Intermittent Spikes on Vibration and Motor Current Caused by Water Carry Over on the 3rd stage of a Centrifugal Air Compressor.

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Outline

- Problem introduction
- Vibration data
- Observations on vibration data
- Observations during rebuild
- Repairs and Modifications
- Conclusions

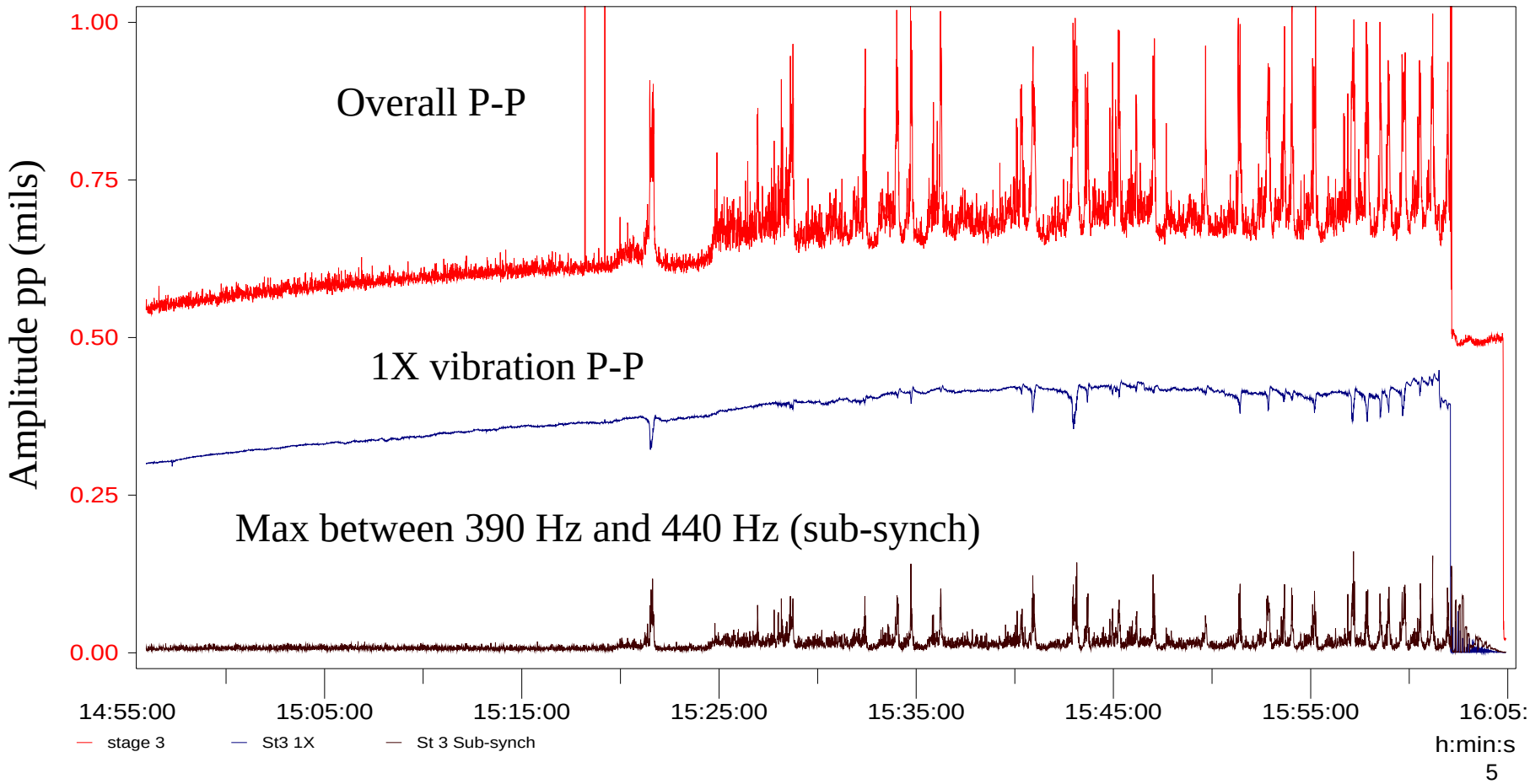
Problem Introduction

- 3-stage integrally geared air compressor used for plant air.
- The compressor has an eddy current probe on the bullgear, and on each of the three stages
- The unit had a series of problems since March 2005. One concern was oscillation on the vibration of the 3rd stage between 0.75 mils and 0.95 mils
- At the same time the motor Amps were oscillating between 256 amps and 315 amps

