46TH TURBOMACHINERY & 33RD PUMP SYMPOSIA
HOUSTON, TEXAS | DECEMBER 11-14, 2017
GEORGE R. BROWN CONVENTION CENTER

# Inlet Bay Flow Turbulence


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|---|---|
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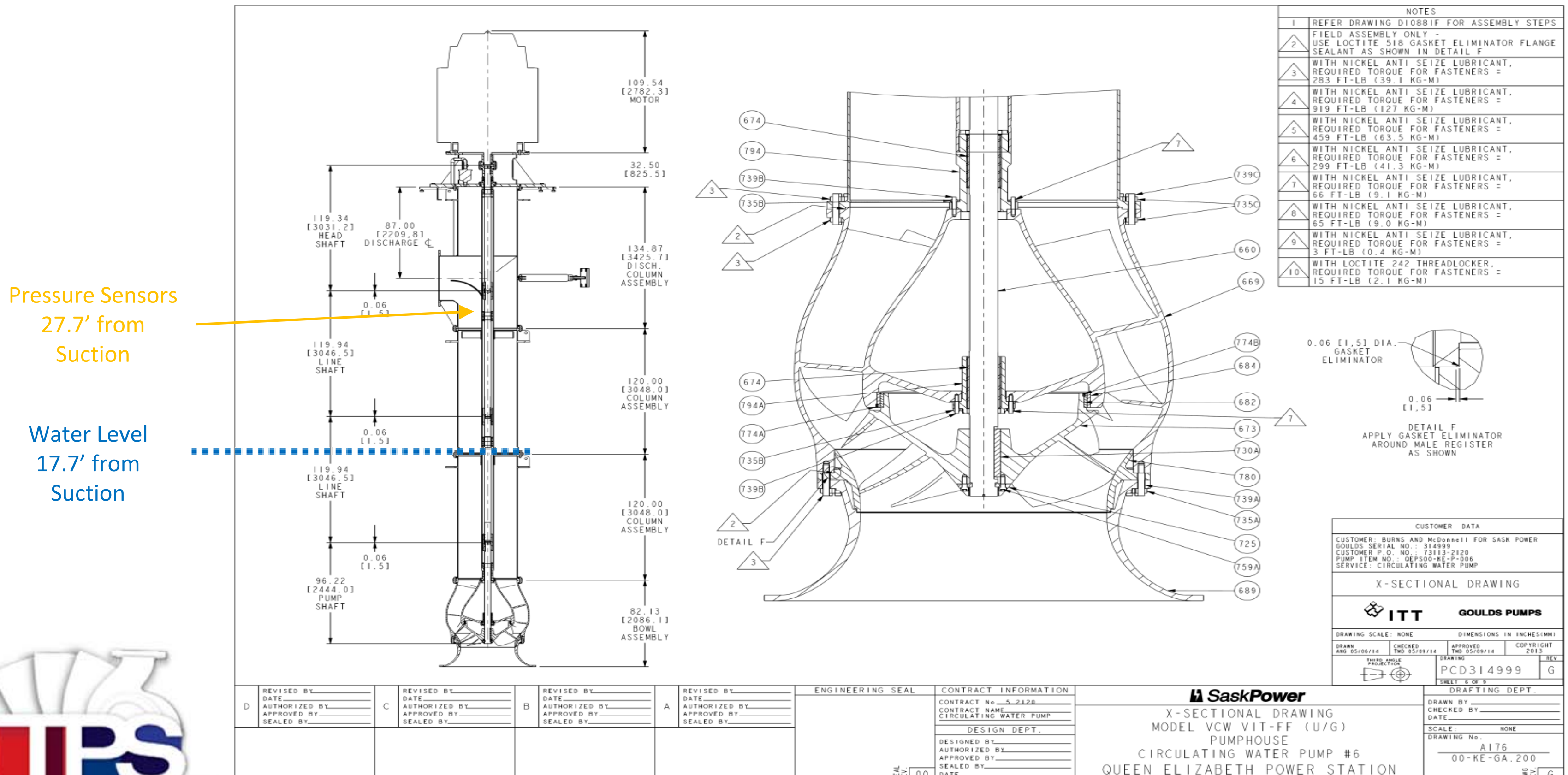
ITT GOULDS PUMPS

