Vertical Seawater Lift Pump Reversible Performance Deterioration

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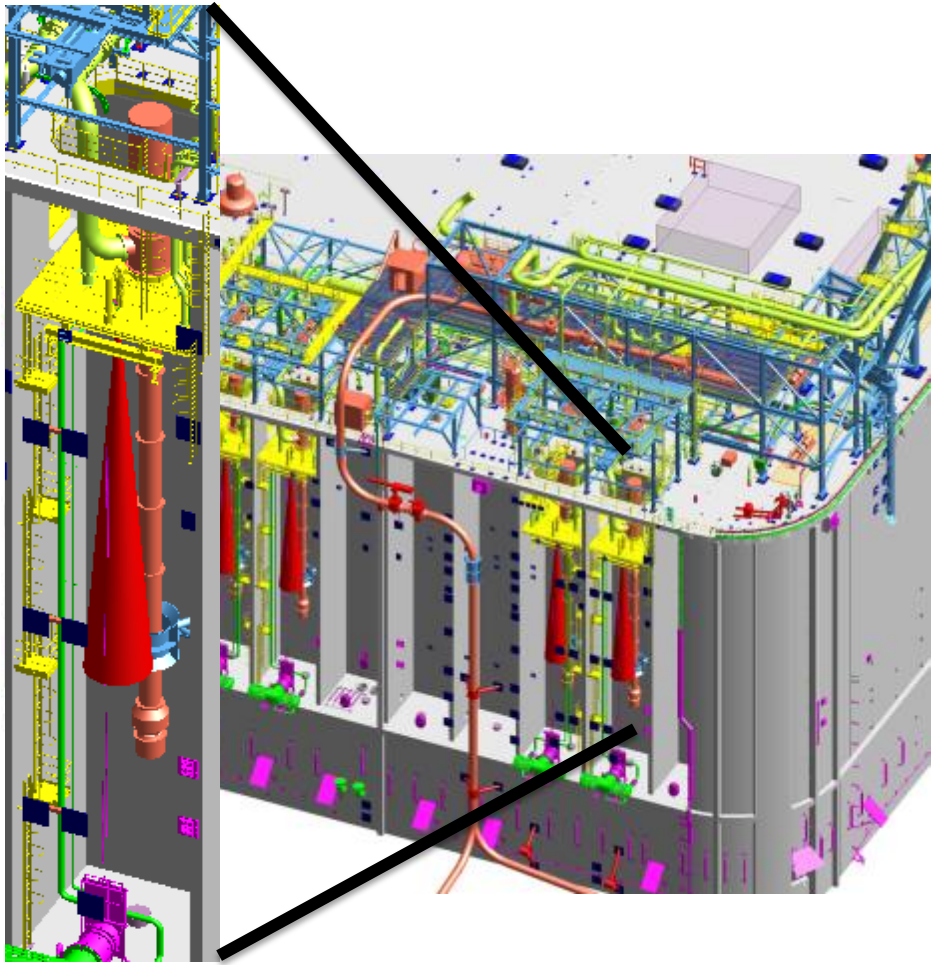
Abstract

