
Case Study: Fast Response Vibration Interlock of High Pressure Reciprocating Compressor

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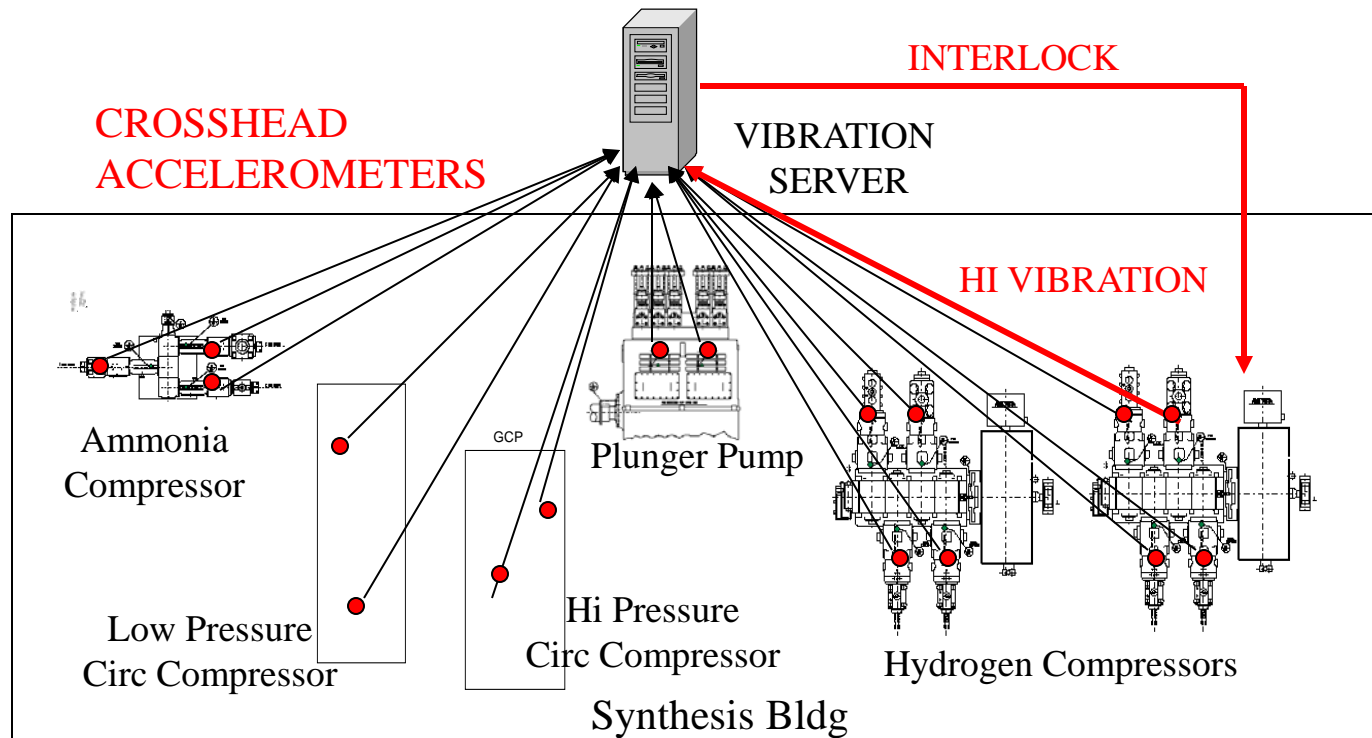
Mechanical Engineer