TEES TURBOMACHINERY LABORATORY
TEXAS A&M ENGINEERING EXPERIMENT STATION

TEXAS A&M UNIVERSITY

# Vertical Circulating Water Pump

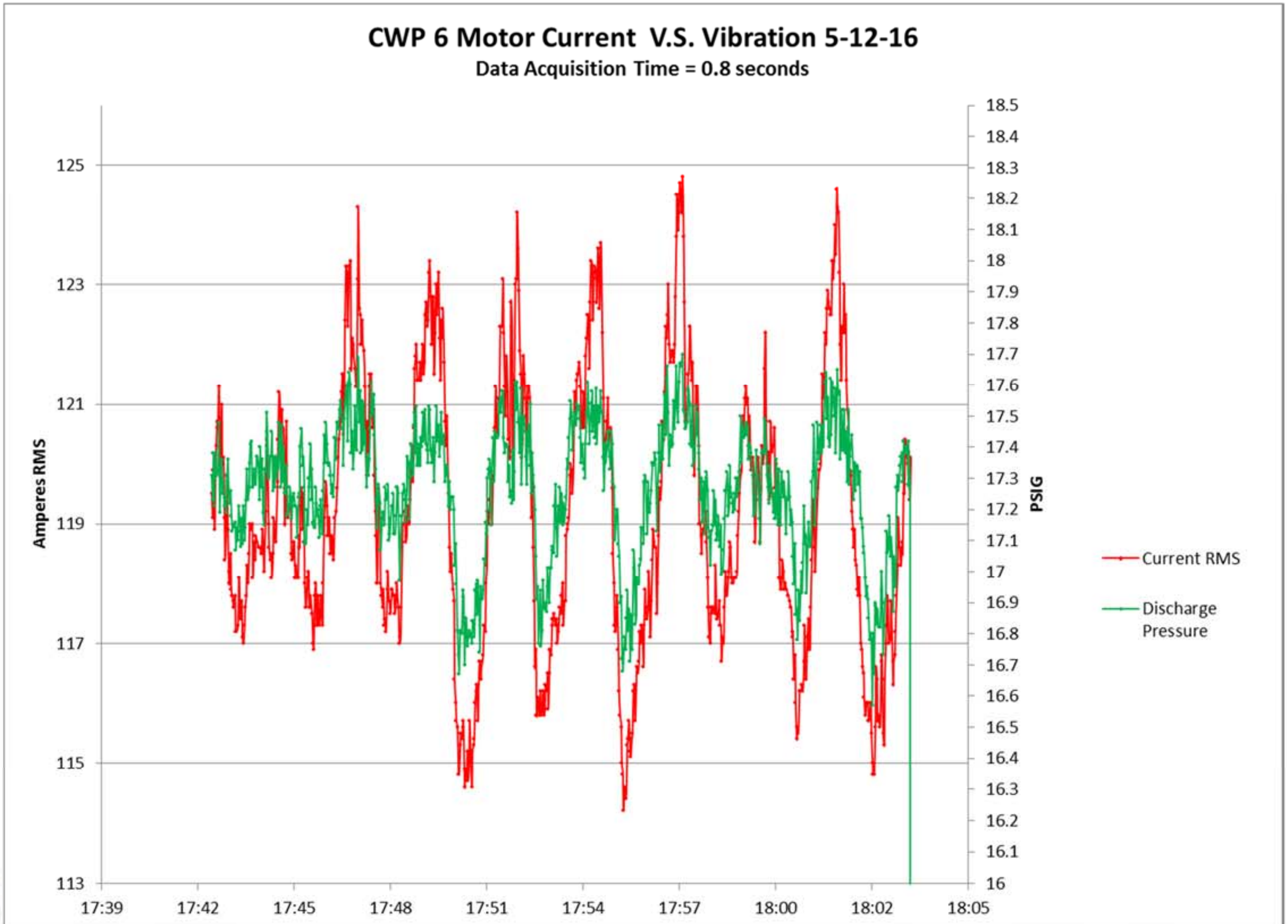


# Background / Problem

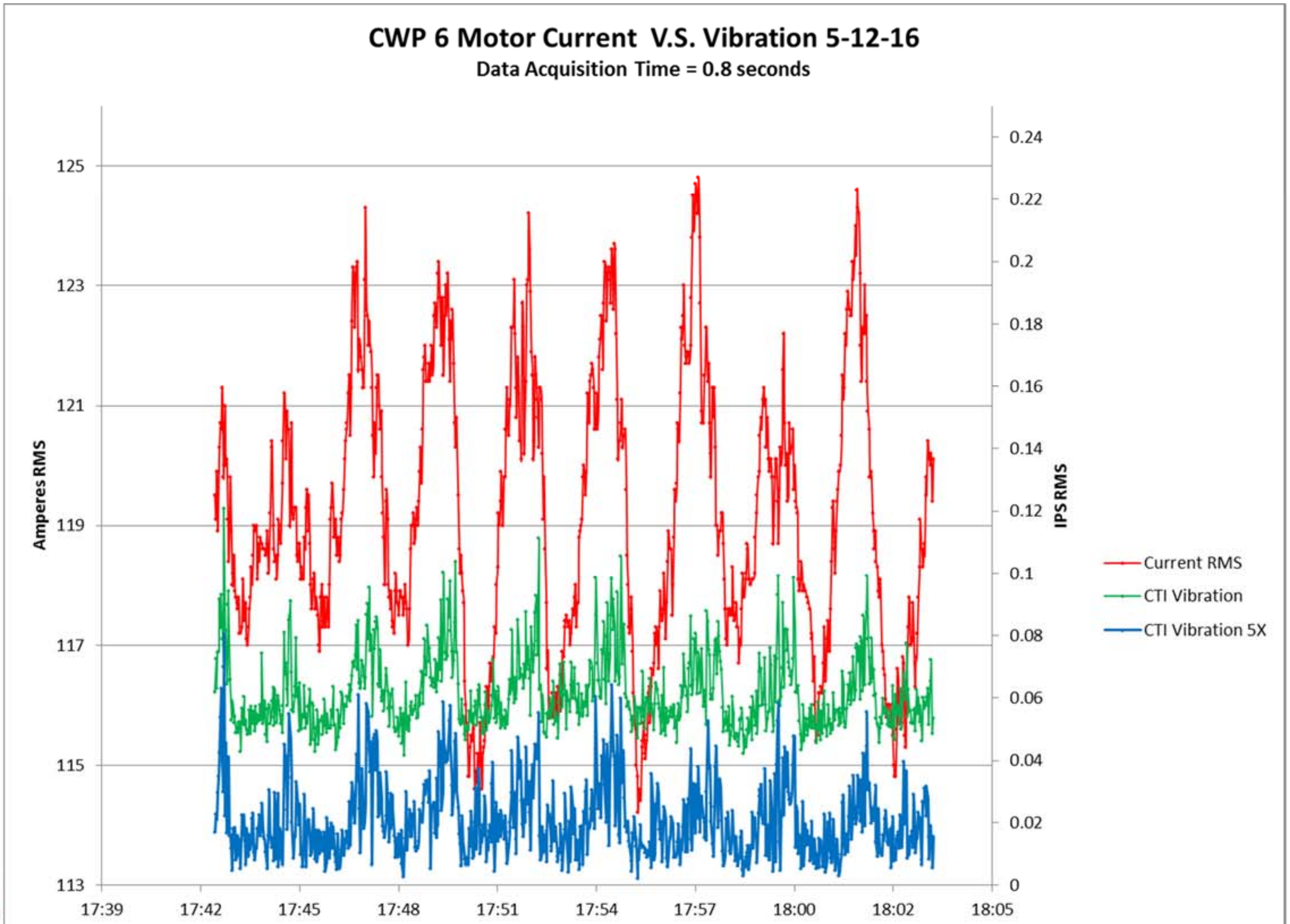
A 58,000gpm single-stage vertically suspended cooling water pump experienced power and discharge pressure oscillations. Vibration and performance testing indicated power and pressure oscillations were caused by turbulence and vortex formation in the inlet bay. Physical hydraulic model testing confirmed that the flow entering the pump suction bell was indeed turbulent and unsteady. A vortex suppressor was used to straighten the flow from the inlet bay structure. The power and TDH variations with time were essentially eliminated