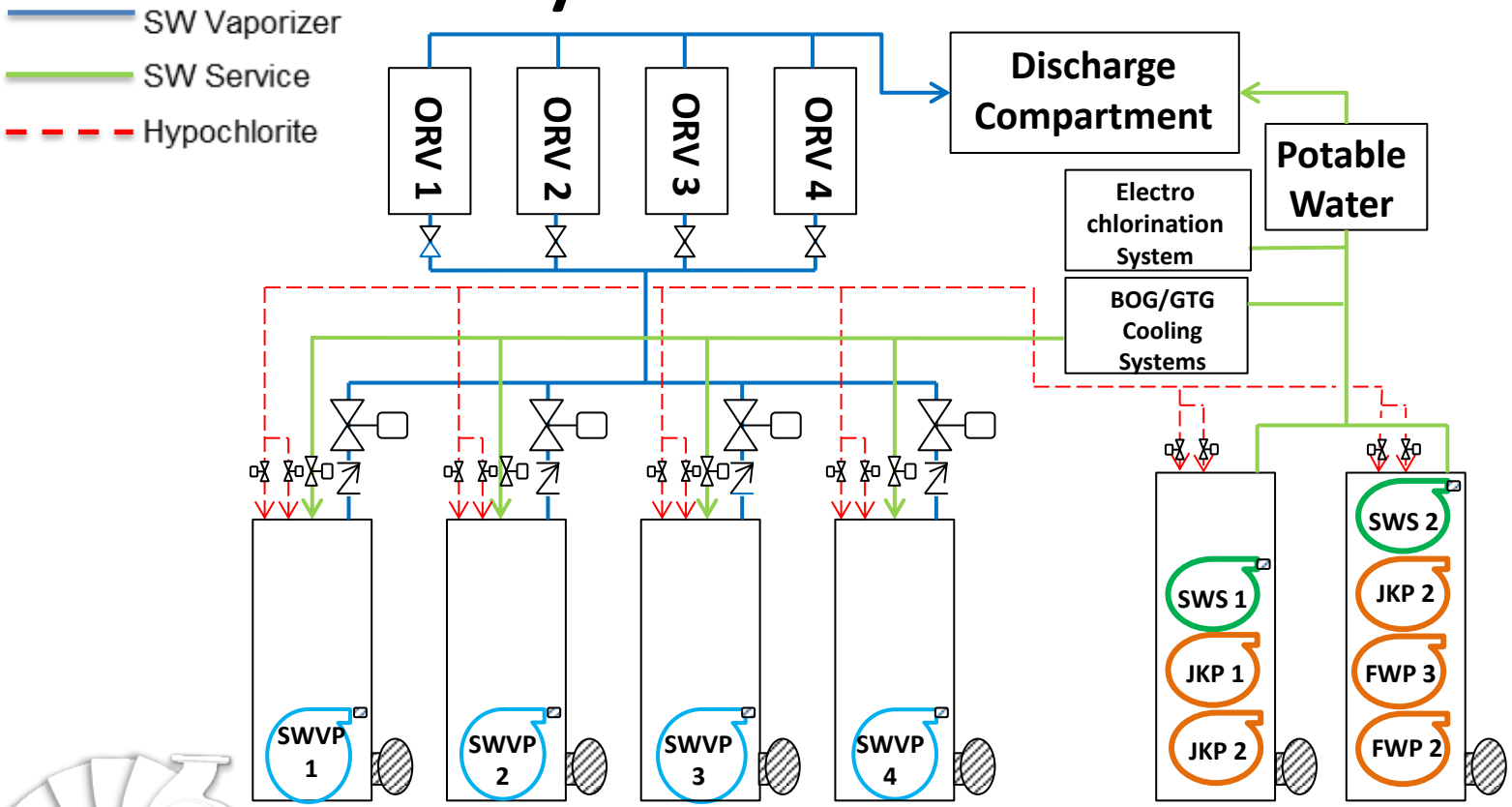
Reversible performance deterioration of one of four parallel seawater vertical lift pumps has limited the pump's ability for continuous operation. Given the pump's flat performance characteristics curve, a systematic approach to field troubleshooting was required. Non-conventional inspections, inclusive of online video inspection, revealed performance deterioration caused by marine fouling. This case study will describe the troubleshooting steps, highlighting limitations of typical troubleshooting theories, and recovery through the use of an air lift pump.

Problem

- SW vertical lift pump (24 m) inside a concrete basin
- Limited continuous operation due to reduced flow
- Reversible on each re-start
- Problem with 1 out of 4 pumps