Invista Sabine River Works

Background

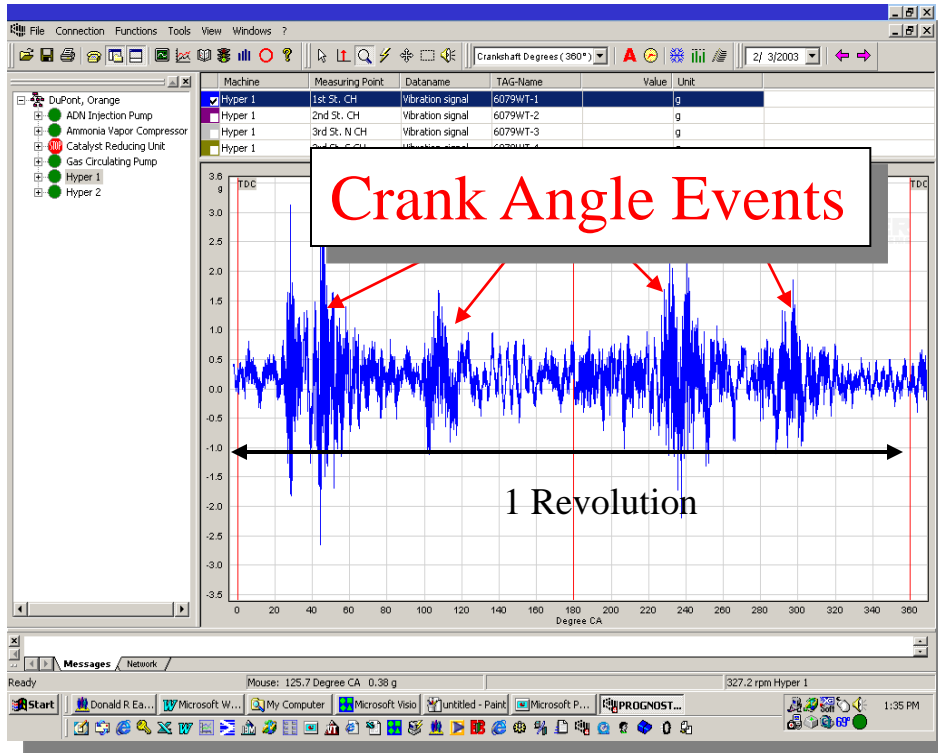
- Plunger Pump Failure
 - Pull rod failure
 - Loss of containment
 - Fire
 - Significant production loss
 - Subsequent Study of Synthesis Pumps & Compressors
 - Performed risk assessments for identified hazard events
 - Recommended: For reciprocating machines, a safety interlock system based on vibration be installed to detect mechanical failure and automatically shutdown the machines.
 - Installed High Speed Vibration Interlock System on 6 Reciprocating Machines
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Vibration Interlock System



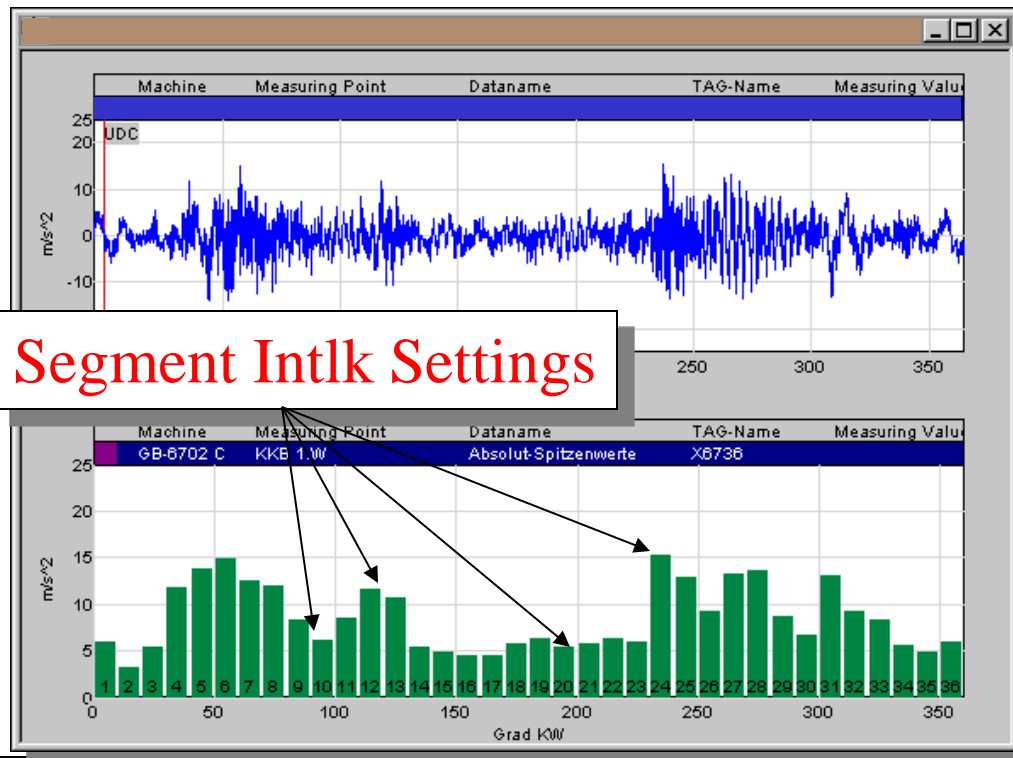
- Designed for Reciprocating Machines
 - Crank-Angle-Based Vibration Analysis
 - High Speed Threshold Interlock Monitoring
 - Offered More Capability Than Other Options
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Vibration Interlock System