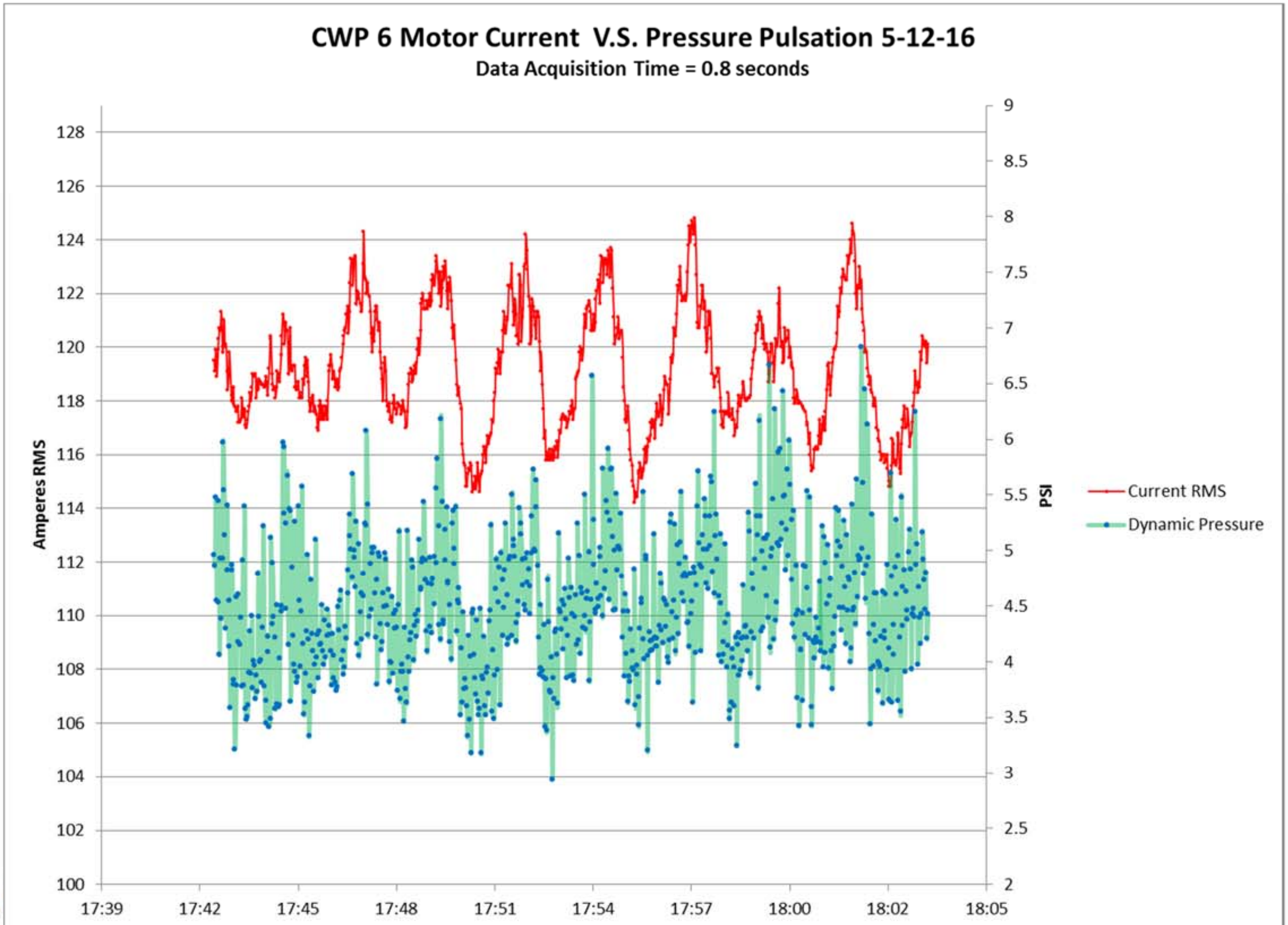
# Observations

- The system resistance is constant; however, significant power, vibration, and discharge pressure variations were observed.
- There was a strong correlation between power, vibration, and discharge pressure changes with time.
- The most likely explanation for these oscillations was variable hydraulic load due to inlet flow pre-rotation/turbulence.
- The motor was used as a sensor in this test; current is proportional to power consumed by the pump.



