'B' Reactor Recirculation Pump
Stuffing Box Measurements Summary

Concern:

'B' Reactor Recirculation pump has historically higher vibrations than 'A' Reactor Recirculation pump and higher vibrations than the industry average. During RF12, maintenance collected a series of shaft runout readings under a repair plan in the mechanical seal replacement WO 60036037. The following is an evaluation of that data.

Evaluation:

The data was collected in three different configurations:

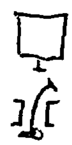
1) Pump coupled to motor.
2) Pump uncoupled sitting on the bottom of the pump casing.
3) Pump uncoupled sitting on the temporary bearing.

The data collected with the pump coupled shows an equal and concentric runout of 5 mils on the pump shaft over the entire stuffing box region. See Attachment 1. This indicates that the shaft is relatively straight (unbowed) over this region. The 5 mils of runout is due to inconsistencies in the motor bearings, the motor shaft, and the coupling stack-up, and is within the vendors acceptance criteria for shaft runout.

The data collected with the pump uncoupled, both with and without the temporary bearing, shows the shaft at an angle in the stuffing box. See Attachments 2 & 3. This indicates a shaft bow of some sort. The data collected with the uncoupled pump sitting on the bottom of the pump casing was evaluated in Attachment 4 and determined a shaft bow of 4.8 mils. This evaluation assumed that the pump impeller sits evenly on the bottom of the pump casing. This assumption can not be verified; however, the bottom of the pump casing is a machined surface. The data collected with the temporary bearing installed was not repeatable. Looseness in the bearing caused the shaft to rock slightly while it rotated resulting in variations in the data. However, when the upper and lower readings are compared, they indicate that the runout is greater at the top than the bottom, which was the expected result for a bowed shaft.

Historically, the pump vendor reports that the most likely location of a shaft bow is the thermal mixing region directly below the stuffing box. The bow is caused by residual stresses from the initial manufacturing of the shaft and from uneven thermal stresses caused by the inefficient heat exchange between the relatively cool mechanical seal purge water, and the relatively hot reactor coolant water in the thermal mixing region. With the pump coupled, the larger mass of the motor pulls the pump shaft in alignment with the motor shaft, and causes the impeller to bow over to the side in the pump casing.

With the pump uncoupled, the larger mass of the impeller allows the impeller to center itself in the pump casing, which causes the upper end of the uncoupled shaft to move over to the side of the stuffing box.