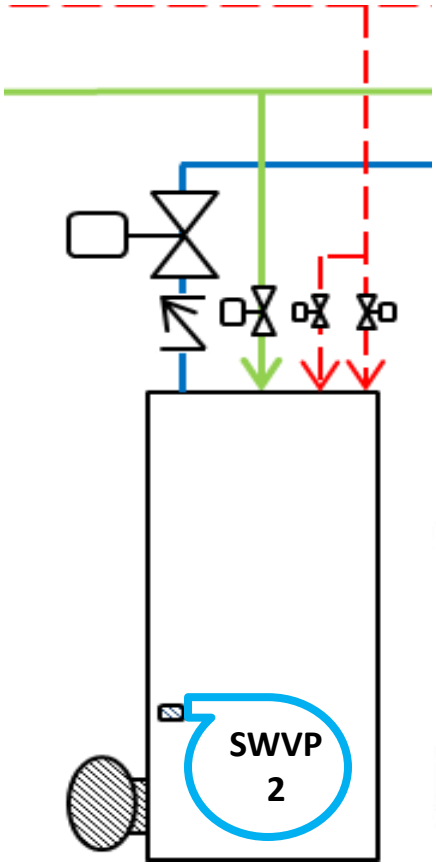


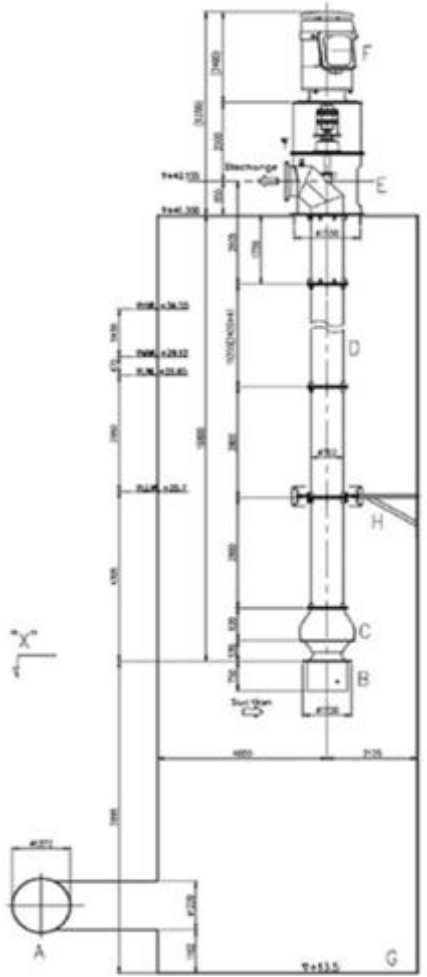
System Overview



Data Analysis

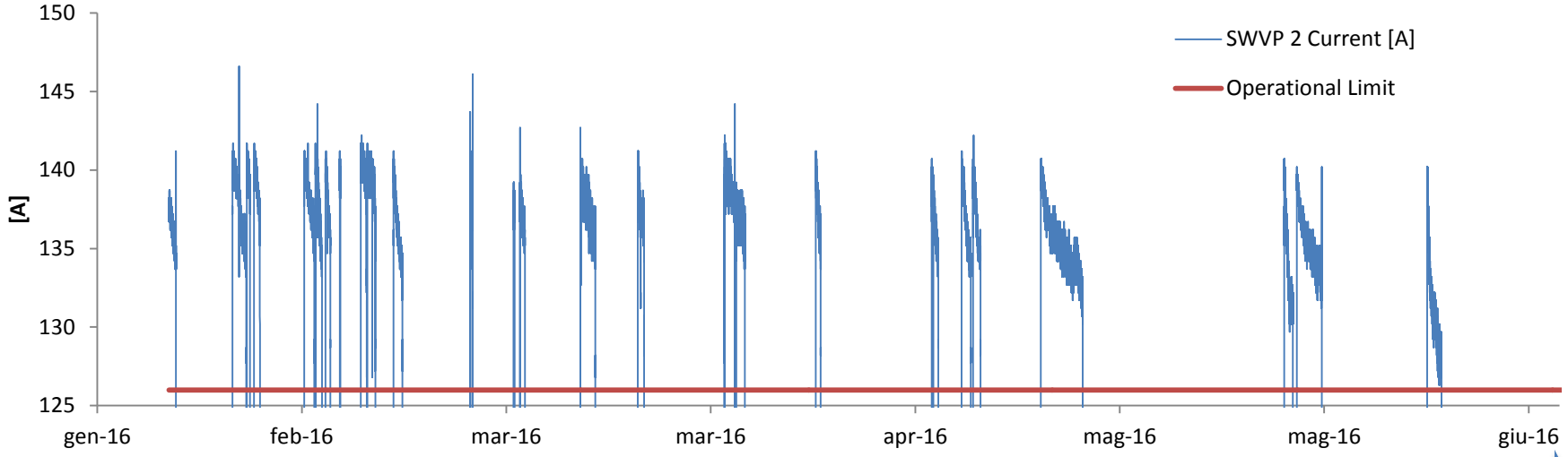
- Evaluate system – define boundary
- What data was available?
  - Decrease in motor current
  - Overall SW header flow
  - Vibration Spectrum