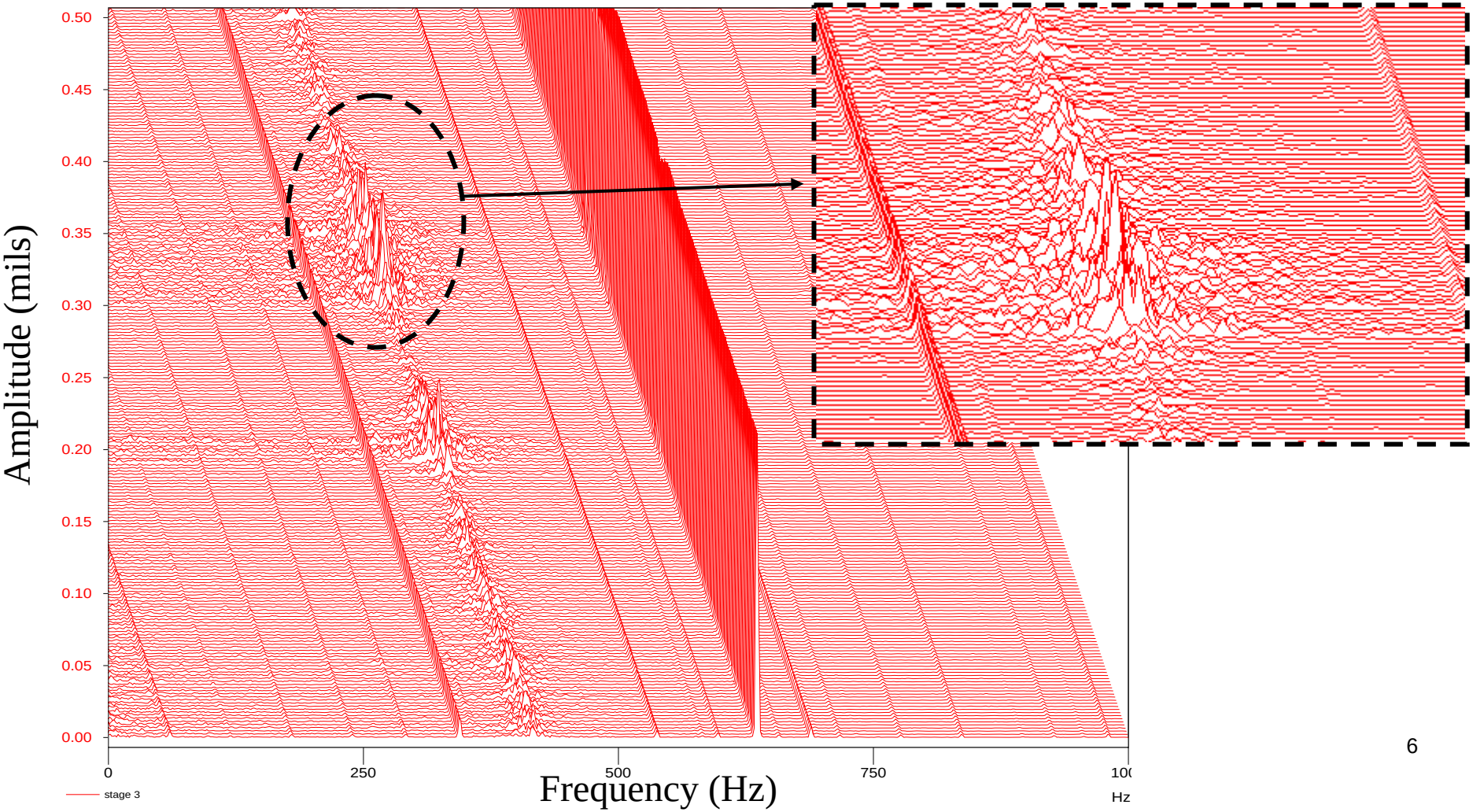
Problem Introduction

- On August 2006, collected high speed data from the eddy current probes on the compressor for diagnostics
- Based on results from vibration analysis suspected water carry over.
- On October 2006, decided to overhaul the unit.
- This case study presents the result of the work and modifications to the compressor

Vibration data on 3rd stage



Vibration on 3rd Stage



Observations on vibration data

- Scratch on the probe indicating surface
- The upset incidents on 3rd stage coincided with Motor Amps oscillations
- The vibration on the bull gear and the 1st and 2nd stages was steady
- Sub-synchronous vibration indicated that the 3rd stage was marginally stable

Observations on vibration data

- Based on the vibration data and the motor amps oscillations, concluded that the most likely cause was water carry over
- We also found that the oil supply to the compressor was hot. Probably a problem associated with the oil cooler but could not verify at the time.

