Innovative VFD Pump System for Hydrocarbon Products Pipeline

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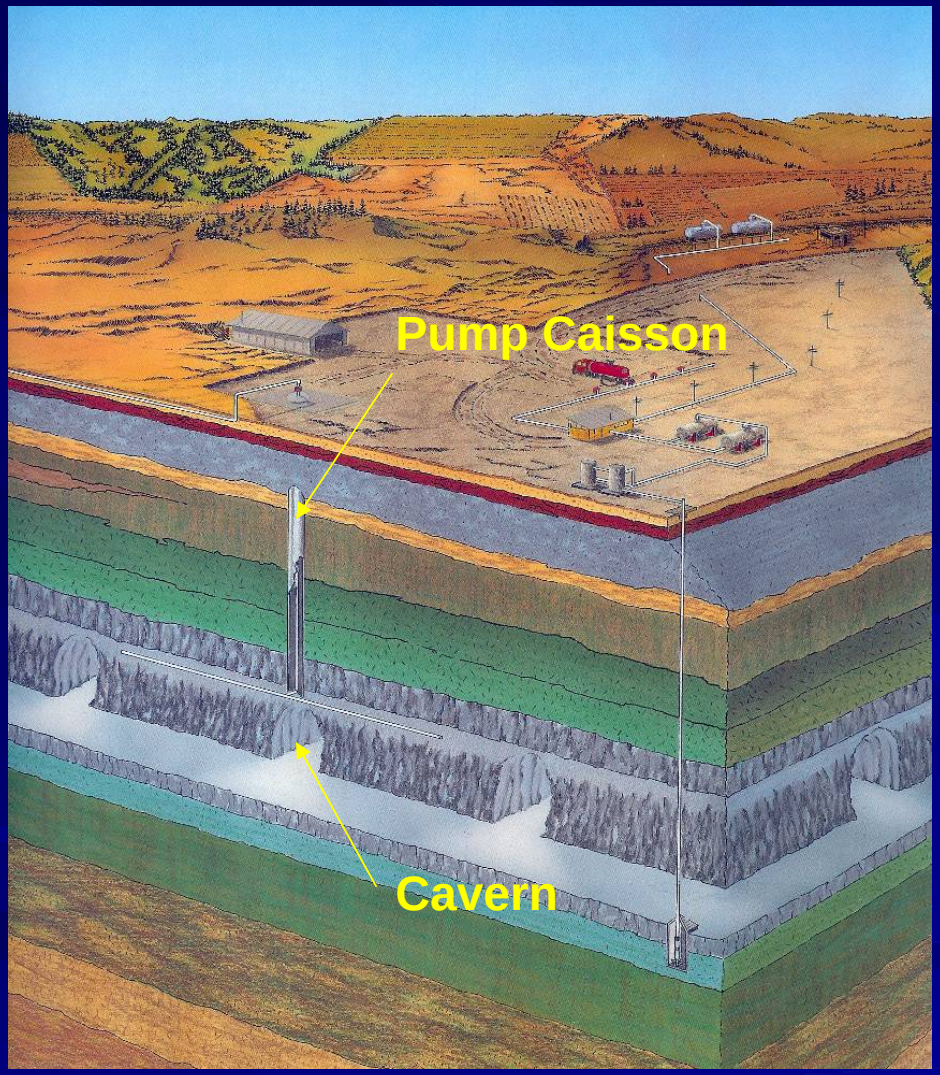
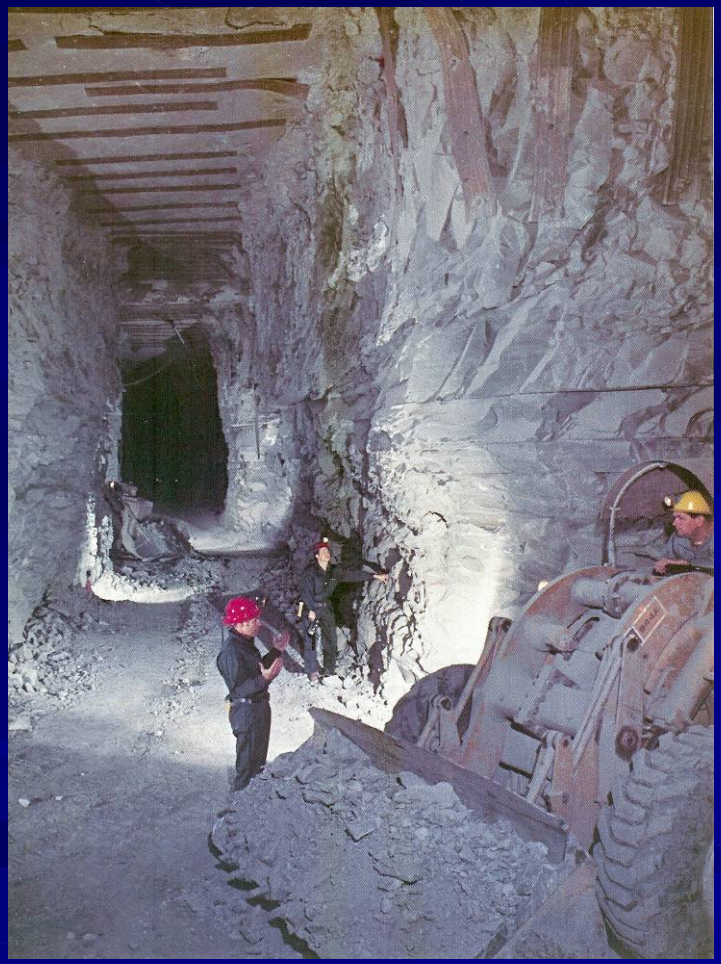
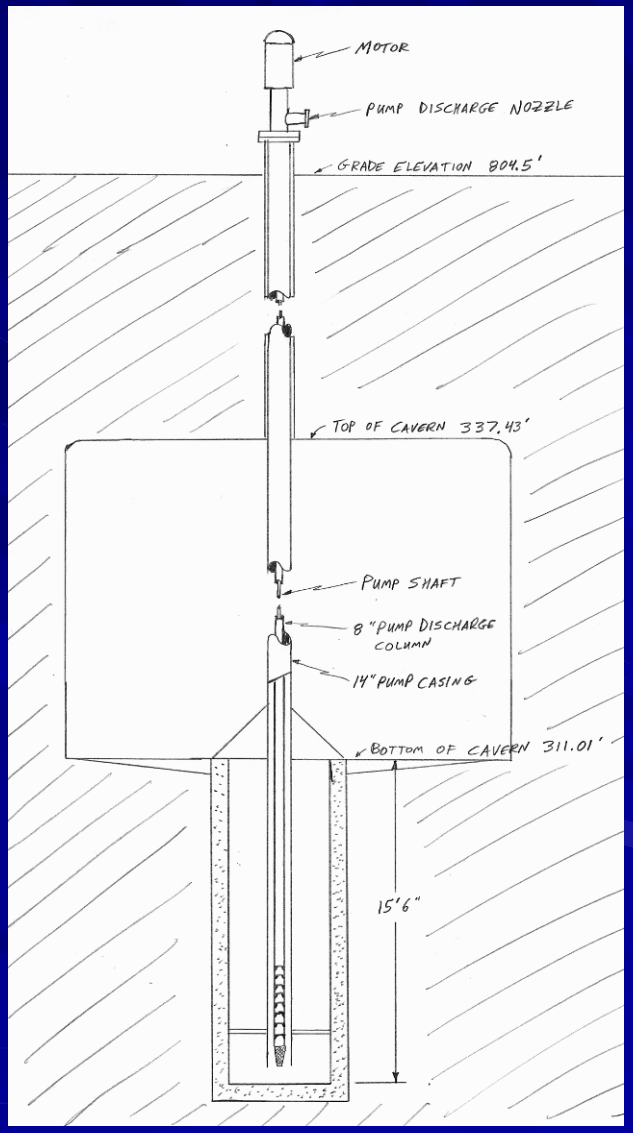
Background



