PC271 Lessons Learned: Scotford Manufacturing Twin-Screw Compressors in Styrene Vent Gas Service

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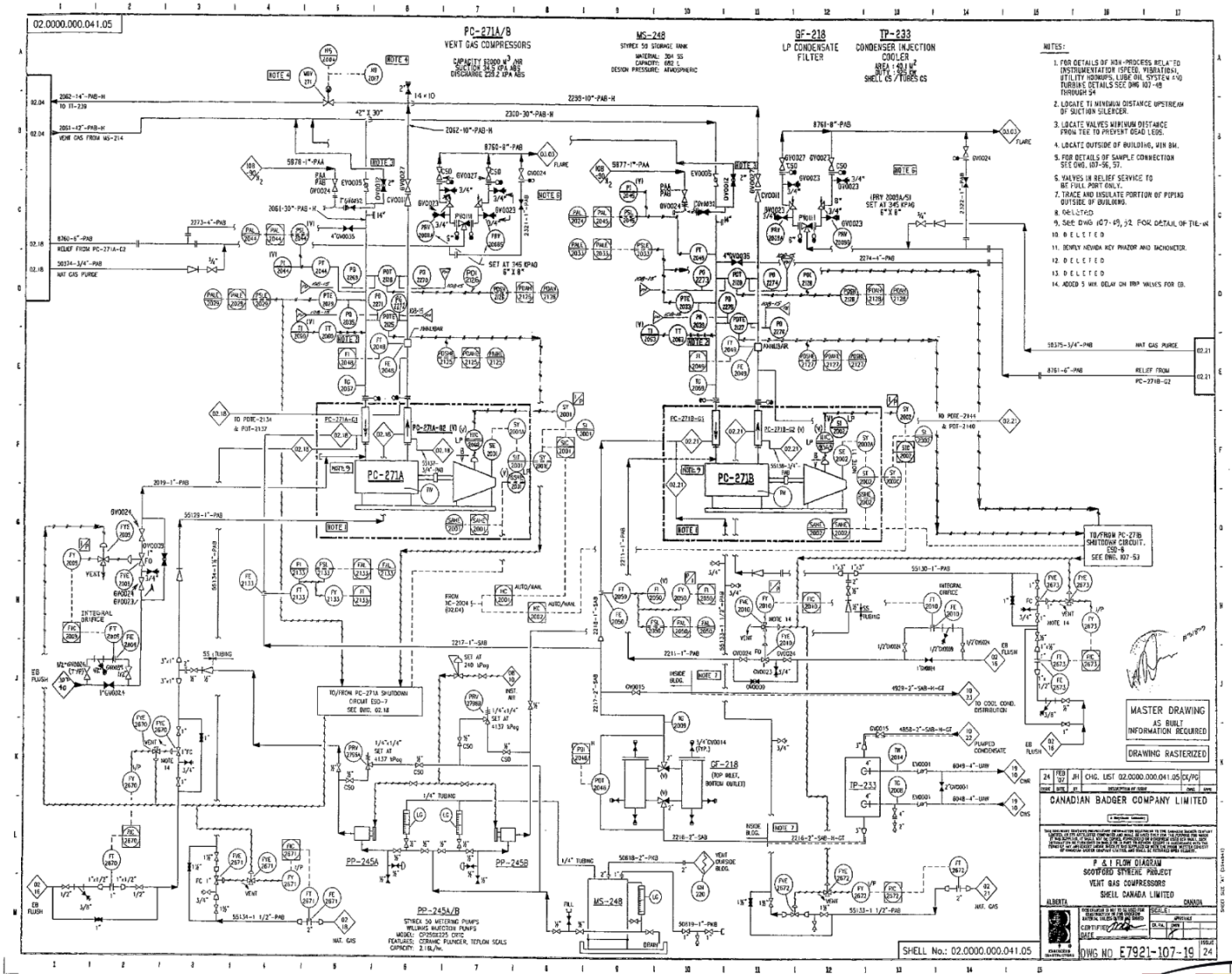
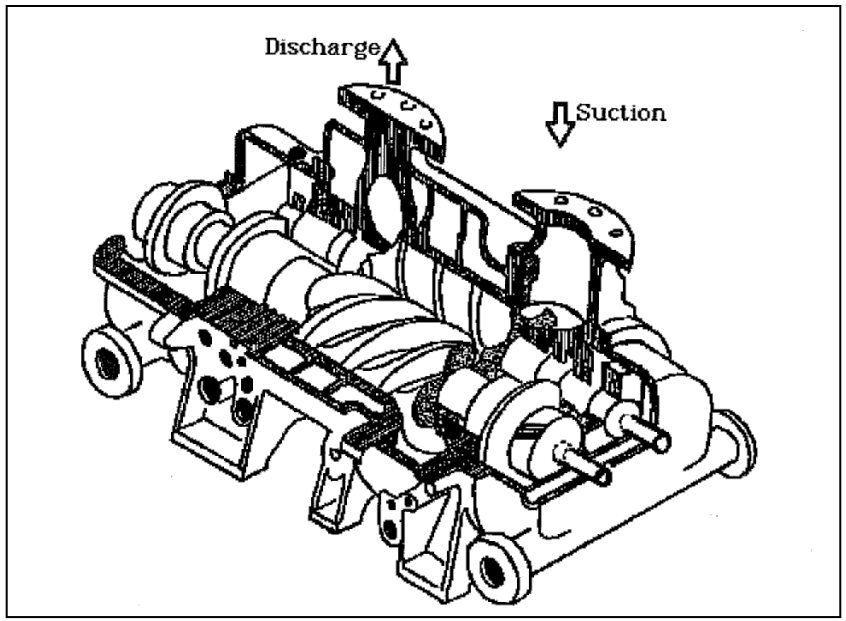
Presentation Overview