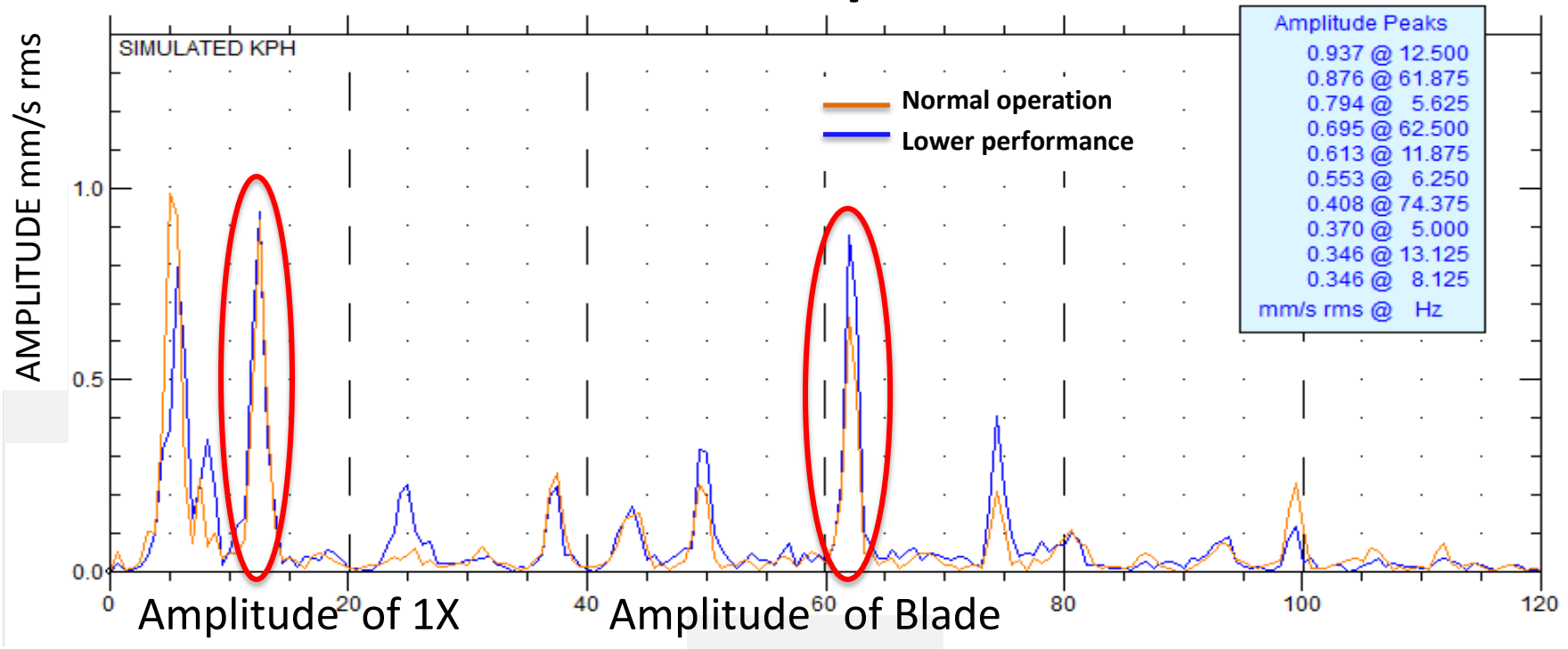
Motor Current

- Motor current is the available performance measure
- Behavior limited to #2 pump
- SW header following same trend