- Propane Storage Cavern along Mid-west USA Pipeline
- Location Iowa City, Iowa
- Shale Formation
- 500’ below grade
- 26’ floor to ceiling
- Propane in Liquid Phase
- 3 pumps, 525 GPM each

Background-Inside a Mined Cavern





Pump History at Site

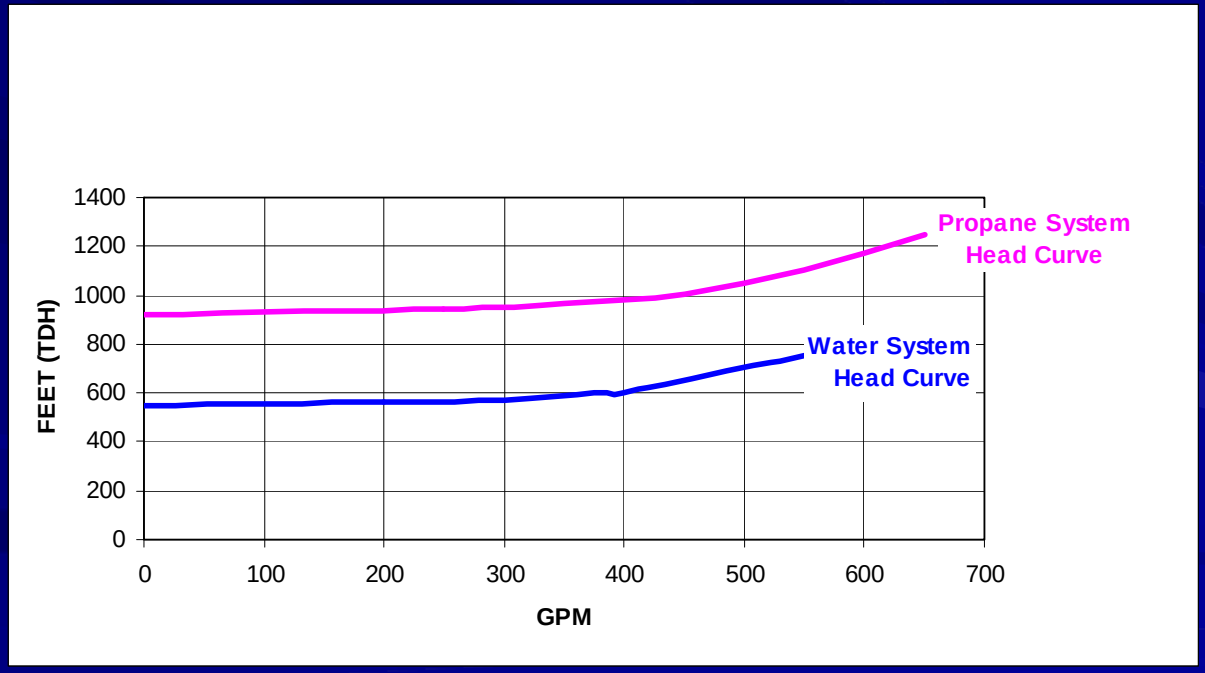
- Pumps driven by vertical motor with 500Ft shaft.
- Shaft support provided by steady bearing every 10Ft.
- Primary pump failure mode is line shaft shaft bearing wear resulting in seal failure.
- Mechanical seal failure on propane Service can be very dangerous
- Environmental Concerns

Why Convert to Submersible Pump Design?

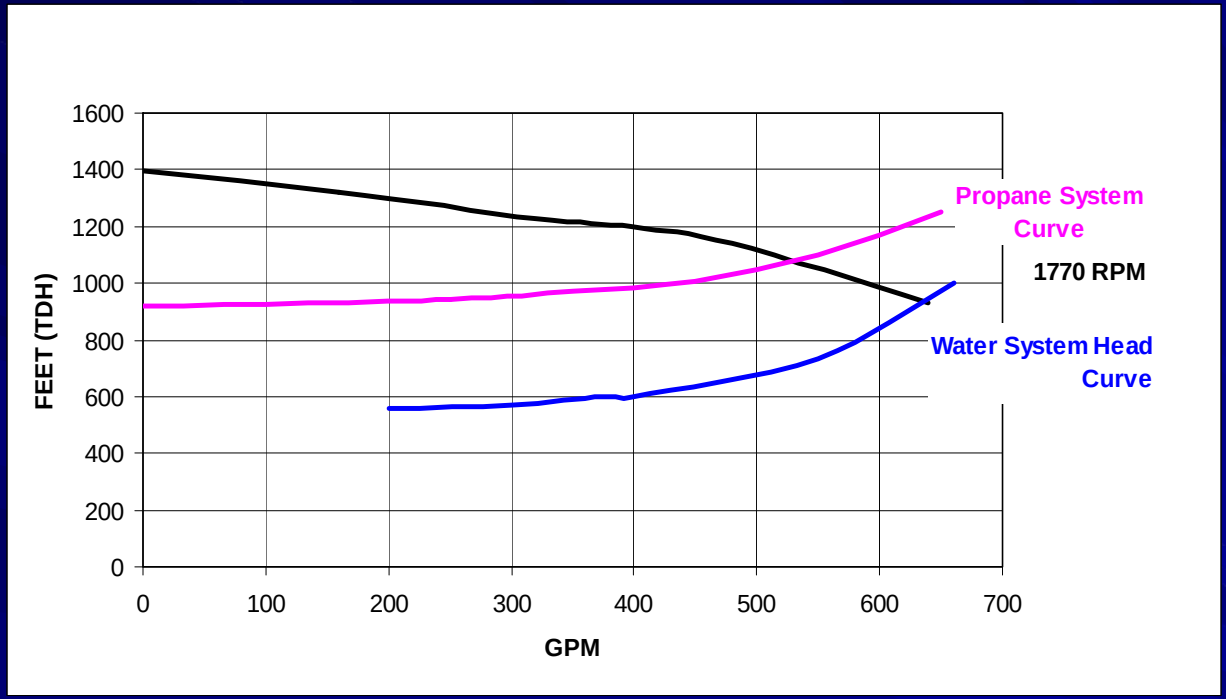
- Eliminate pump mechanical seal.
  - ZERO Fugitive Emissions
  - NO risk of catastrophic seal failure!
- Elimination of line shaft steady bearings/wear and resulting failures.
- Environmental concerns virtually eliminated
- Ease of pump removal
- Noise Reduction