- Suction valve opens
- Intake phase
- Suction valve closes
- Compression phase
- Discharge valve opens
- Discharge phase

Vibration Interlock System

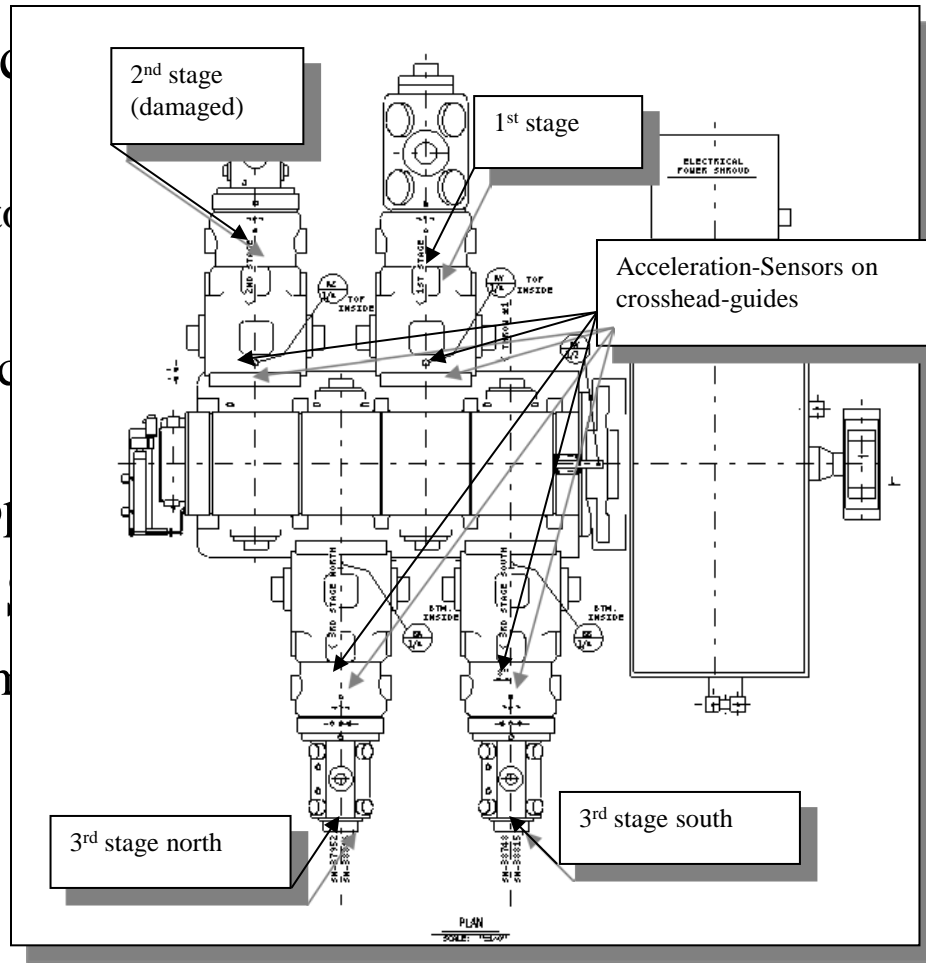


H2 Compressor Rod Failures

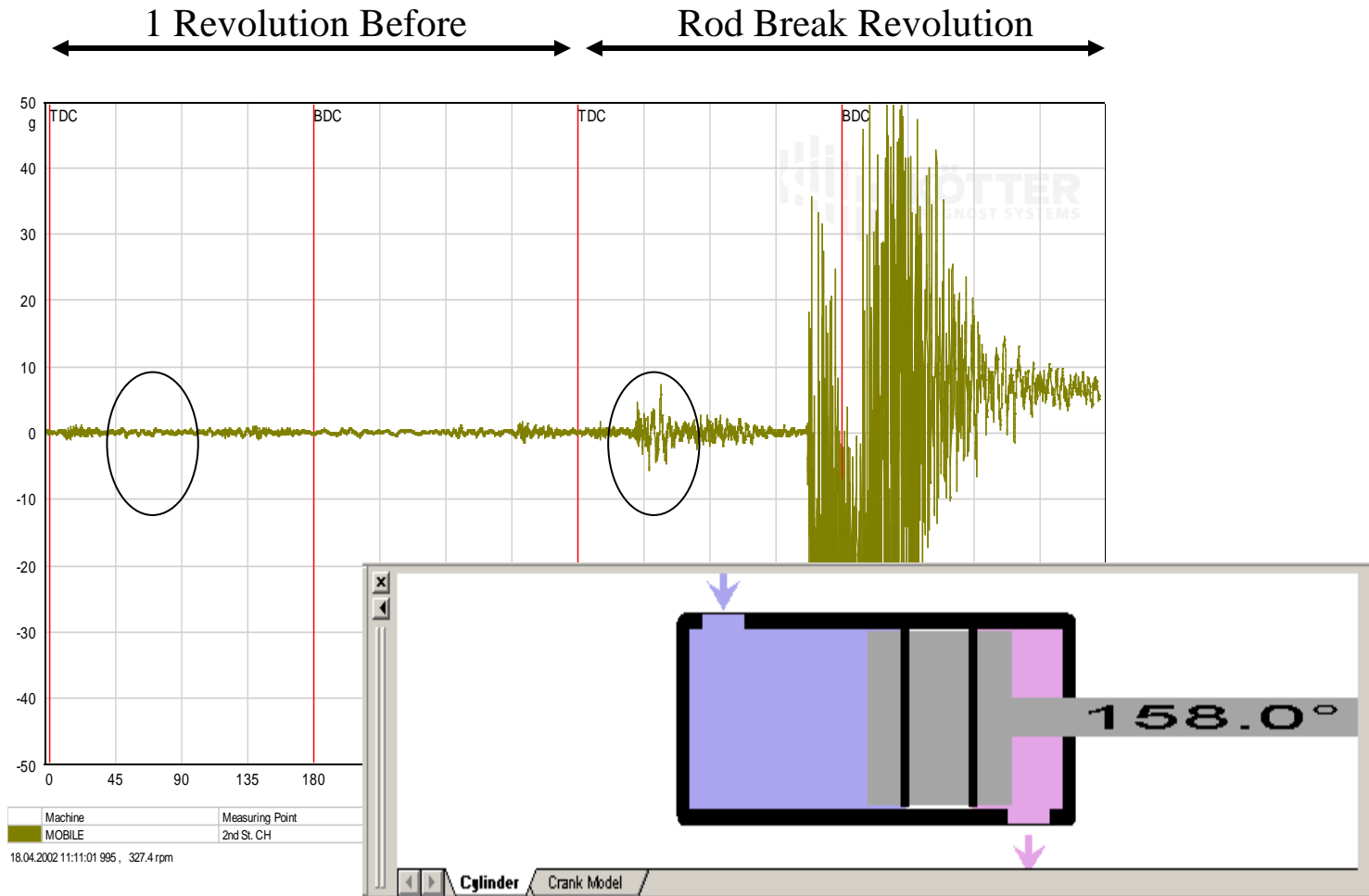
- Sudden Catastrophic 2nd Stage Rod Failure on H2 compressor
 - Bent Crankshaft to Crosshead Connecting Rod
 - 3 Weeks Later
 - Sudden Catastrophic 2nd Stage Rod Failure on other H2 compressor
 - Identical (carbon copy) in nature to first failure
 - Vibration Interlock System
 - Shutdown Both Compressors Within 1 Second
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H2 Compressor Rod Failures