Rate of performance degradation increase over time

Vibration Spectrum



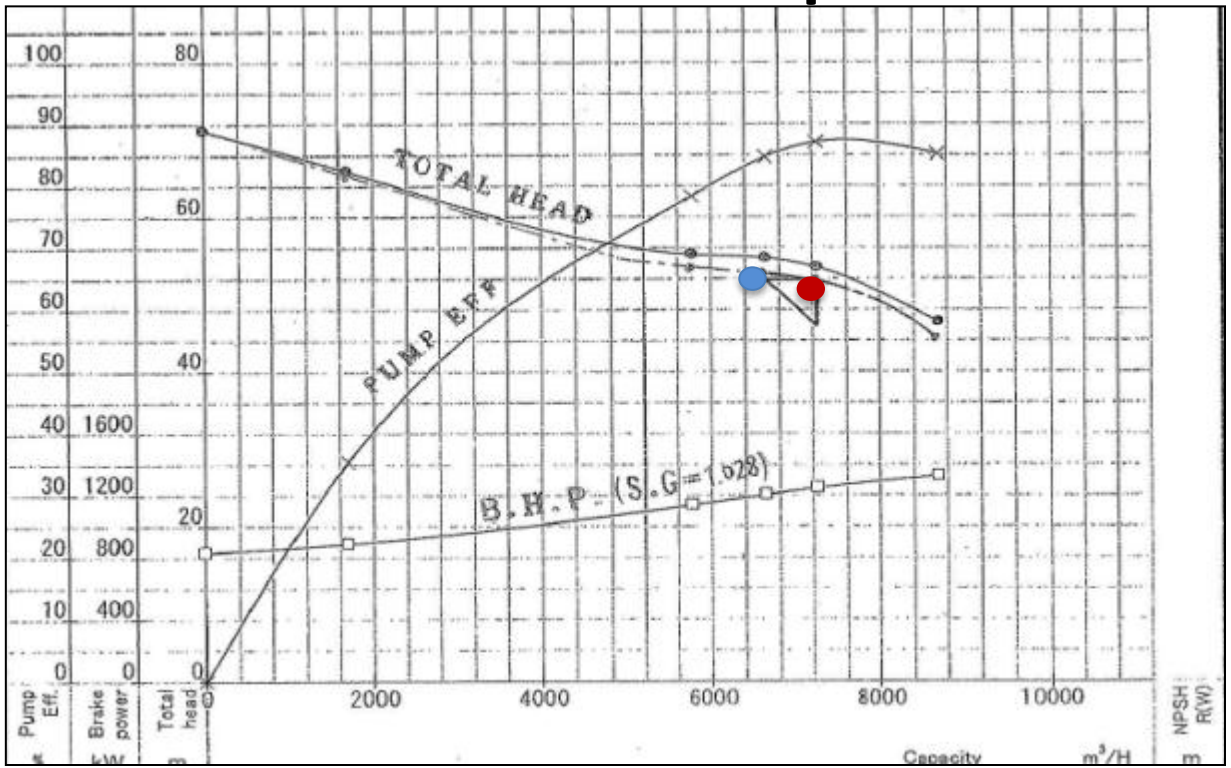
Amplitude of 1X unchanged

Amplitude of Blade Pass Frequency increases

Data Analysis

- Limitations?
  - Pump curve
  - Historical performance

Pump Curve



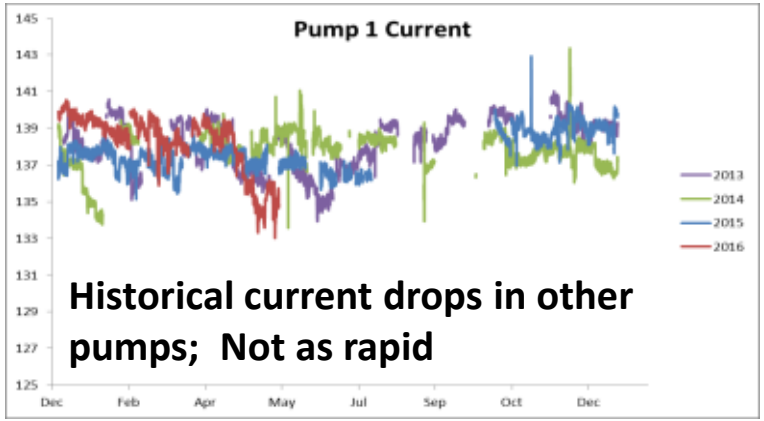
- **Design:**
  H = 52.57 m
  Q = 7,250 m^3/h
- **Operating:**
  H = 53.8 m
  Q = 6,600 m^3/h

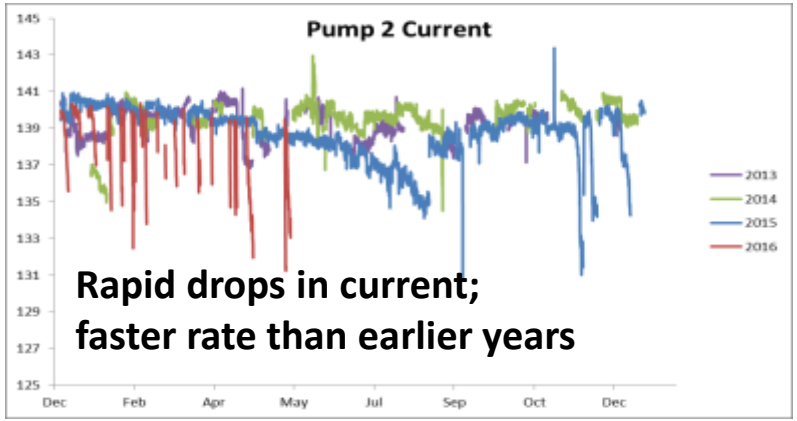
Operational Changes:
0.05 bar (0.7 psi) increase in either discharge pressure or DP across suction strainer
→ 5800 m^3/h (13% drop)