Engineering Considerations

- Caisson filled with 231Ft water column during pump removal to isolate propane in cavern.
- Submersible Motor Size (physical) vs. 14” Caisson I.D. i.e. It has to fit in the hole…
- System head curves for Propane and Water



Engineering Considerations



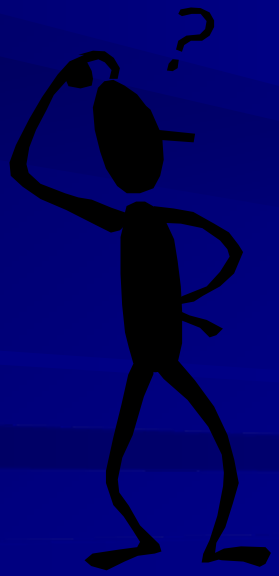
- Motor HP for Water 1.0 SG.= 250HP
- Motor HP for Propane .51SG.= 125HP
- 250HP Motor required in order to pump water at synchronous speed of 1770 RPM

Engineering Considerations

Houston We Have a Problem!!!!

250HP 1800 RPM Motor too large to fit into 14” I.D. Caisson I.D.

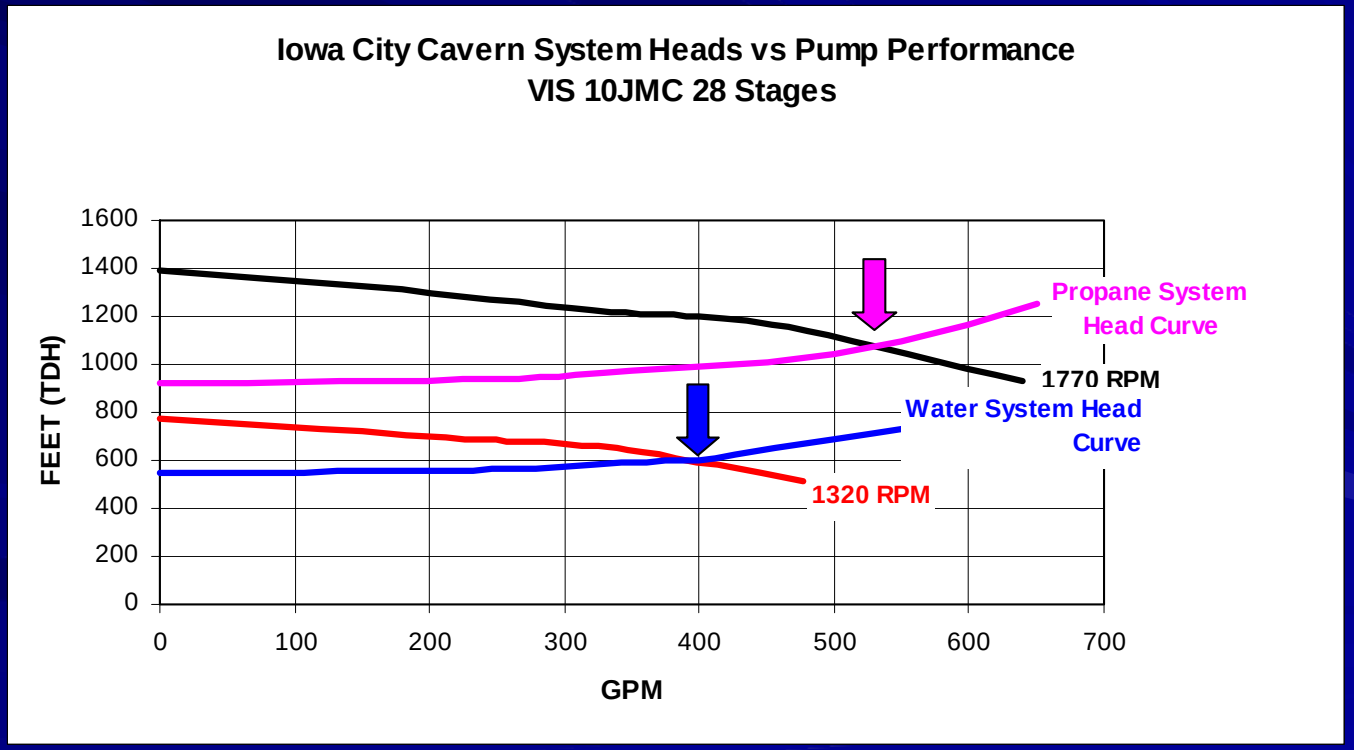
Maximum motor size that fits is 125HP 1800RPM



