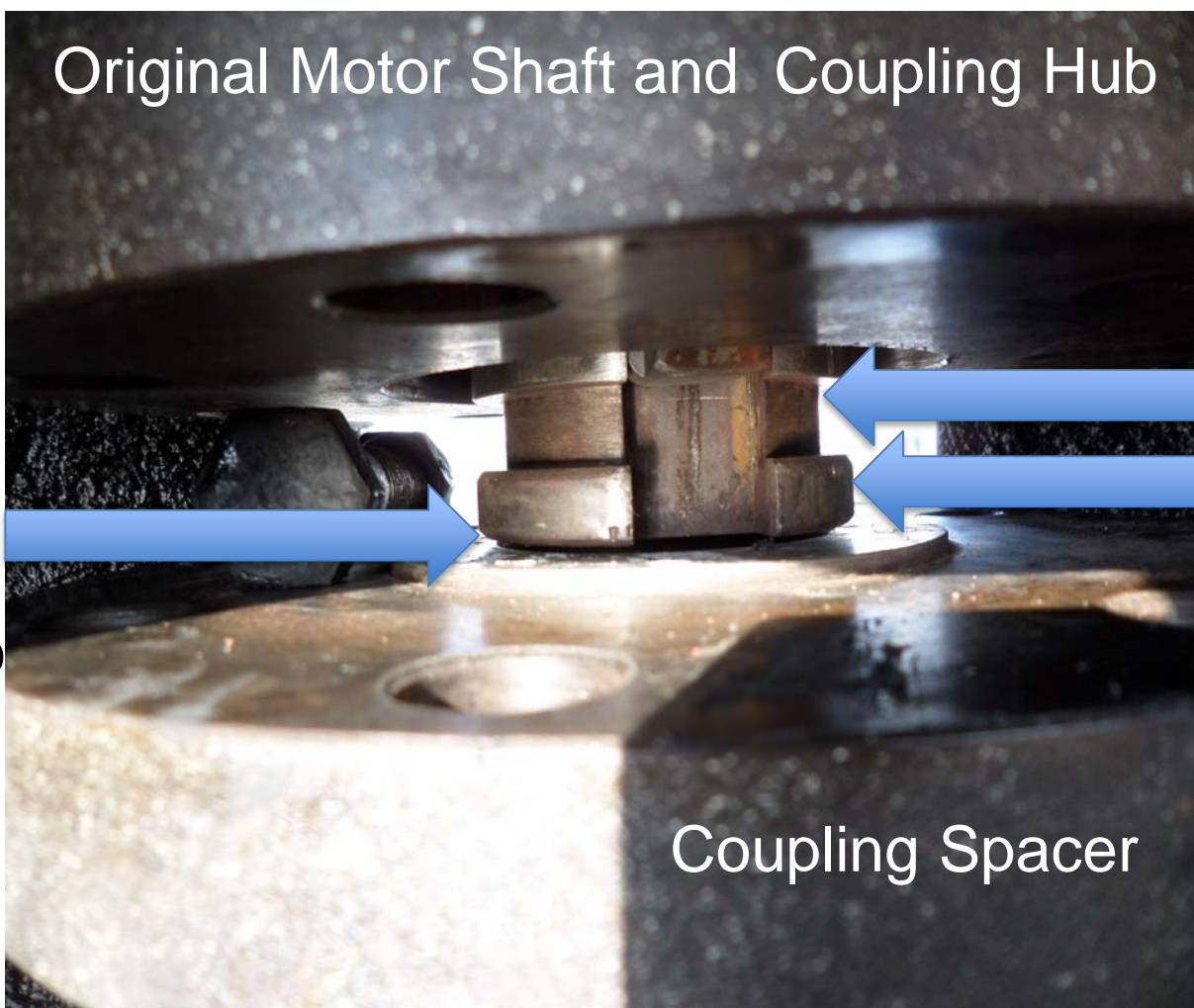


Pump Hub



Original Motor Shaft and Coupling Hub

ID and OD
difference
transfers
up thrust to
motor

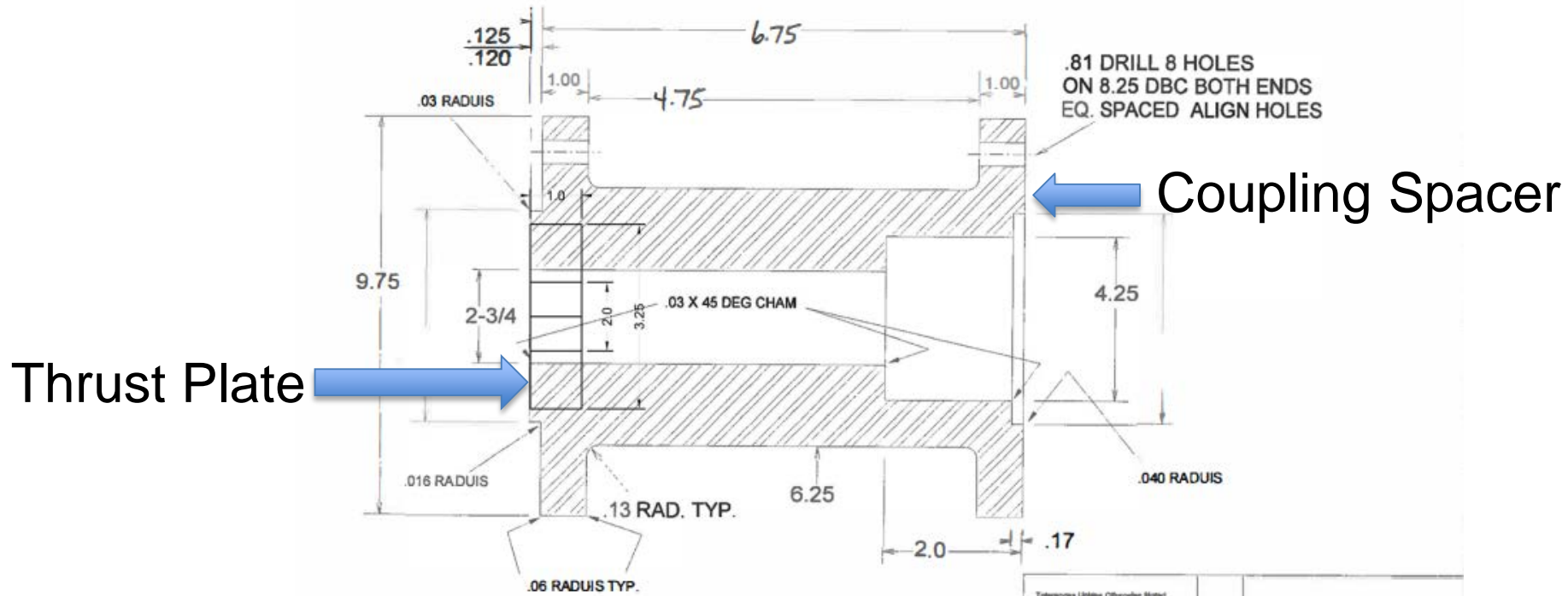


Location for
Split Ring
Motor Shaft

Coupling Spacer



Modify spacer and install thrust plate – 3.25" OD, 1" thick



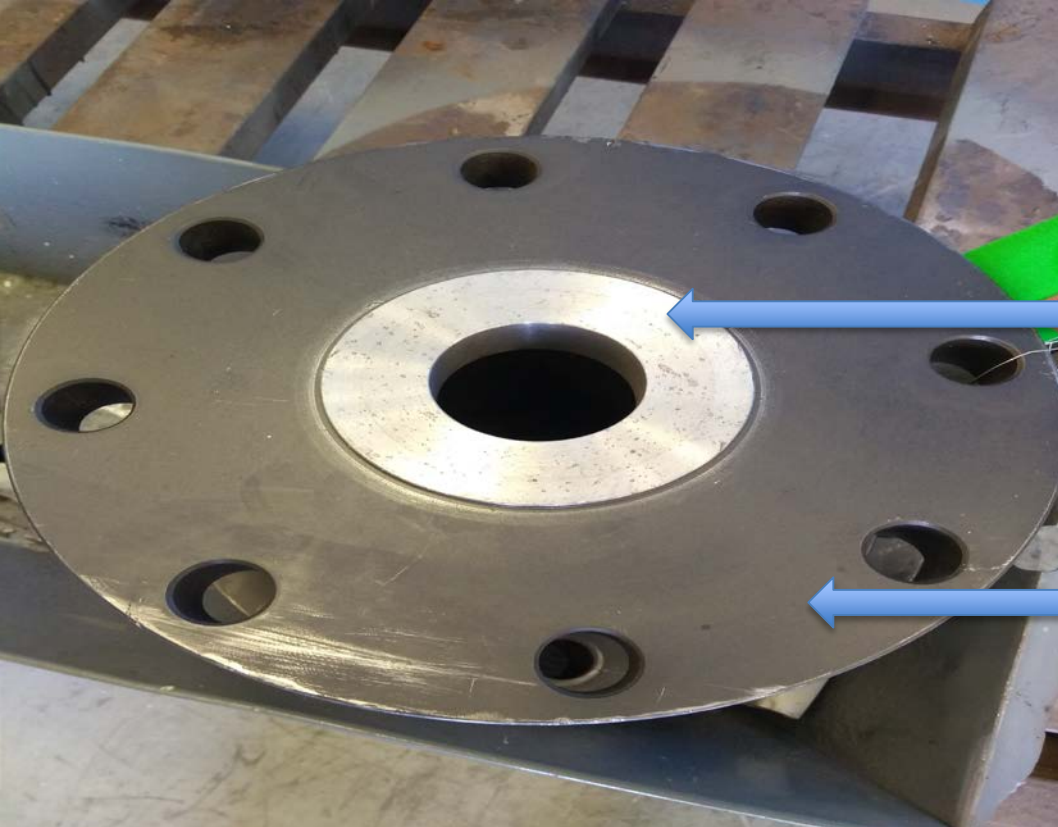
.81 DRILL 8 HOLES
ON 8.25 DBC BOTH ENDS
EQ. SPACED ALIGN HOLES

ALL SURFACES TO A 125 FINISH UNLESS OTHER WISE NOTED

Tolerances Unless Otherwise Noted	
1 Place Decimal (0.1)	± 0.1
2 Place Decimal (0.00)	± 0.02
3 Place Decimal (0.000)	± 0.005
Fractions	± 1/16
Angles	± 0.30
All Dimensions in Inches Break All Machine Centers	



Modified coupling spacer with thrust plate installed that stops upward axial movement of pump shaft and prevents seal failures.



Thrust Plate

Coupling Spacer



Summary

- When installing replacement motors on vertical can pumps, check the up and down thrust ratings on both motors and check the thrust requirements of the pump.
- When installing vertical can pumps, check the operational and start up requirements to see if a unit check valve will be required.
- New motors often have smaller diameter shafts than very old motors so new motor coupling hubs are often required when old motors are replaced.



Summary

- If replacement motors have different shaft diameters make sure that a smaller shaft will not be able to slip inside the hollow coupling spacer/center member and create a condition in which the motor will not be able to supply any force to stop the up thrust movement of the pumps.
- Excessive pump shaft movement upward during start up can damage mechanical seals.