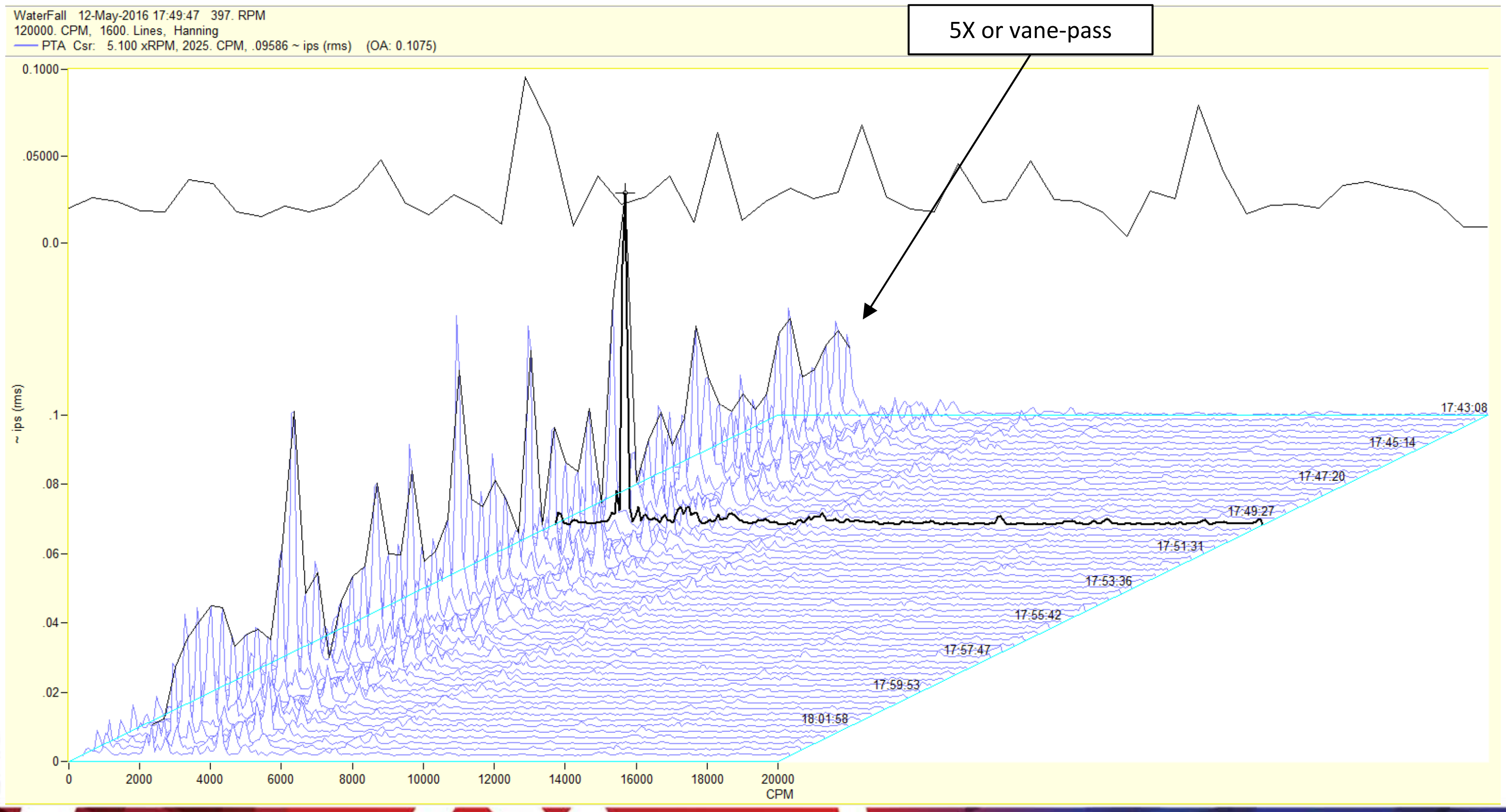
CWP 6 Motor Current V.S. Vibration 5-12-16
Data Acquisition Time = 0.8 seconds
Amperes RMS
PSIG
125
123
121
119
117
115
113
18.5
18.4
18.3
18.2
18.1
18
17.9
17.8
17.7
17.6
17.5
17.4
17.3
17.2
17.1
17
16.9
16.8
16.7
16.6
16.5
16.4
16.3
16.2
16.1
16
17:39
17:42
17:45
17:48
17:51
17:54
17:57
18:00
18:02
18:05
Current RMS
Discharge Pressure