Performance calculation can not identify the problem

Historical Pump Performance

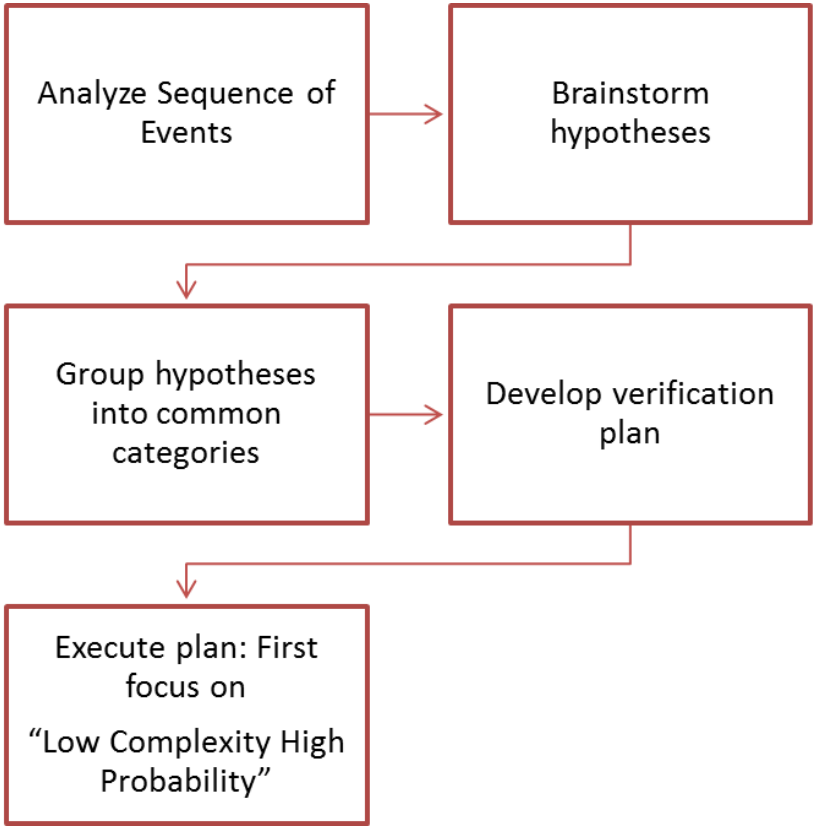
- Historic seasonality effect across all pumps
- Change in behaviour related on pump 2
- Basin strainer gets plugged, but no performance effect





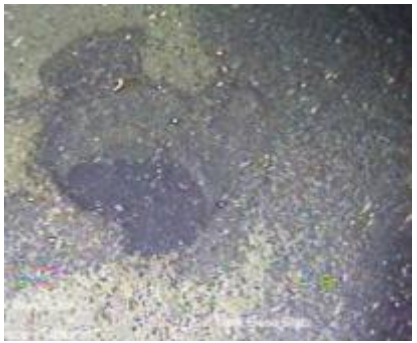
Verification Plan

- Hypotheses table developed
  - Discharge Blockage
  - Internal Fouling
  - Suction Blockage
- Verifications based on probability and complexity



Underwater Basin Inspection (ROV)

Significant marine fouling

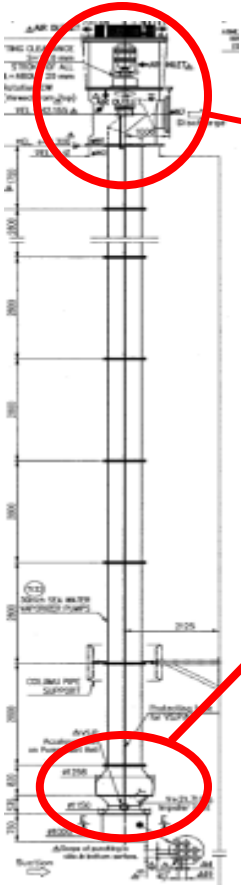


Clean strainer

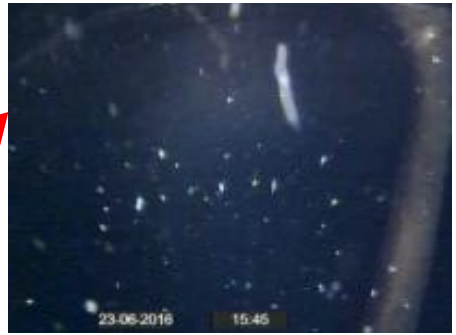
Mechanical cleaning required to remove mussels