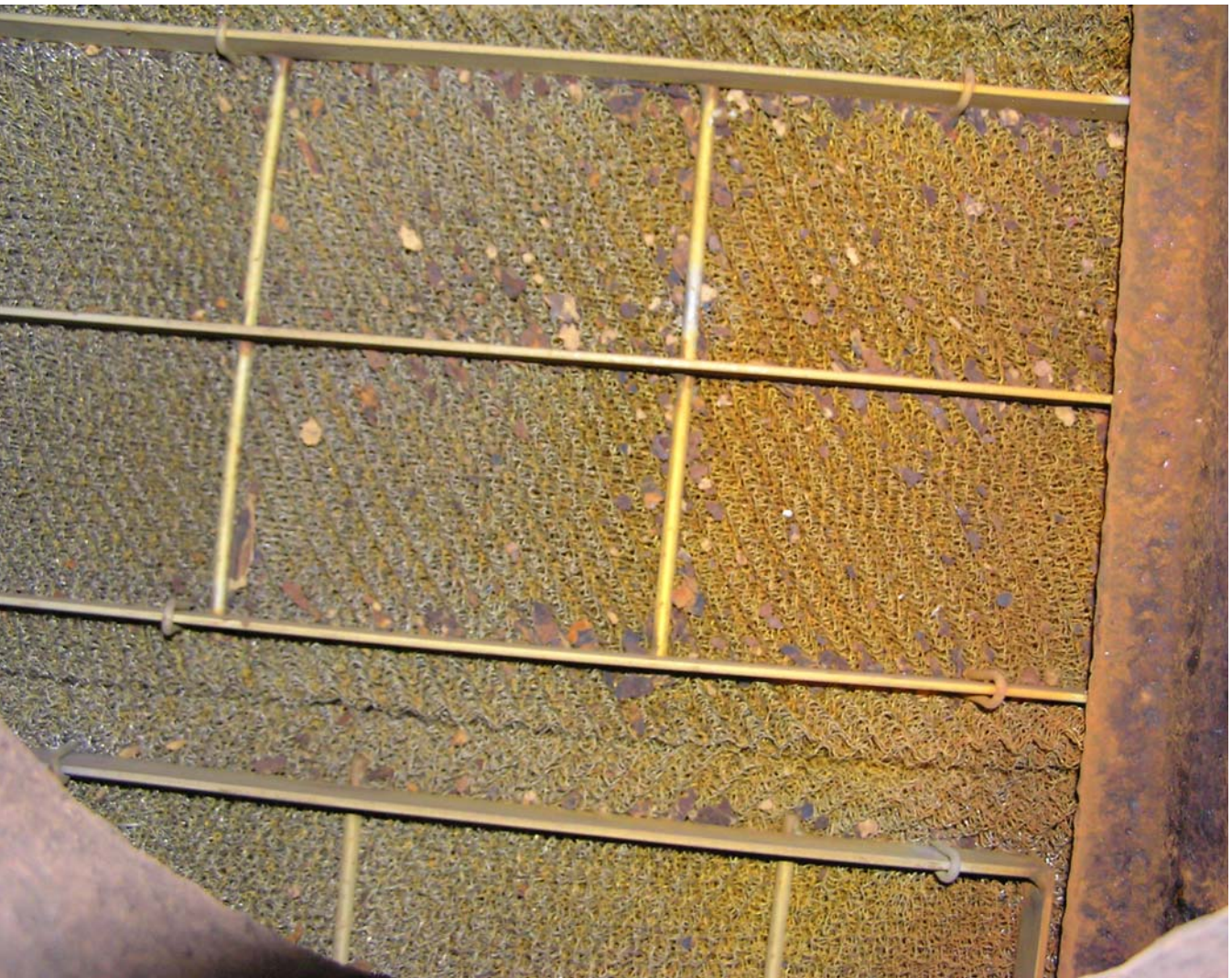
Observations during rebuild

- The unit was rebuilt on October 2006
- The following slides show pictures of what we found

Observations during rebuild

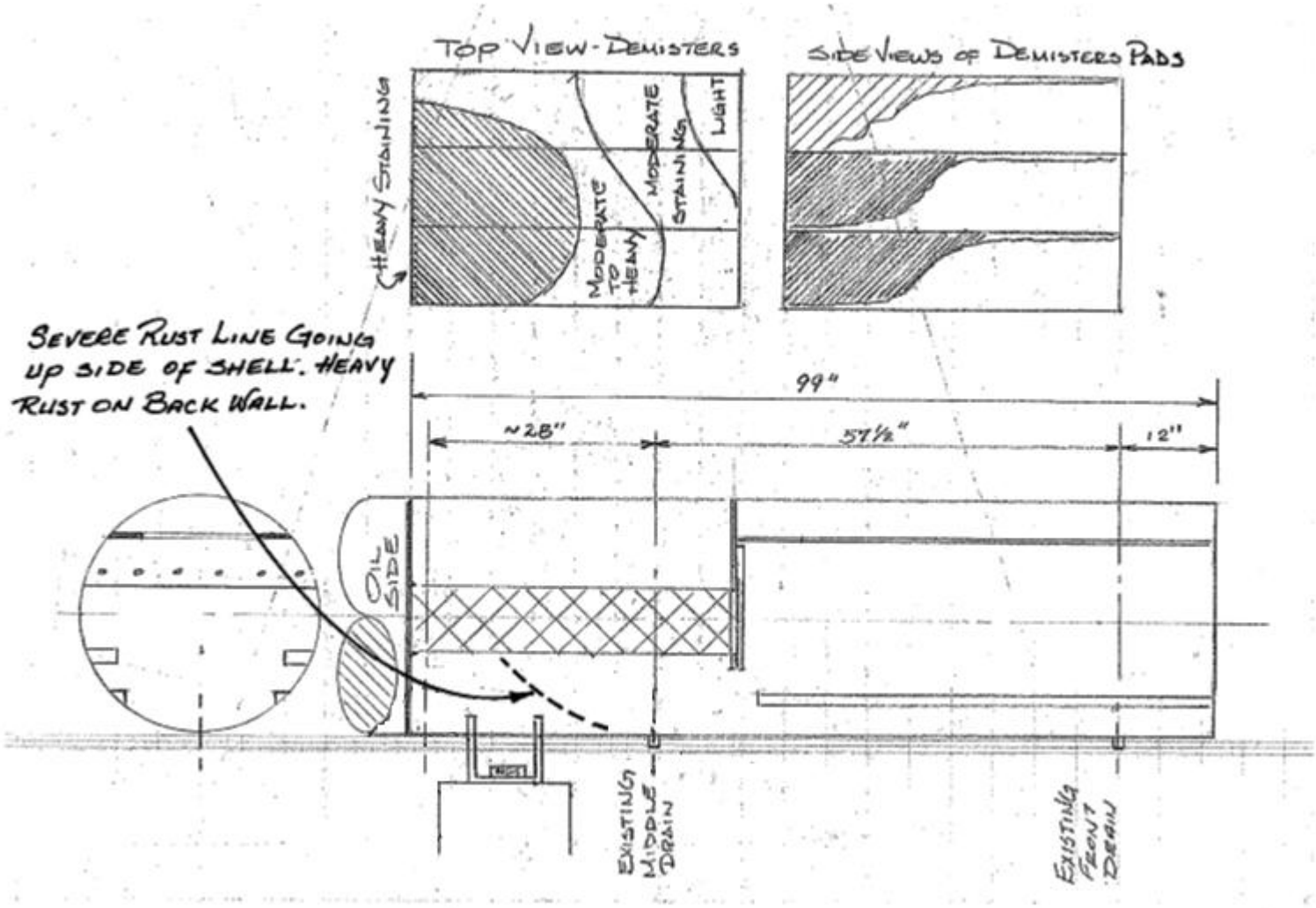
Inlet cone of the 2nd stage. Picture shows normal wear. The first intercooler and inlet piping showed only normal wear as well