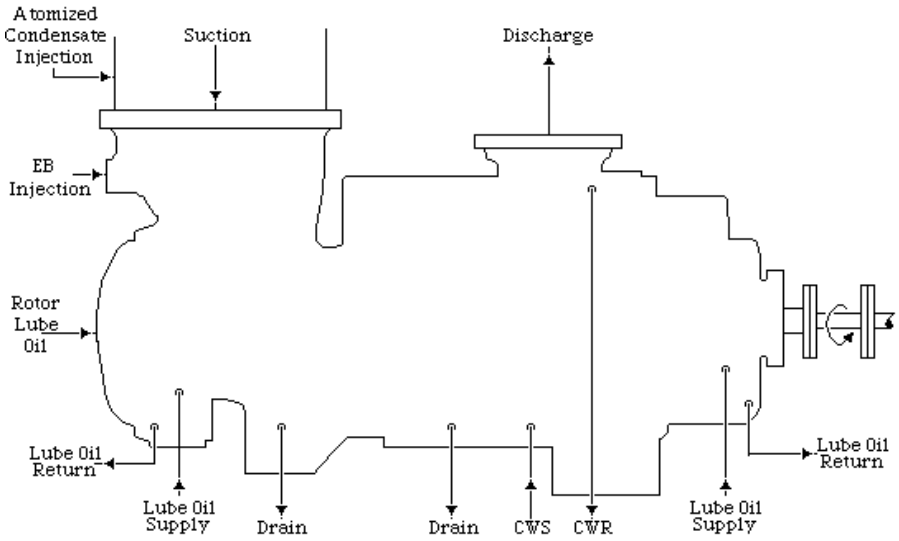
- System Arrangement
- Problem
- What We Found?
- Solutions
- Lessons Learned

System Arrangement



System Arrangement





Problem

- LOPC
  - Vibration was sufficient to cause seal gas nipple to shear off and building to fill with CH4
- Loss of Machine
  - Rotors were written off
  - Long Lead Time
    - Site was vulnerable as it takes upwards of 18 months to fix the spare
- Maintenance Costs
  - Over $1,000,000 to fix
  - Taking resources from other badly needed repairs
- Production
  - Potential to limit production if demand was high enough