125HP Motor is a tight fit

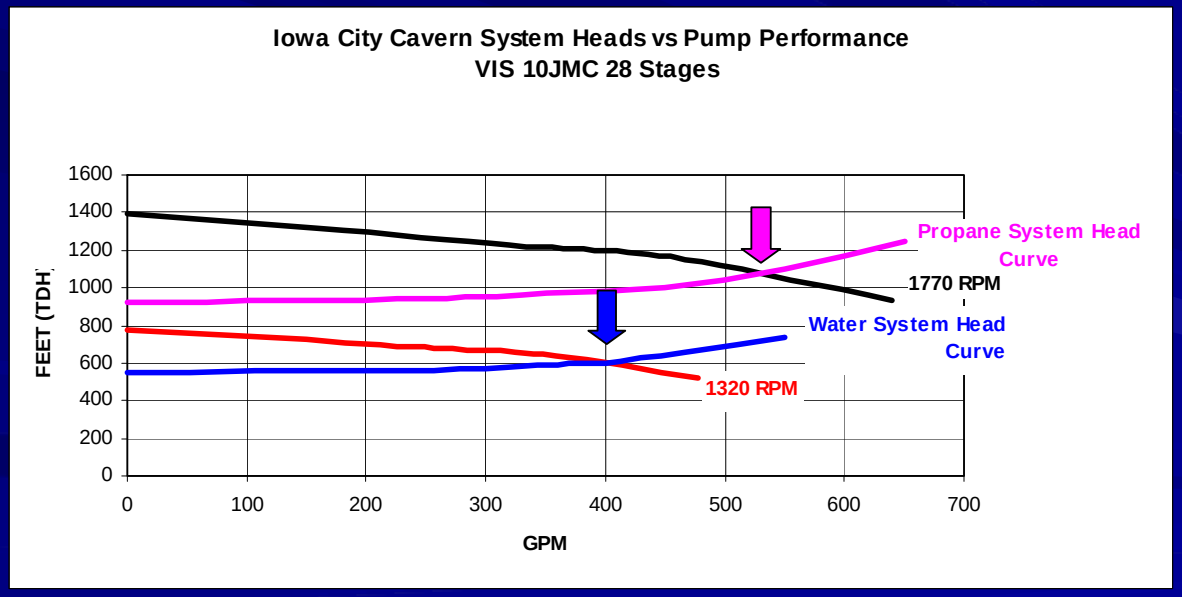
Resolution

- Slower Speed of 1320 RPM can be used to pump water at the lower system head curve
- Required BHP is only 89 HP for water at 400GPM at Non-Synchronous 1320 RPM



Resolution

It was determined that a 125 HP 1770 RPM variable speed pump could be used for both the Propane and Water system head curves when utilizing a VFD for pumping water to atmosphere during de-watering operation.