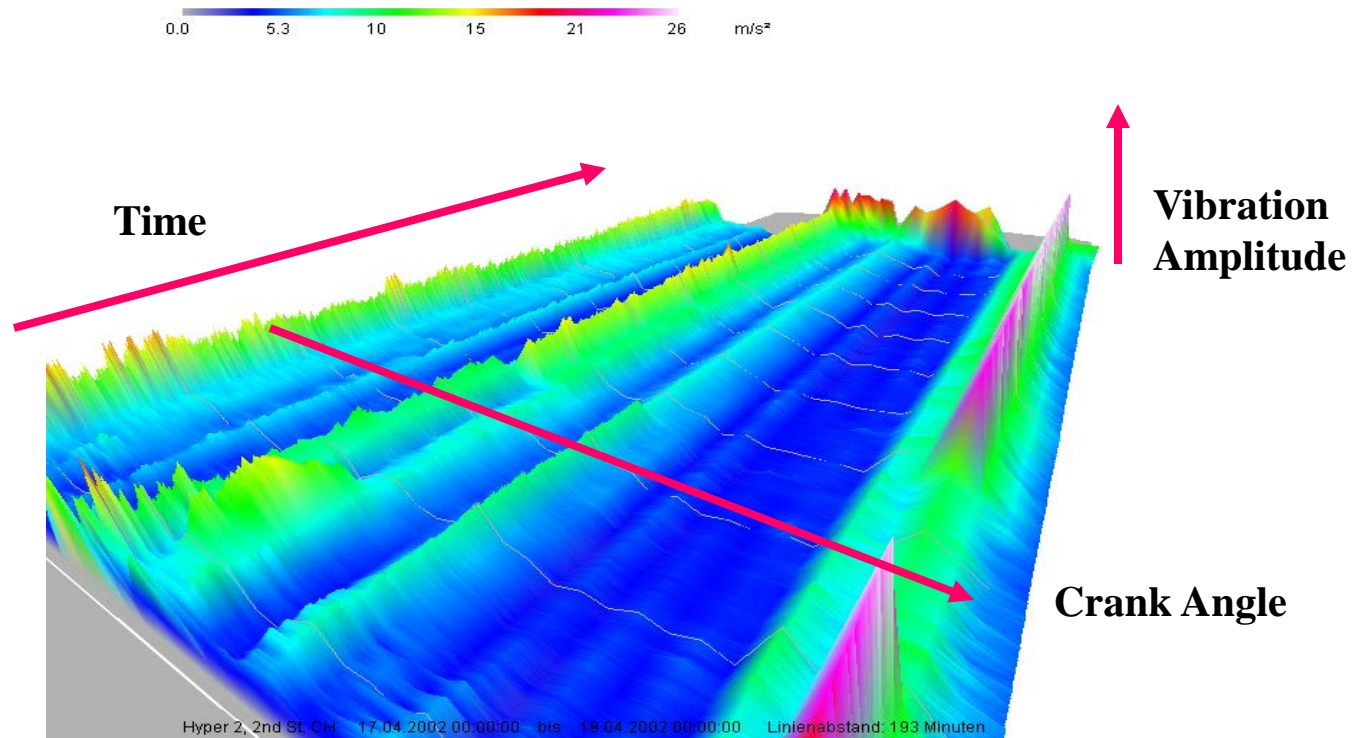
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H2 Compressor Rod Failures