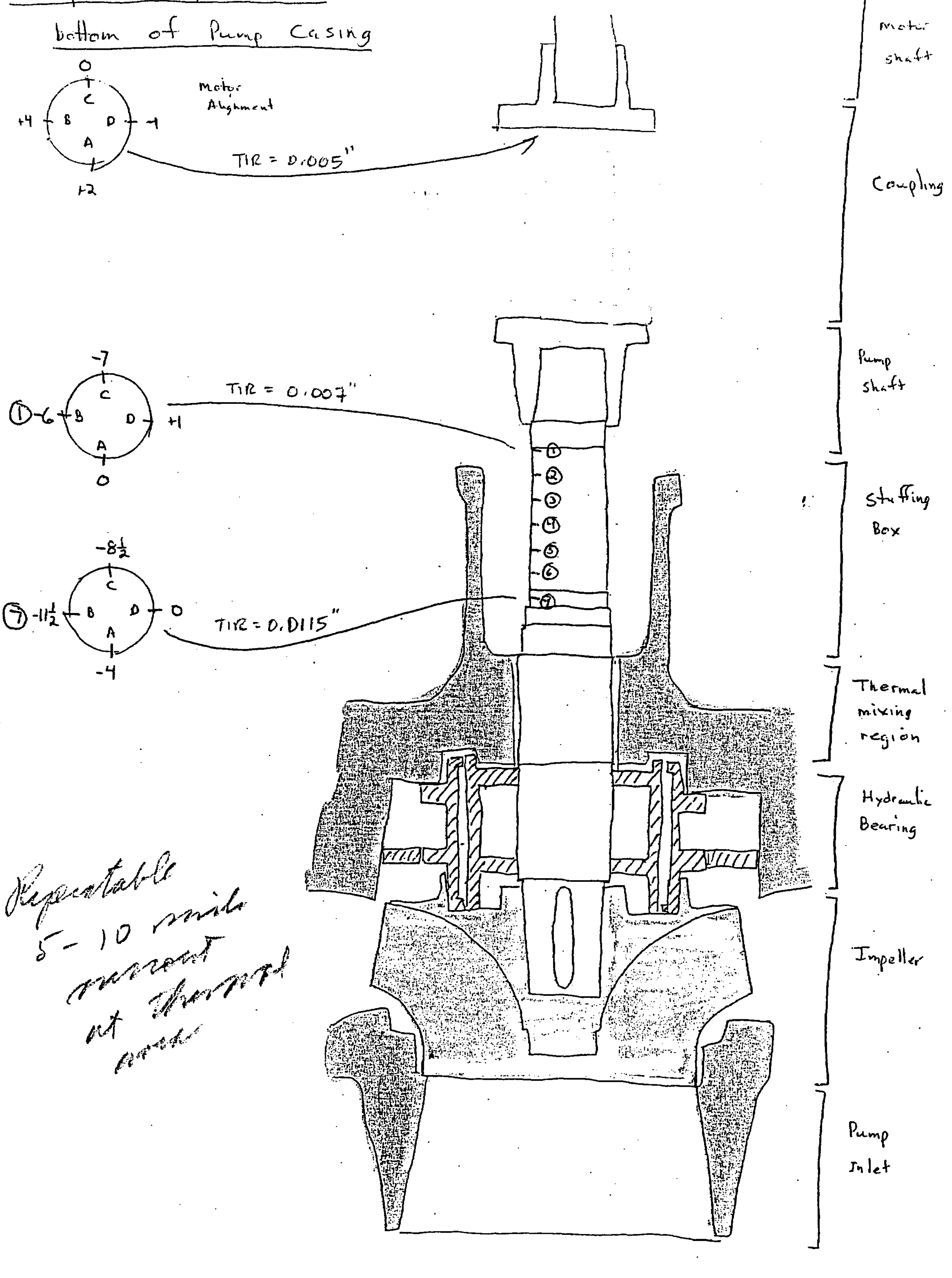
The 5-10 mil shaft bow is not detrimental to the immediate operation of 'B' Reactor Recirculation pump. The section of shaft in the stuffing box has consistent and concentric runout of 5 mils. This indicates no bow in this region and is within the vendor acceptance criteria for shaft runout; therefore, the bow in the shaft does not have a direct adverse affect on the mechanical seal. This is also seen in the mechanical seals satisfactory operation throughout Cycle 12. However, the bow moves the impeller out of its proper centered position in the pump casing, and caused elevated vibrations, which are seen in the 10-12 mils vibration levels recorded when the pump is in operation. These vibration levels have been steady for the last three years. Any pump vibration decreases the life expectancy of the pump's mechanical seal. The vendor's technical note gives a pump vibration limit of 25 mils. At this point the pump should be removed from service, due to impending failure of the mechanical seal. 'B' Reactor Recirculation pump's 10-12 mil vibration levels are well within this limit, and under the vibration levels of other stations.

Conclusions:

1) The section of shaft that runs through the pump stuffing box, and interacts with the mechanical seal has consistent runout.
2) The shaft contains a "bow" below the stuffing box, most likely in the thermal mixing region, and most likely has a magnitude of 5-10 mils.
3) 'B' Reactor Recirculation pump has higher vibrations, but is not adversely affected by the presence of the bow in the shaft.