Observations during rebuild

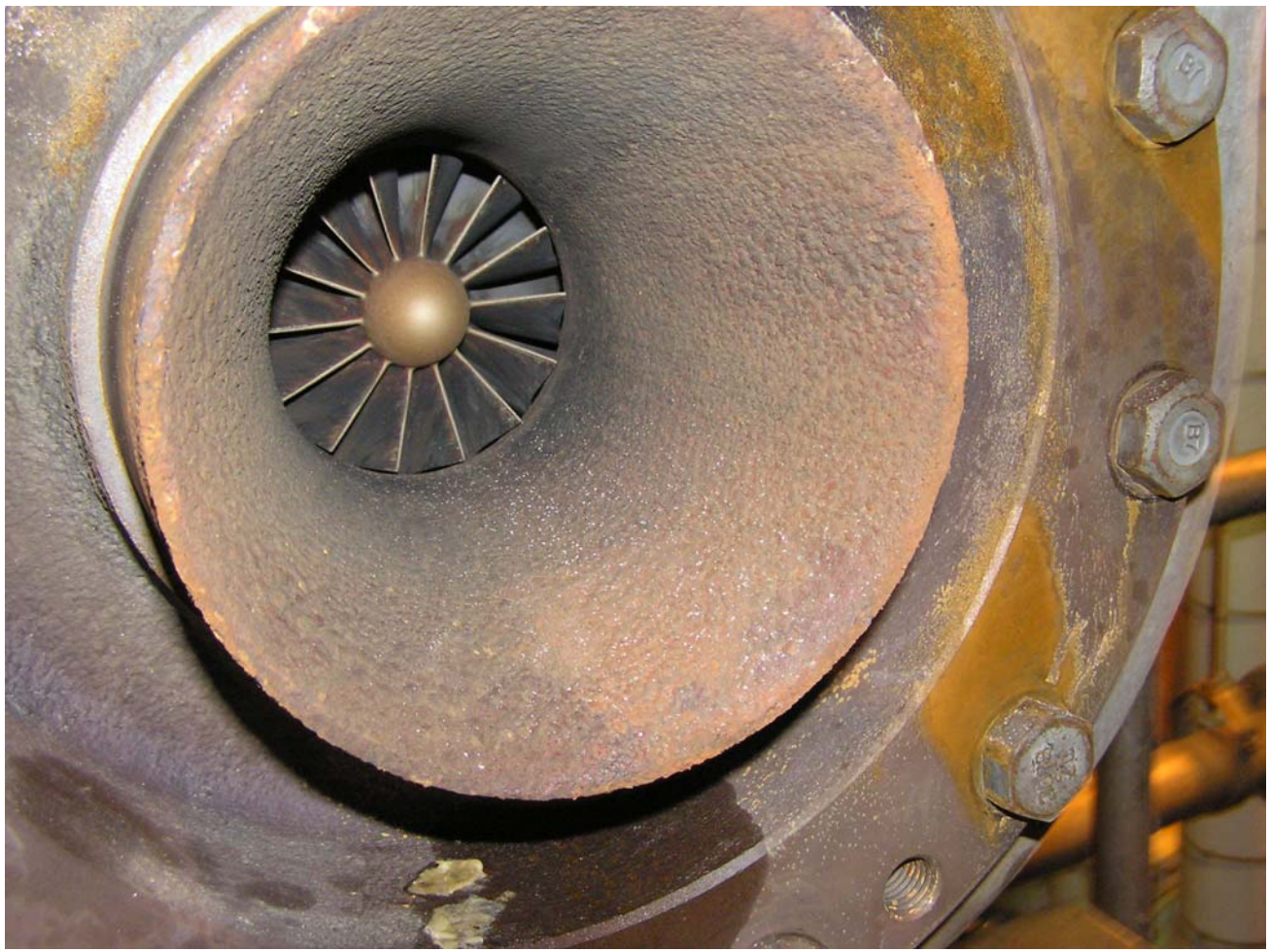


Demister pads on Second Intercooler (between 2nd and 3rd stage) showing rust and corrosion scale

Observations during rebuild



Observations during rebuild



Inlet cone of the third stage. Picture shows heavy rust on the cone and deposits on the impeller.
The inlet pipe was corroded beyond repair.