Non-Intrusive Inspections

Partially stuck check valve

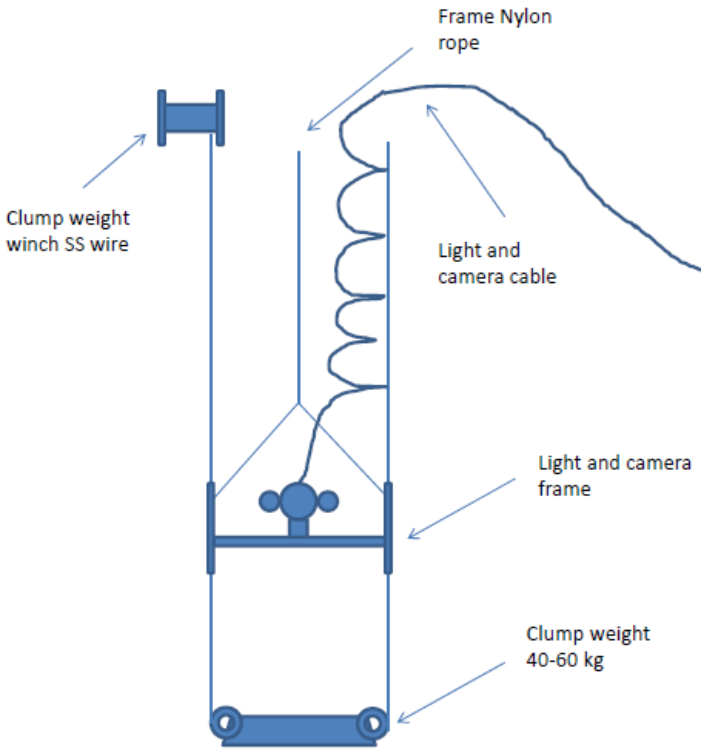


Camera inspection inside pump

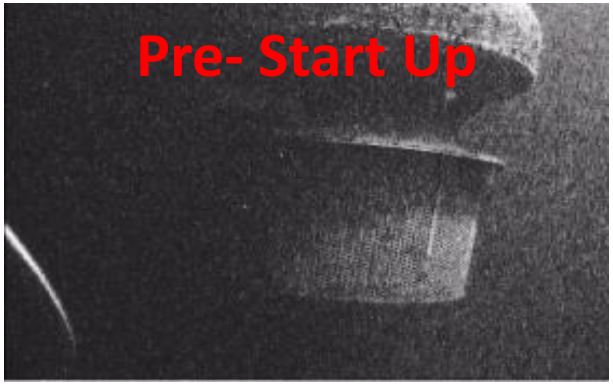


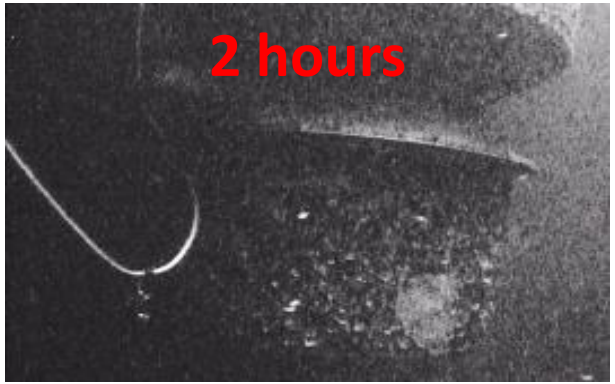
No attached growth on pump internals

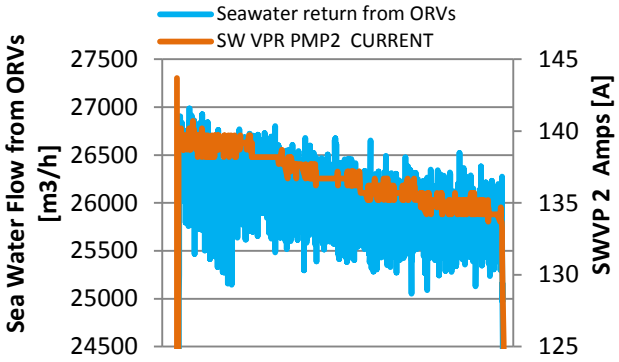
Non-Intrusive Inspections: Suction

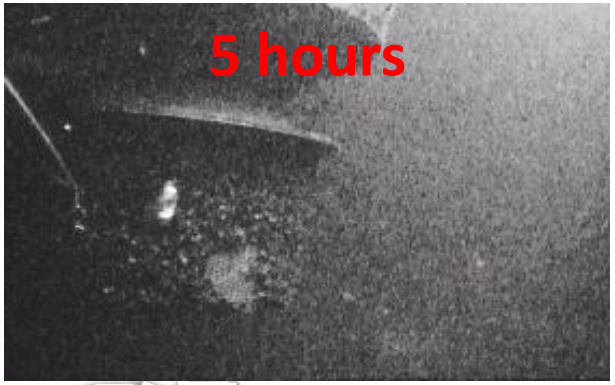


Suction Blockage Video Summary







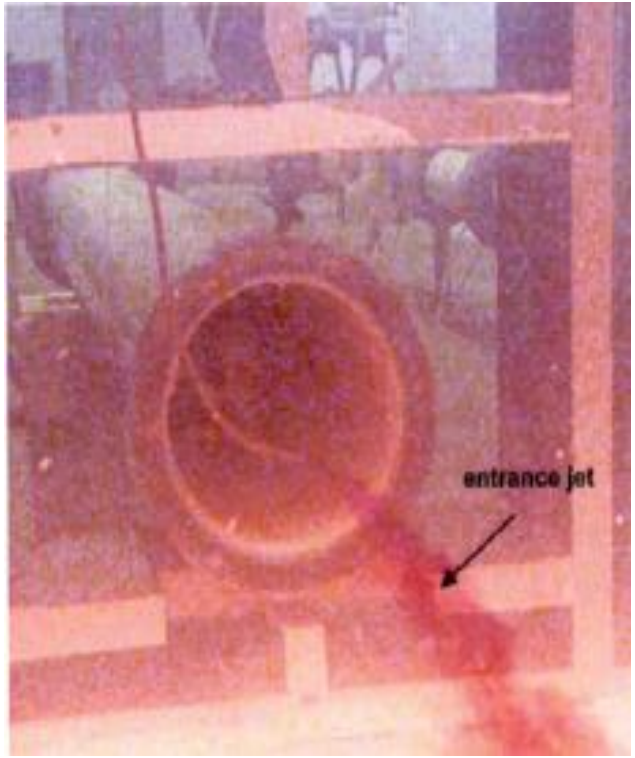


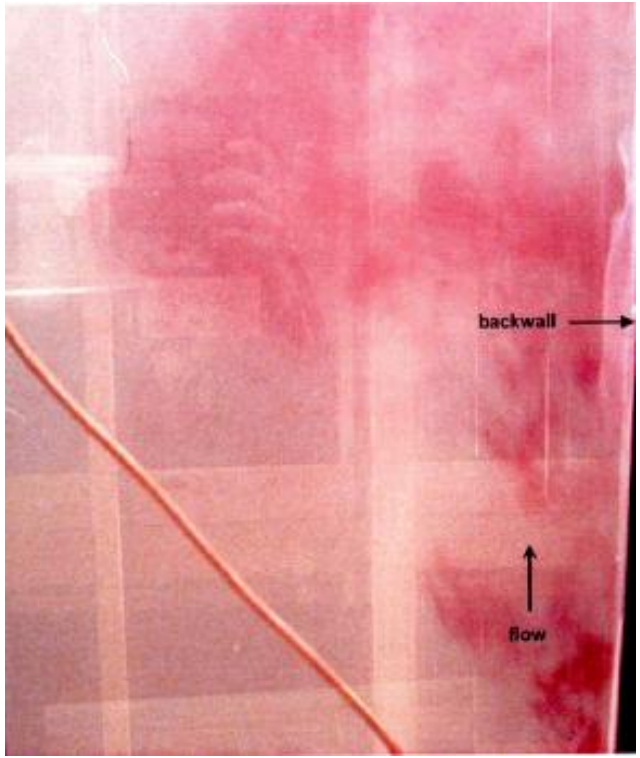
5 hours to block strainer at >6000 m3/hr water flow…Why?

Basin Design

Jet flow through basin entrance

Flow distribution in basin affects rate of suction strainer blockage



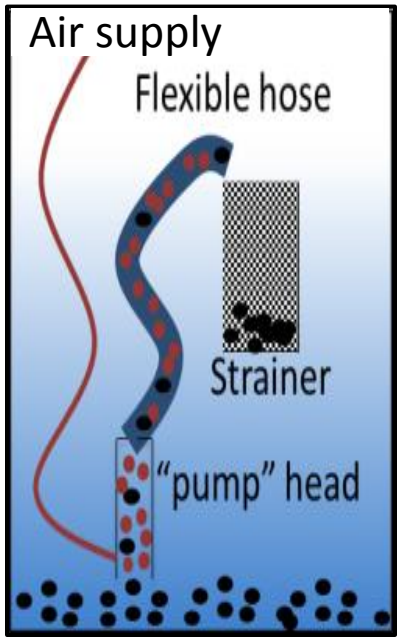


Way forward

- Challenges:
  - Confined space
  - Where to discharge water and loose material?
  - How to separate water from debris?
  - High head (30 m) from basin floor – need for submersible pump
  - How to collect debris from around basin corners?

1.5 MW pump used for normal service!

Basin Cleaning – Air Lift Pump



- Min equipment
- No debris interaction
- Old technology
- 1.5 m3 loose debris recovered

Issue resolved on pump start up!

Conclusion

- Common problem for relatively simple equipment
- Recovery could become demanding
- Methodical approach to troubleshooting
- Non-conventional troubleshooting and recovery actions
- Continuous surveillance helps

Thanks!