CWP 6 Motor Current V.S. Vibration 5-12-16
Data Acquisition Time = 0.8 seconds
Amperes RMS
IPS RMS
125
123
121
119
117
115
113
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
17:39
17:42
17:45
17:48
17:51
17:54
17:57
18:00
18:02
18:05
Current RMS
CTI Vibration
CTI Vibration 5X



CWP 6 Motor Current V.S. Pressure Pulsation 5-12-16
Data Acquisition Time = 0.8 seconds
Amperes RMS
128
126
124
122
120
118
116
114
112
110
108
106
104
102
100
PSI
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
17:39
17:42
17:45
17:48
17:51
17:54
17:57
18:00
18:02
18:05
Current RMS
Dynamic Pressure

# Pump Top Axial Waterfall



# Physical Hydraulic Model Study


Photo 5-1 Unsteady Flow Around the Pump


Photo 5-1 Unsteady Flow Around the Pump

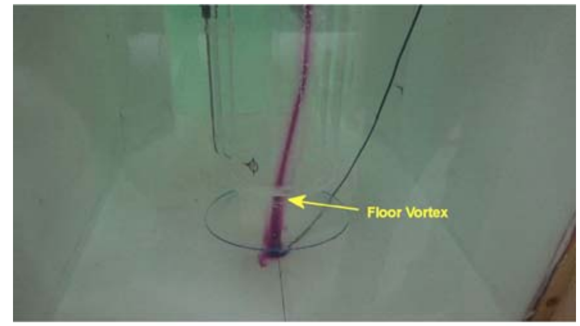



Photo 5-5 Floor Vortex

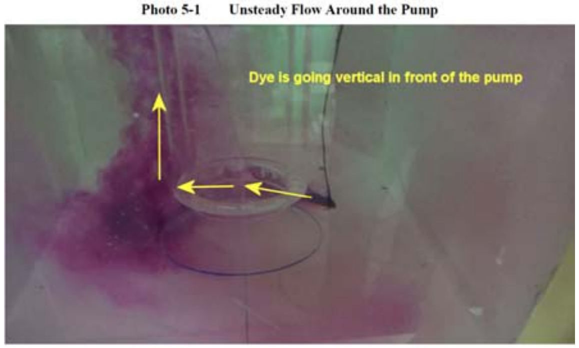



Photo 5-2 Stalling and Lifting in Front of Pump - Flow Should Towards Pump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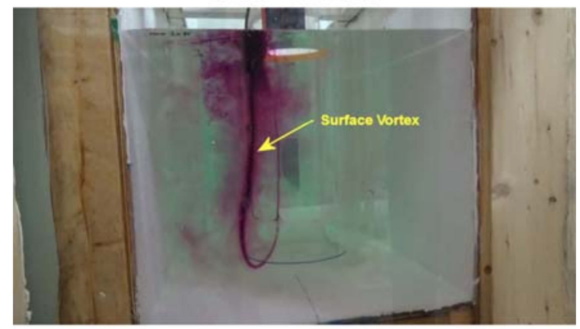
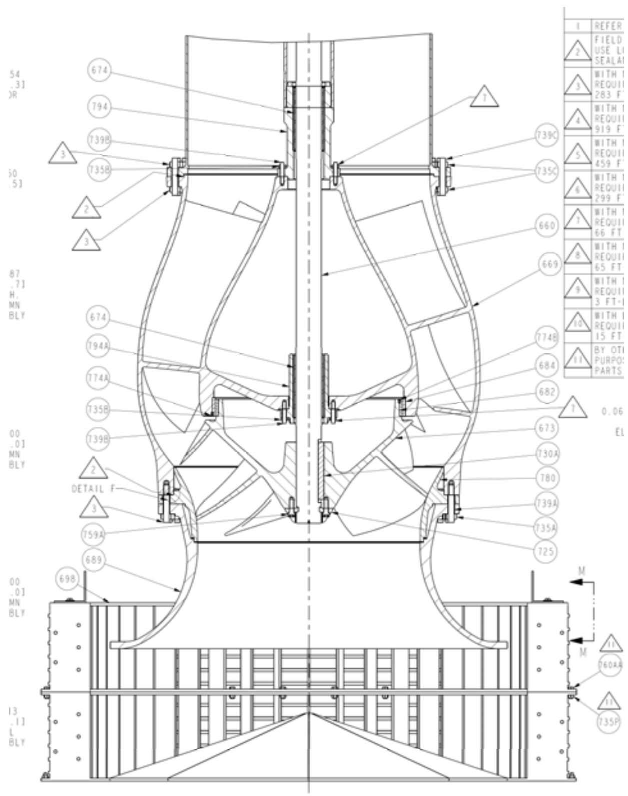
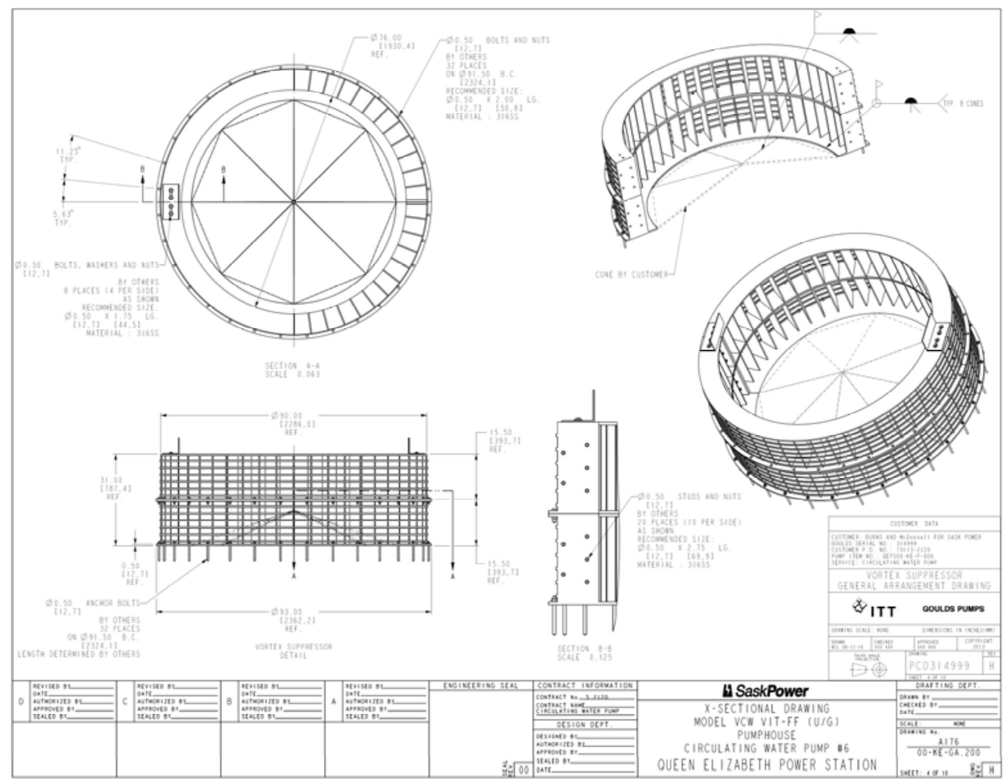