Observations during rebuild

Close up of the 3rd stage inlet cone. It shows deposit and rust

Observations during rebuild

3rd stage discharge with heavy deposits

Observations during rebuild

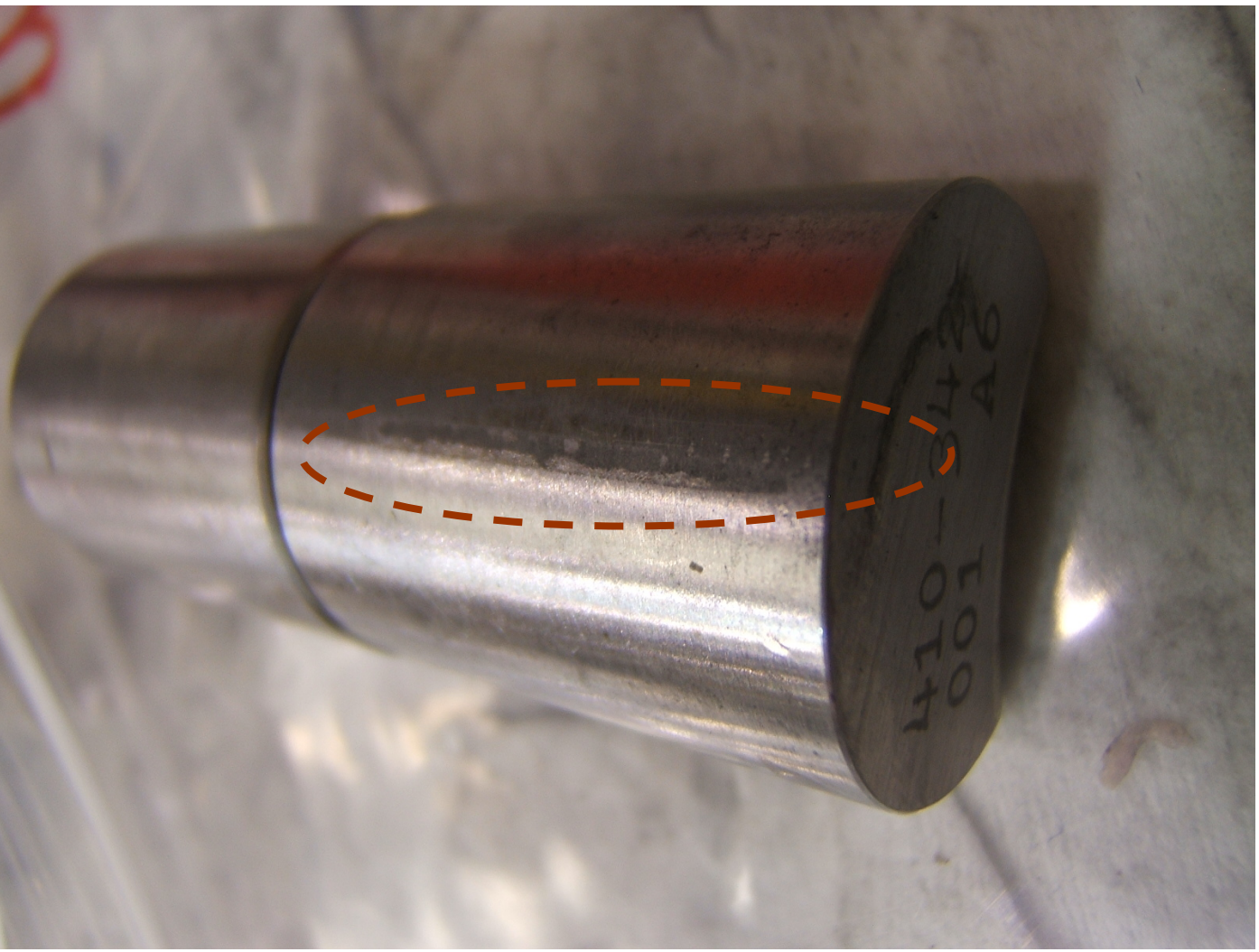
Deposit found inside the 3rd stage volute.

Analysis showed just ordinary silicates, “dirt.”