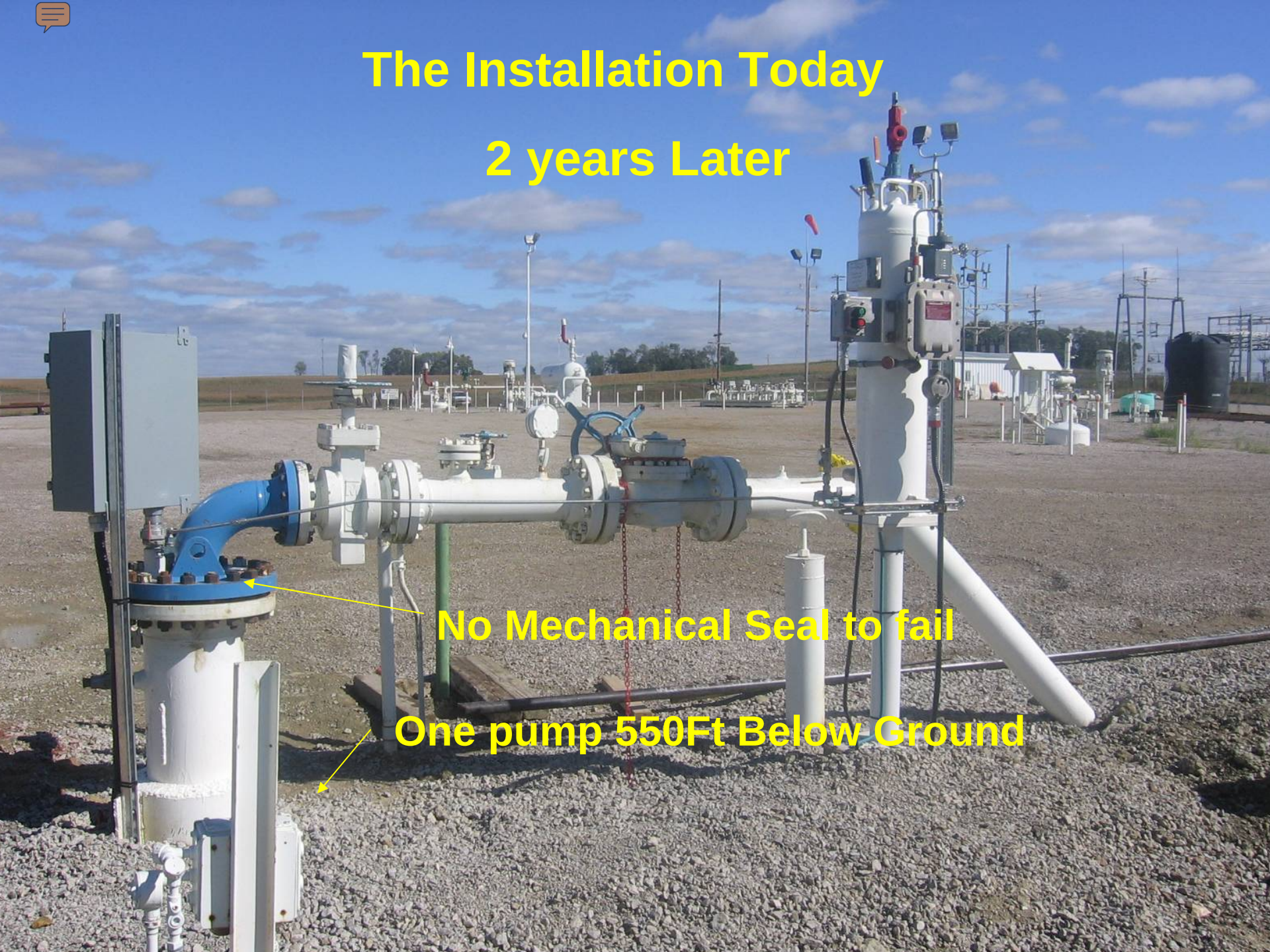


Pump and VFD Installation

Pump being installed into caisson

VFD Configured for Dual Speed Operation

Pump Installation


The Installation Today
2 years Later
No Mechanical Seal to fail
One pump 550Ft Below Ground

Conclusions

- Without the use of a VFD on this application, a submersible pump could not have been installed into this service.

- By using a VFD for the purpose of speed optimization, a single pump can be used effectively on varying system head curves and fluid densities, without the need of artificial throttling and wasted energy.

Questions?

Thank you for coming.