Problem

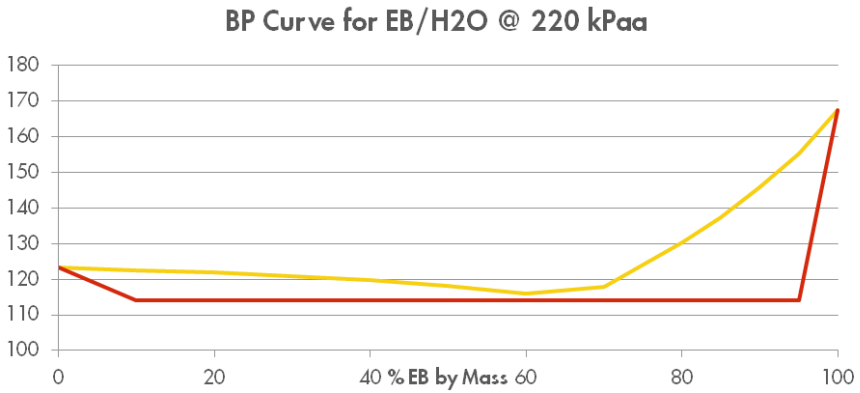
Problem

What we found?

- Vibration Protection System Disabled
  - BN-3300 Racks
  - Improperly configured
    - Single voting in most cases
    - No time delay
    - Latching trip relays
  - This configuration lead to many nuisance trips
- Many Manual Operations During Start-up
  - Spill back valve was manual
  - EB Injection valve was manual
  - Discharge temperature control (condensate injection) was manual during start-up as it was too slow

What we found?

- Poor Process Understanding
  - Condensate / Ethyl Benzene Injection
    - Together they form an azeotrope that will vapourize under the operating conditions
    - Condensate for discharge temperature control
    - EB to prevent polymerization
    - EB will remain a liquid under all compressor operating conditions
      - Cannot inject EB without condensate



What we found?

- Failed Over-Speed Trip Card
  - Uncovered by IPF testing during repair work
  - Machine sped through the over-speed trip set-point and tripped on mechanical over-speed trip
- Neglected Lube Oil Skid
  - Sensing line plugged with gasket material
  - “Failed Pump” was actually plugged suction strainer

Solutions

- Vibration Protection System Enabled
  - Configured more robustly
    - Dual voting
    - Time delay as appropriate
    - Non-latching trip relays
  - No nuisance trips since being enabled
- Manual Operations were Automated
  - Spill back valve was automated
  - EB Injection valve was automated to close if condensate injection valve was below 10% output
  - Feed-forward temperature control scheme was implemented
    - Responds to change in compressor speed subject to meeting an adequate discharge temperature

What we changed?

- Over-Speed Trip Card Replaced
- Neglected Lube Oil Skid
  - PM's established based on findings
  - Checked sister skid at first opportunity
- Compressor Repair
  - Casing was salvageable using an impingement plate
  - Rotor's were scrapped and new rotors ordered
    - Repairs too extensive with no guarantee of success

How does it work today?

- Start-ups are more consistent
  - Less need for operator intervention
  - Automated spill back controller and a capable temperature controller
- No spurious vibration trips
- Enhanced monitoring allows for proactive operator action
  - Managed to operate a damaged machine for several months until a TA window