Observations during rebuild

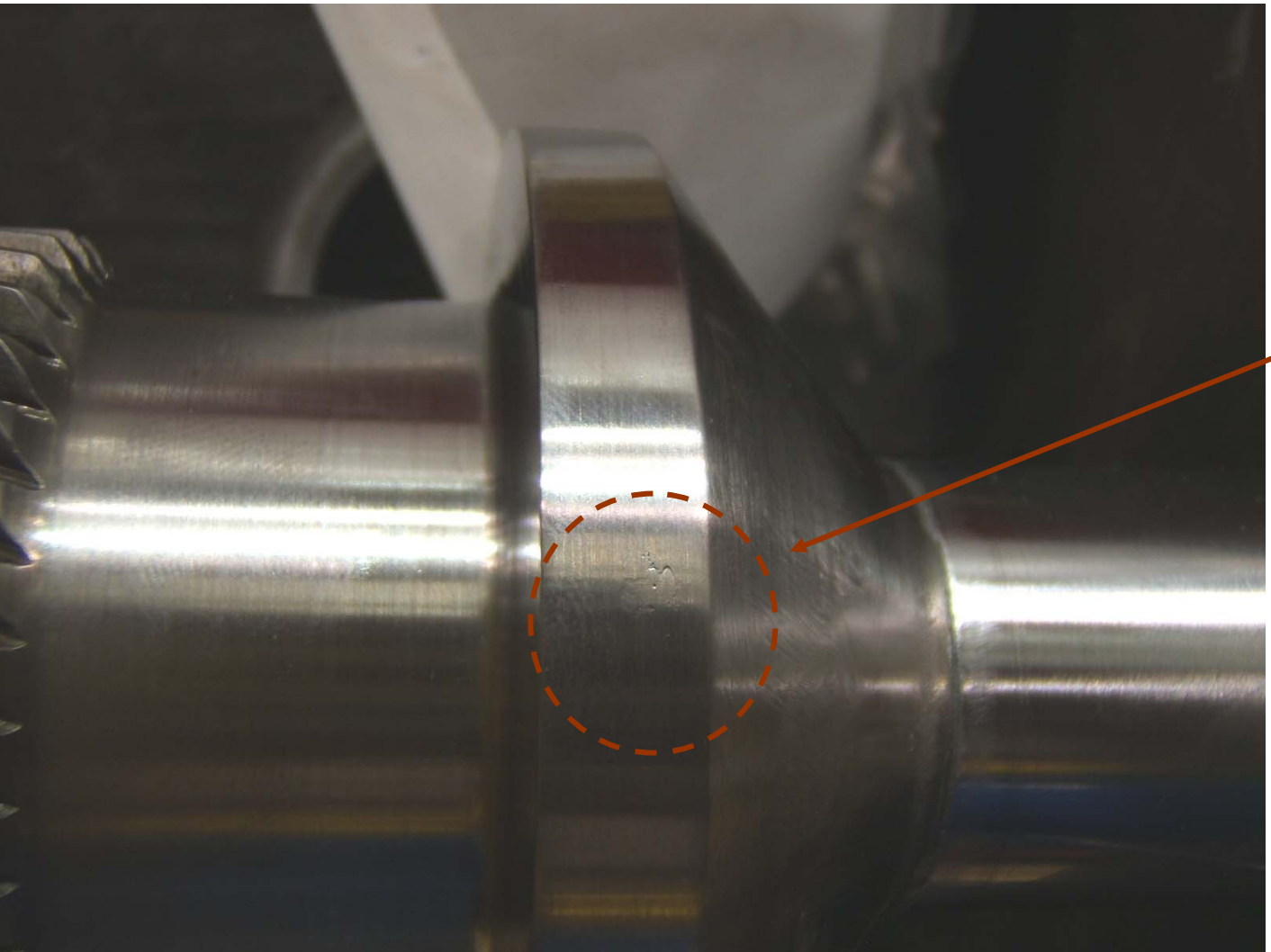
Scales found in the 3rd stage discharge horn.
Seems to be the same kind of material deposit as found in the volute.

Observations during rebuild



Flattened portion of the back of one of the loaded pad on the bearings of the third stage