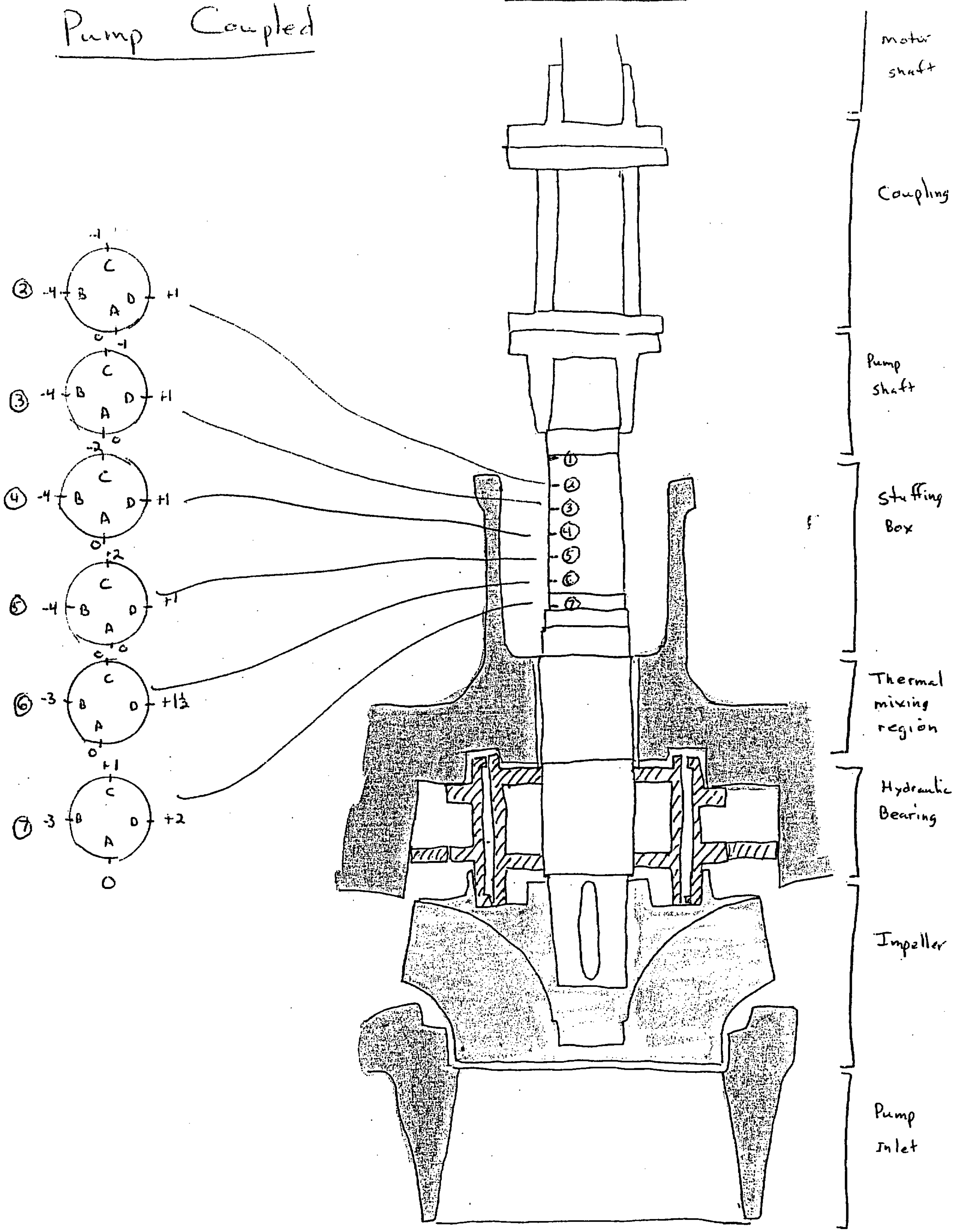
Attachment 2

Pump Uncoupled on bottom of Pump Casing



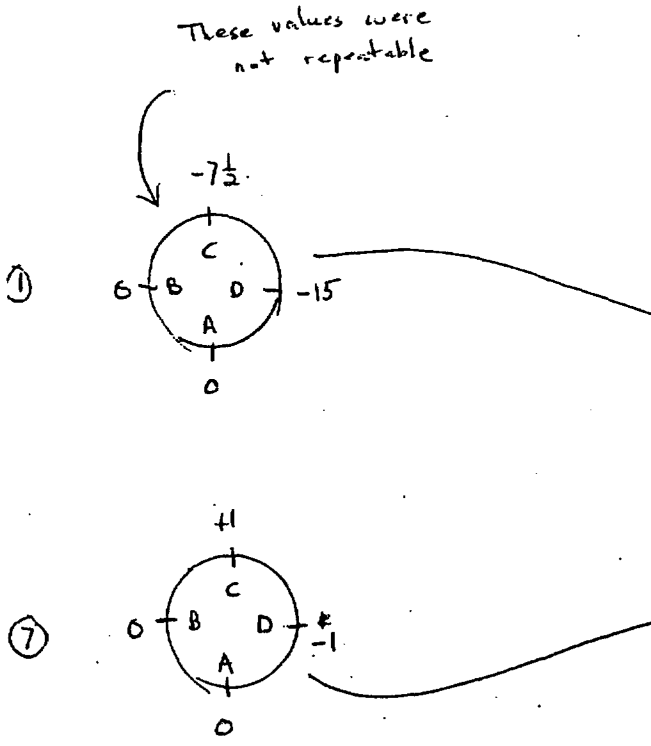
Attachment 1

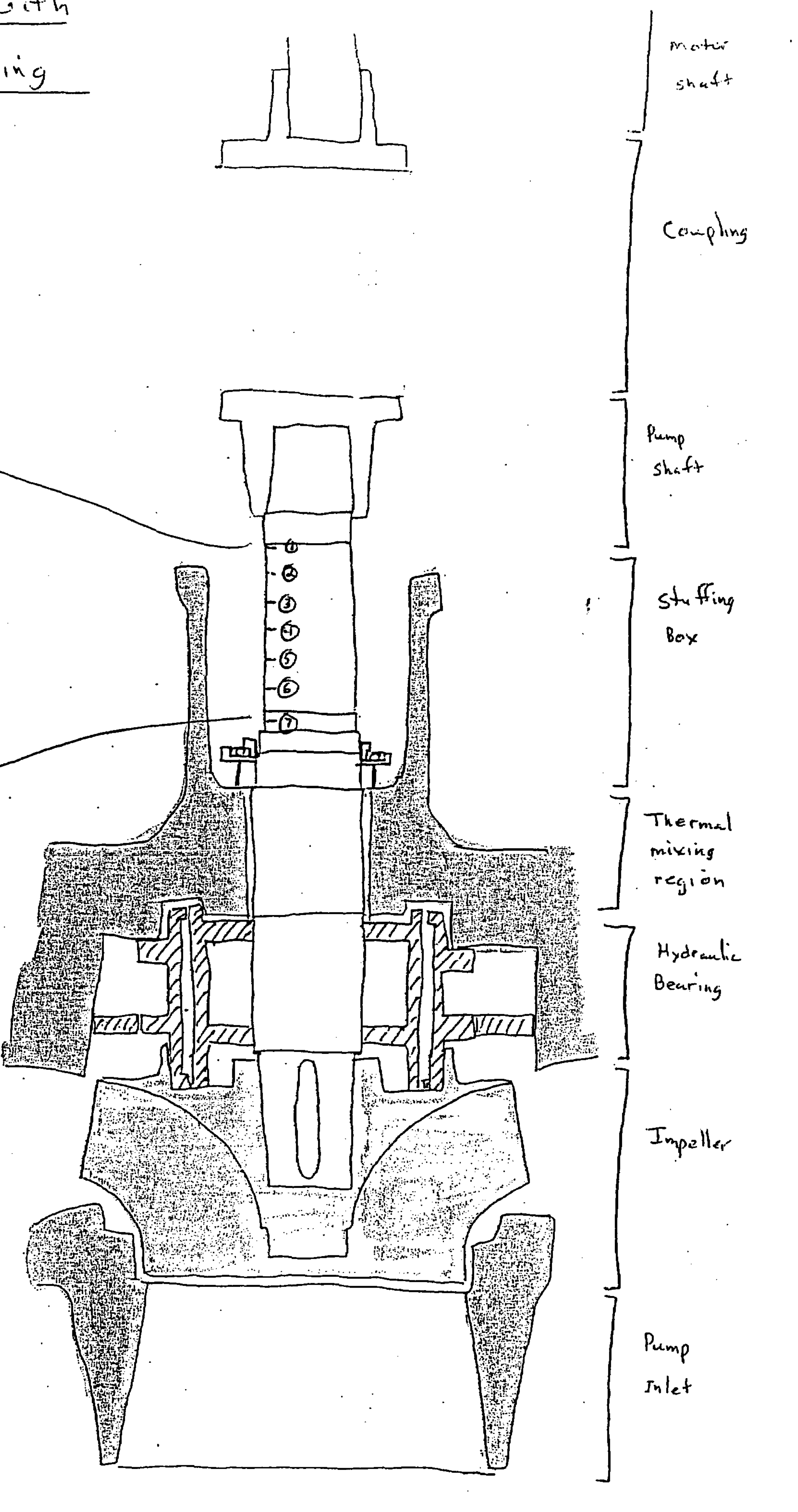
Pump Coupled



Attachment 3

Pump Uncoupled with Temporary Bearing

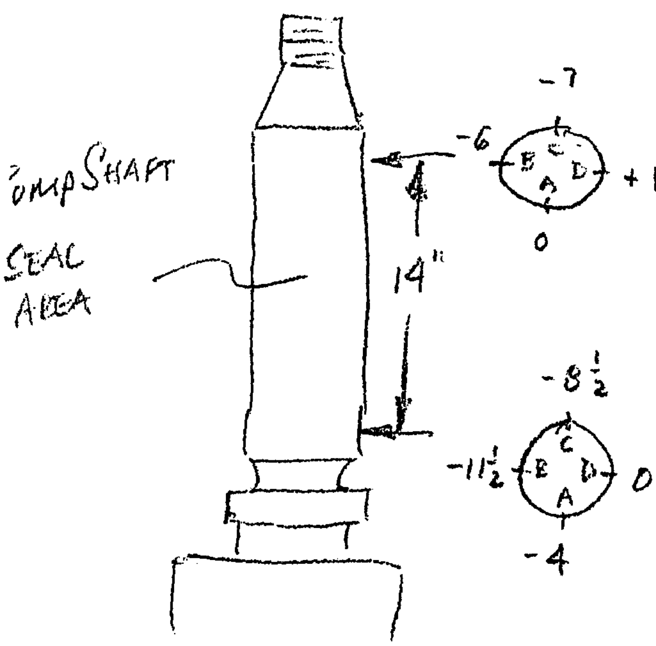




POTENTIAL SHAFT BOW DETERMINATION

ASSUMPTION
- MOTOR / PUMP UNCOUPLED
- MOTOR SHAFT CENTERED IN MOTOR BEARINGS
- PUMP ELEMENT SITTING DOWN, WITH IMPELLER ON PUMP CASE

ACTIONS
- TAKE PUMP SHAFT RUNOUTS TO DETERMINE IF SHAFT BOW IS PRESENT WITH RESPECT TO PUMP STUFFING BOX.



TIR = 0.007"

TIR = 0.0115"

Δ TIR = 0.0045"

Δ SHAFT ℄ POSITION = $\frac{1}{2}$ (0.0045")

= 0.00225"

SHAFT TOTAL LENGTH = 60"

ASSUME – MAX BOW LOCATION AT $\frac{1}{2}$ TOTAL LENGTH.

MAX BOW ESTIMATE $= (60\text{" shaft})\left(\frac{1}{2}\right)\left(\frac{0.00225\text{" ℄ change}}{14\text{" shaft}}\right) = 0.0048\text{"}$