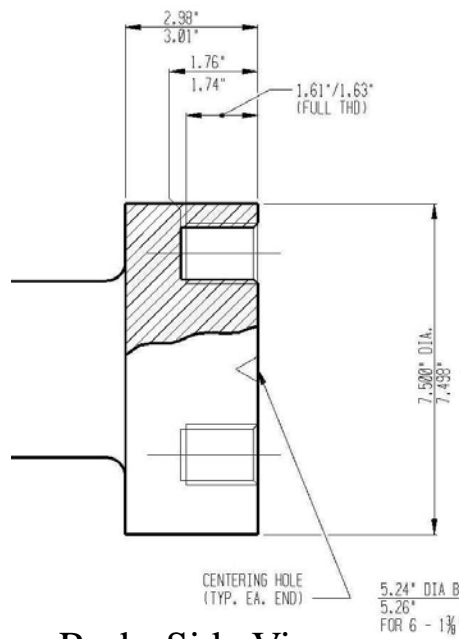
H2 Compressor Rod Failures



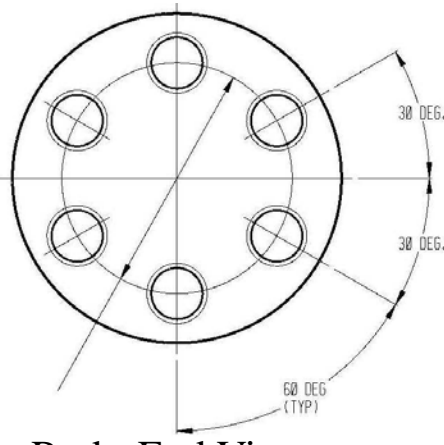
Short-term-trend (Minutely average-value) of Peak-Values on CH Cyl. 2 for one day prior to failure