Photo 5-6 Surface Vortex at El. 13-ft

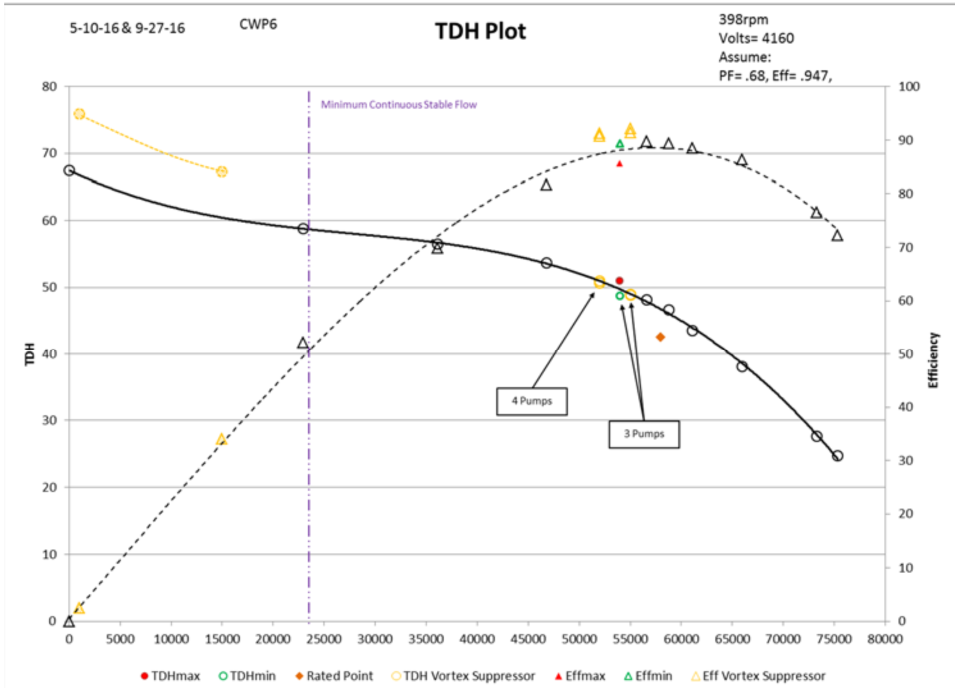
# Modification

## Vortex Suppressor

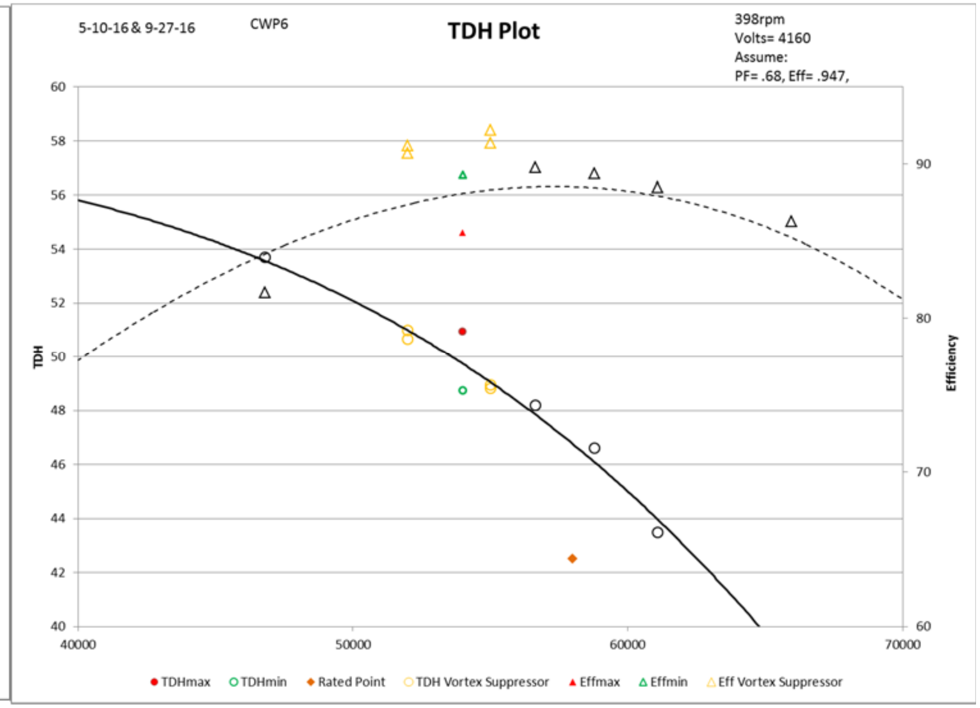




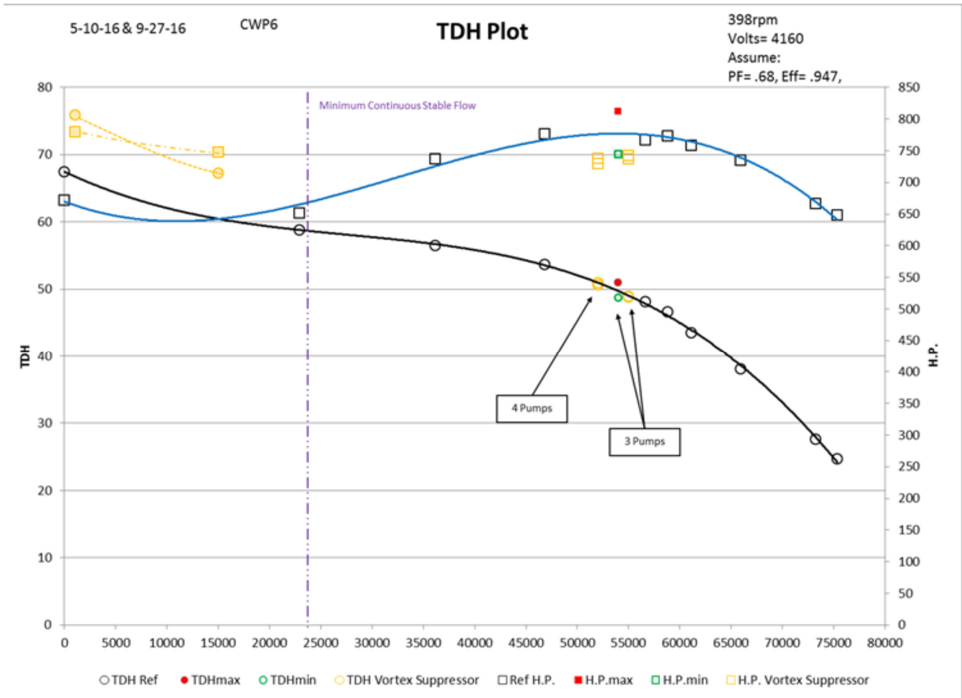
# TDH Curve



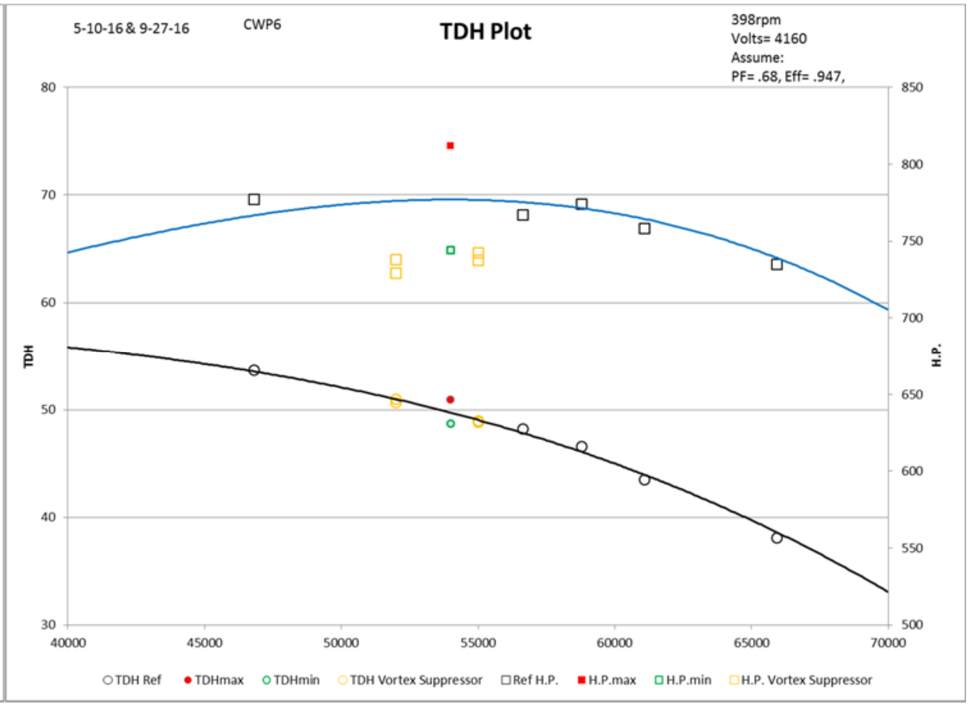

# Zoom Operating Flow Range



# Power Curve

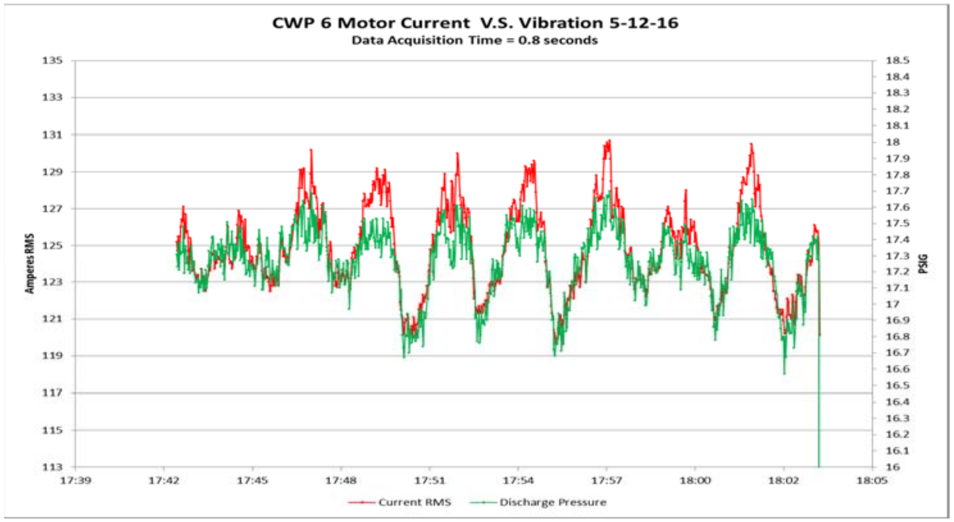