Observations during rebuild

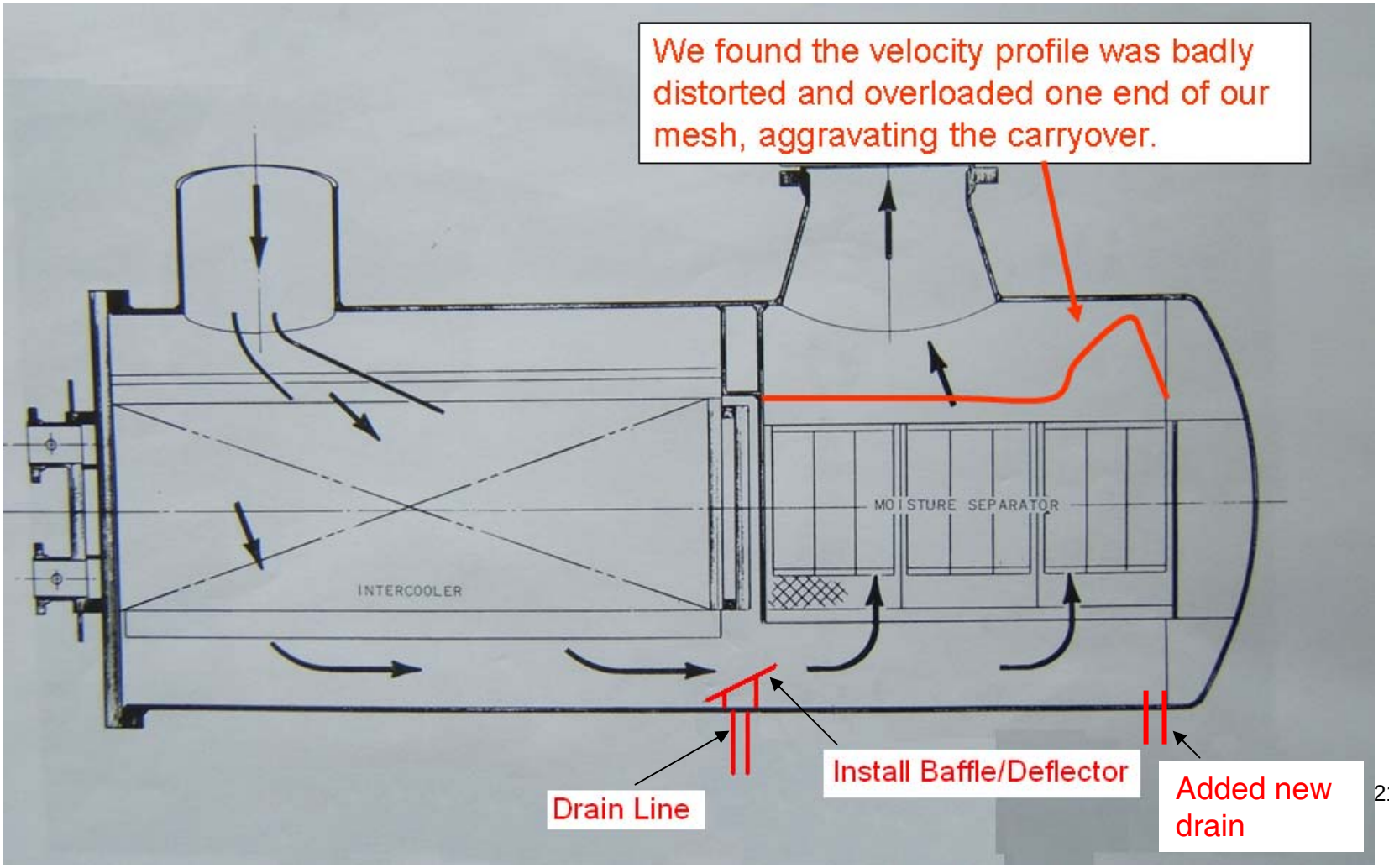


Found damage on probe indicating surface of the 3rd stage, impeller end

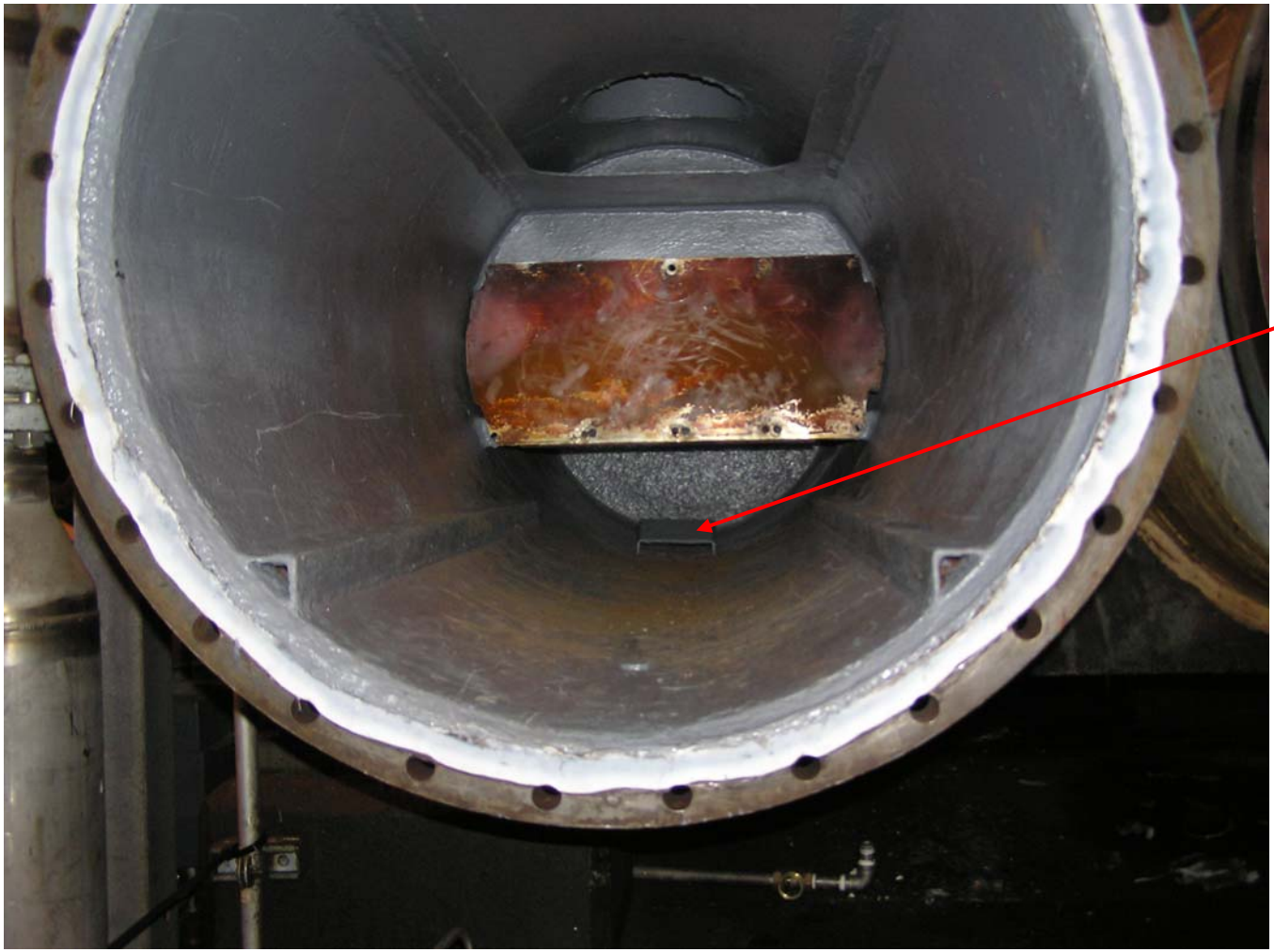
Repairs and Modifications

- Replaced the rusted 3rd stage inlet pipe with a new stainless-steel inlet pipe.
- Coated the second intercooler shell with epoxy (Carboline 450)
- Replaced the 3rd stage original bearings with a new flex-pivot bearing that was designed as an upgrade retrofit.
- Installed a baffle above the 2nd intercooler drain connection.
- Added a second drain connection at the rear of the 2nd intercooler where we believed we had standing water.
- Replaced the old, malfunctioning water traps with “Drain-Alls.”