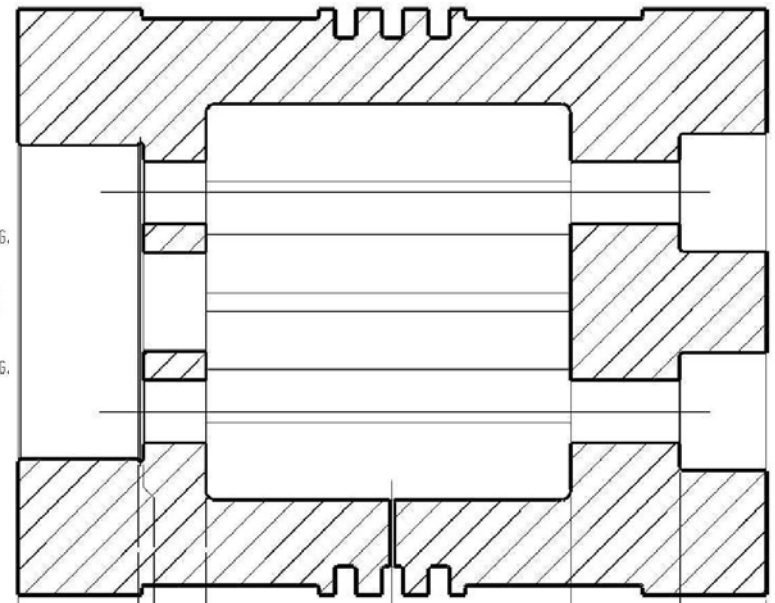
Rod Failure Analysis



Rod - Side View

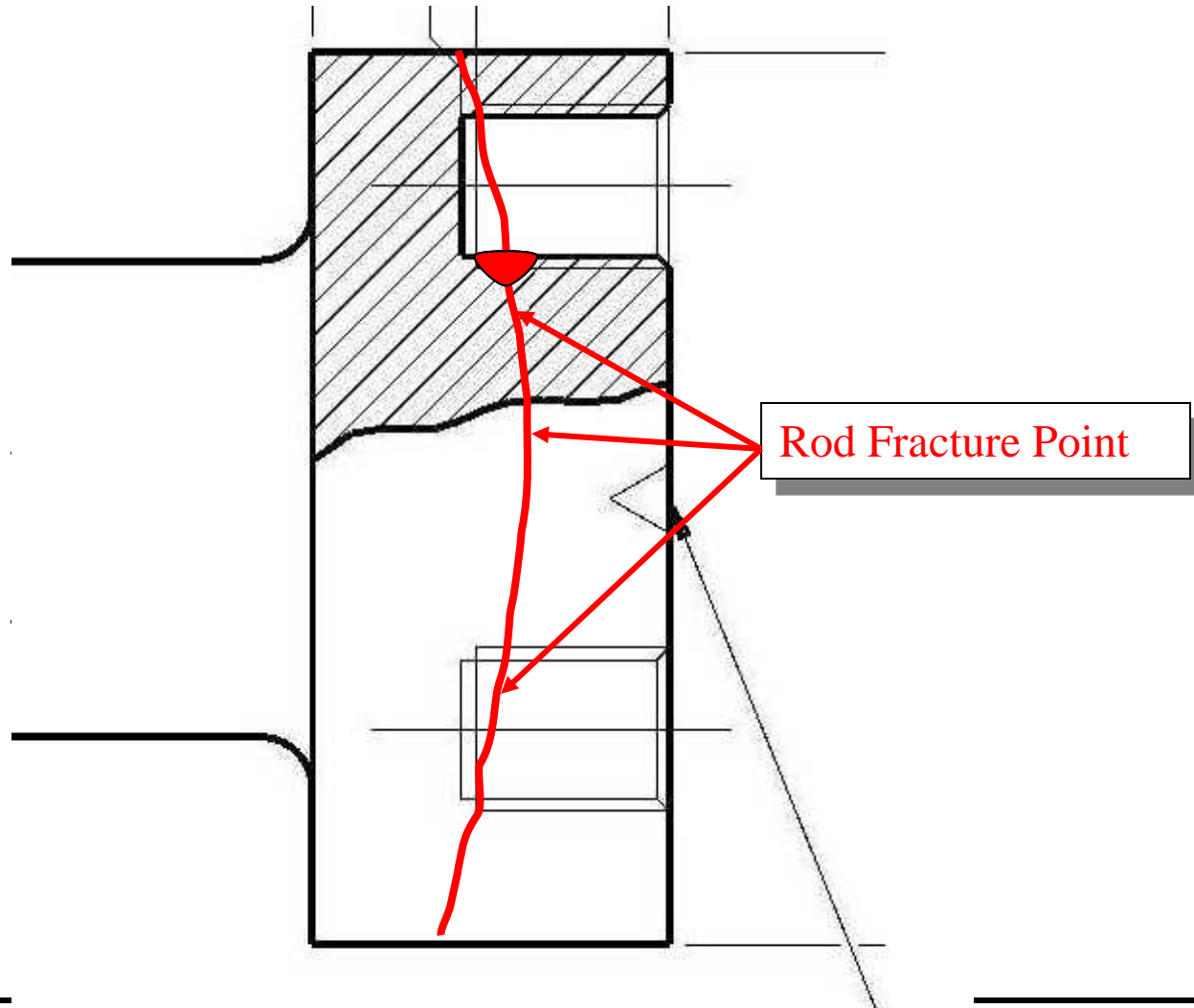


Rod - End View

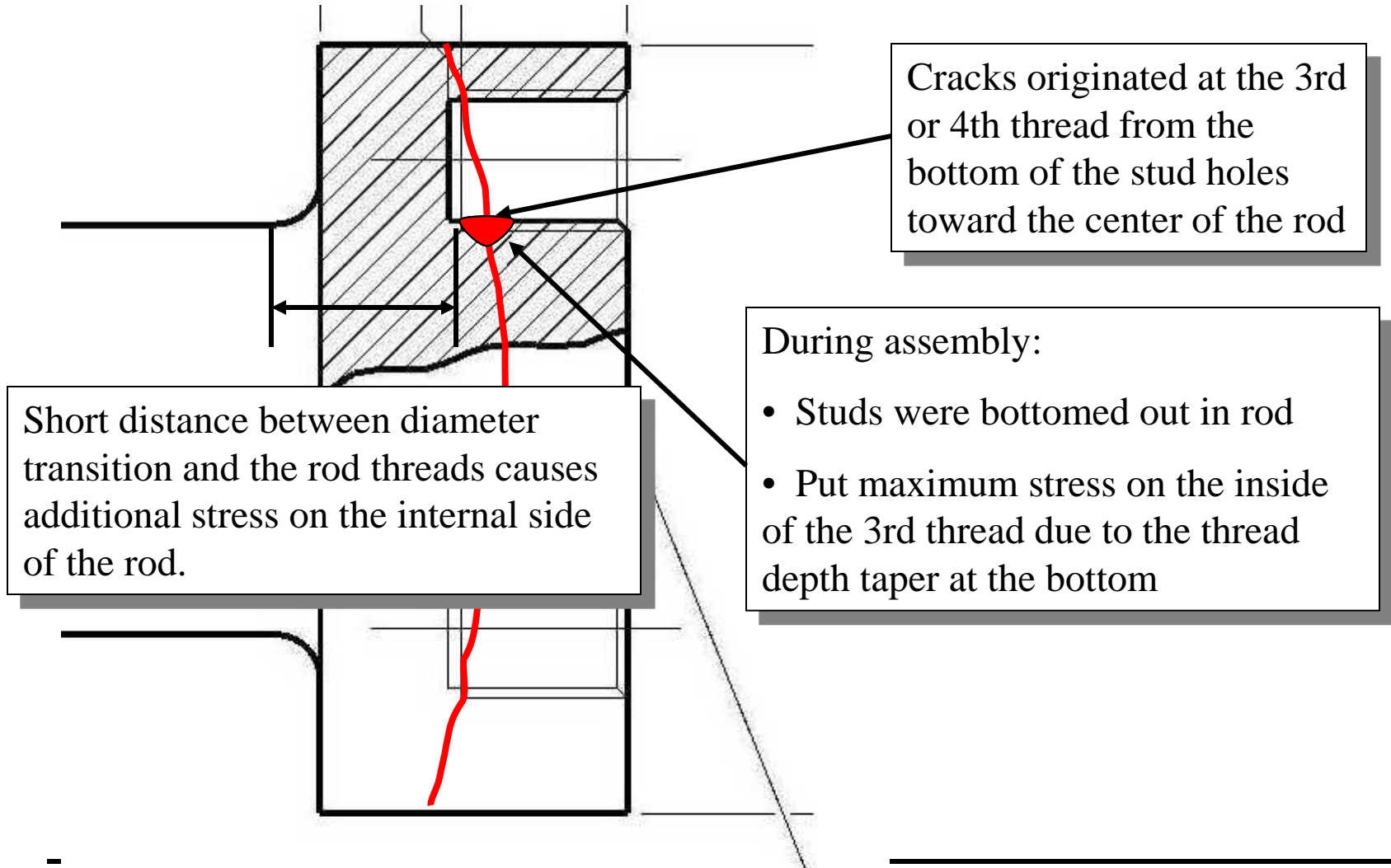


Piston - Side View

Rod Fracture Analysis



Rod Failure Analysis



Pictures



Pictures



Pictures



Failure Analysis Summary

- Items considered
 - Changes in process conditions
 - Rod / Piston assembly
 - Metallurgy & Rod QA
 - Length of service
 - Key Factors
 - Rod & piston installation assembly
 - Torquing threaded stud into bottom of stud holes caused excessive stress in threads
 - Rod Taper / stud hole proximity
 - Close proximity accentuated the stress level in the threads
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Upgrades Implemented

- QA Check Sheet for New Rods
 - Correct metallurgy
 - Meets specifications
 - Rod & Piston Assembly Procedure
 - Detailed instructions
 - Manufacturer input to proper assembly
 - 3 Year Rod Change Out
 - Removed rods are tested and re-furbished if no wear evidence is detected
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Learnings

- Validation of the Vibration Interlock System
 - Fast reaction time (Less than 1 second)
 - Provided data for determination of second break
 - Rod & Piston Assembly Procedure
 - Critical to proper assembly of components
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Questions?

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