# Zoom Operating Flow Range

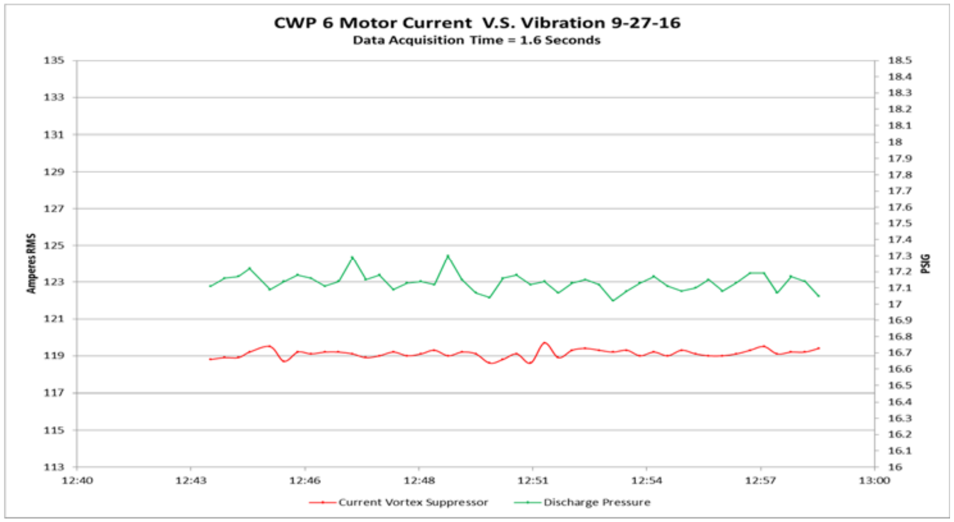


# Compare Performance Data

## Original Condition



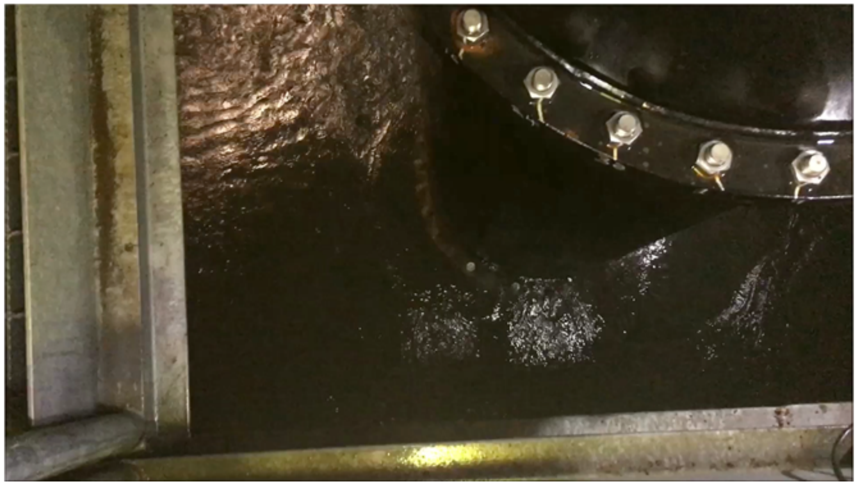

## With Suppressor



# VIDEO

**Surface Vortex Before**

**After Suppressor Installation**



# Lessons Learned

- The vortex suppressor did not eliminate all inlet bay flow issues; however, flow into the pump inlet was more uniform.
- Power and vibration oscillations were essentially eliminated.
- Reduced fluid pre-rotation caused a larger increase in TDH at low flow rates.
- Pump efficiency was improved.
- The suppressor resolved the flow issues without extensive inlet bay modifications.