Modifications – 2nd intercooler



Modifications – 2nd intercooler

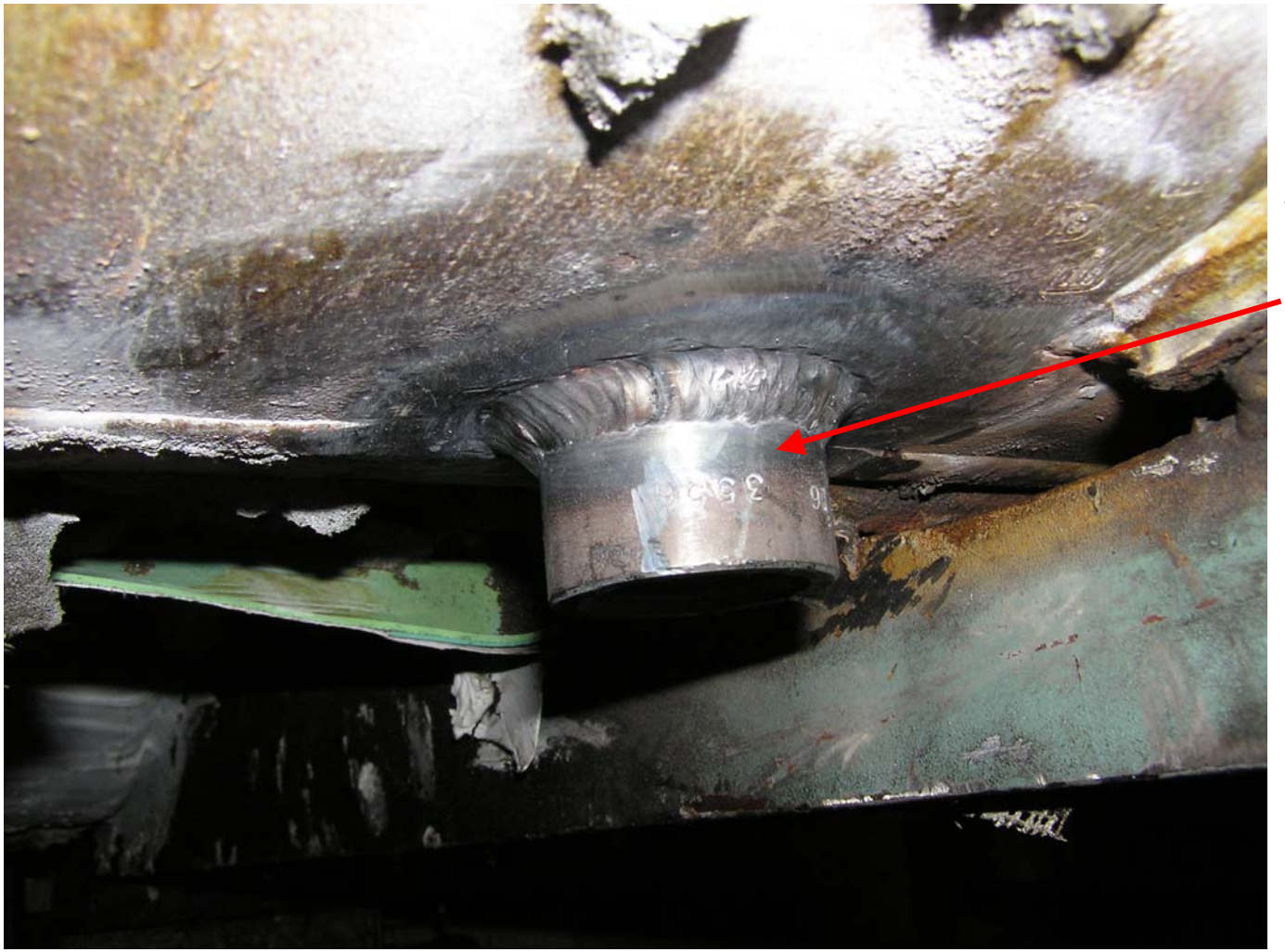


Added baffle/ deflector over 2nd intercooler drain

Modifications – 2nd intercooler

Added baffle/ deflector over 2nd intercooler drain

Modifications – 2nd intercooler



New drain at the rear of the 2nd intercooler

Modifications

Installed new “Drain-All” water traps similar to the this unit

Conclusions

- The old style float traps are not well suited for this application.
- Water in the 2nd intercooler would not drain out.
- The water accumulated on the back of the demister pads which became flooded, and periodically released a mist of water which caused the increase in overall vibration.
- The water carry-over was increasing the mass flow rate, changing the load on the third stage, which was seen as spikes in motor amps. The increased load, coupled with low damping on the bearings, was enough to create the sub-synchronous instability.

Conclusions

- The water also rusted out the 2nd intercooler shell, fouled the demister pads, badly corroded the 3rd stage inlet pipe and caused erosion at the base of the blades on the impeller.
- Water did not exit the 2nd intercooler drain line as expected. High velocity air along the bottom of the cooler was pushing water to the back of the cooler and preventing it from draining properly at the centrally located drain connection

Conclusions

- After the modifications, this air compressor has been in operation since 2007 without problems
- The amount of water coming out of the second intercooler is significantly larger than before with the old style traps.

Thank you for attending this presentation.

Questions?