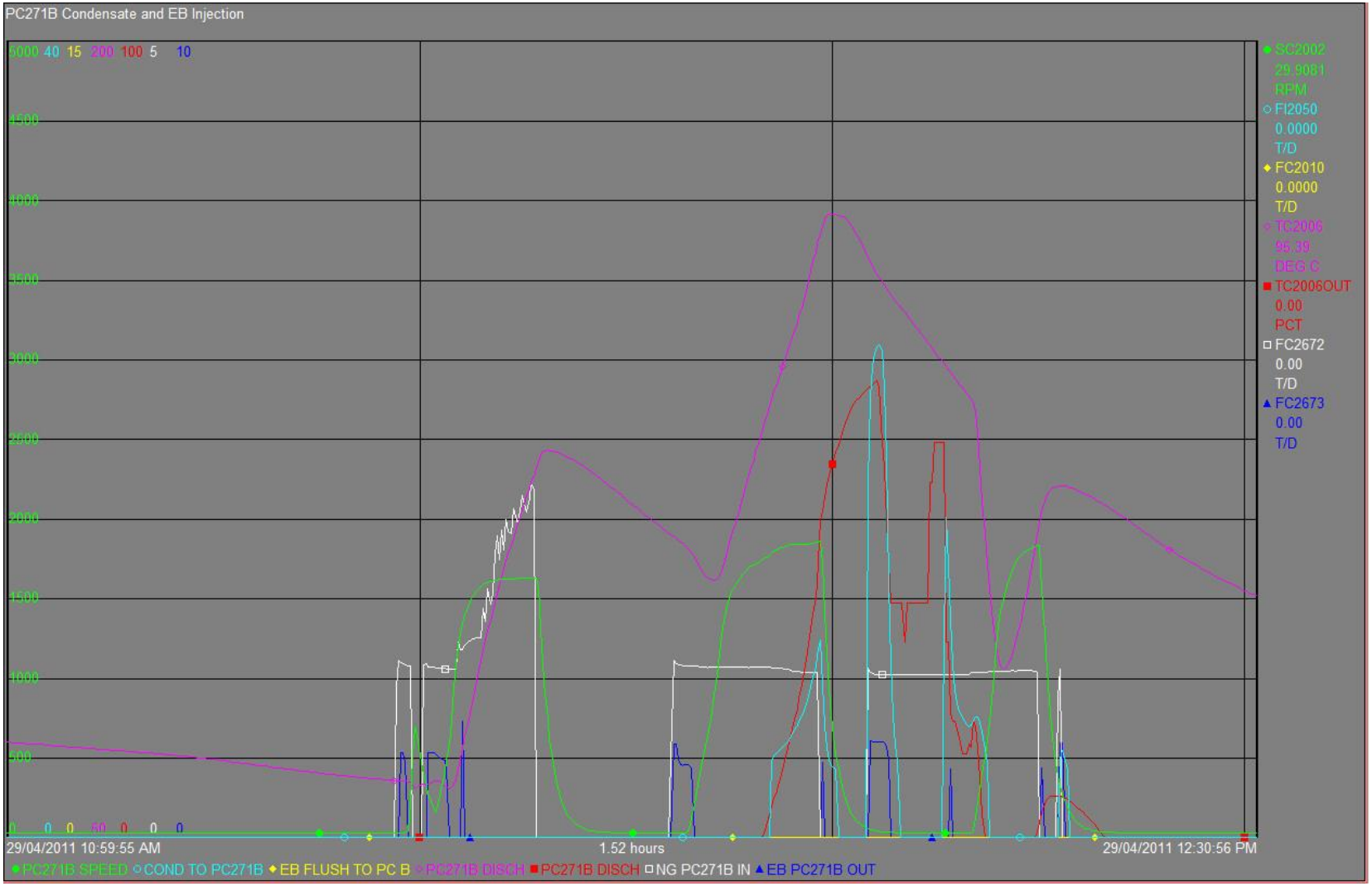
Lessons Learned

- Vibration Systems
  - Vibration systems must be properly engineered and implemented to obtain maximum value
  - Need to consider balance of overall system reliability as well as machine protection
  - Enhanced monitoring allows for proactive operator action
- Modern Control Systems
  - Modern control systems can overcome many problems that were thought to be too difficult to control conventionally only a couple of decades ago
  - Can automate many tasks and provide the operator with more repeatable results
- Preventative Maintenance
  - Reinforces the need to periodically test and maintain the equipment

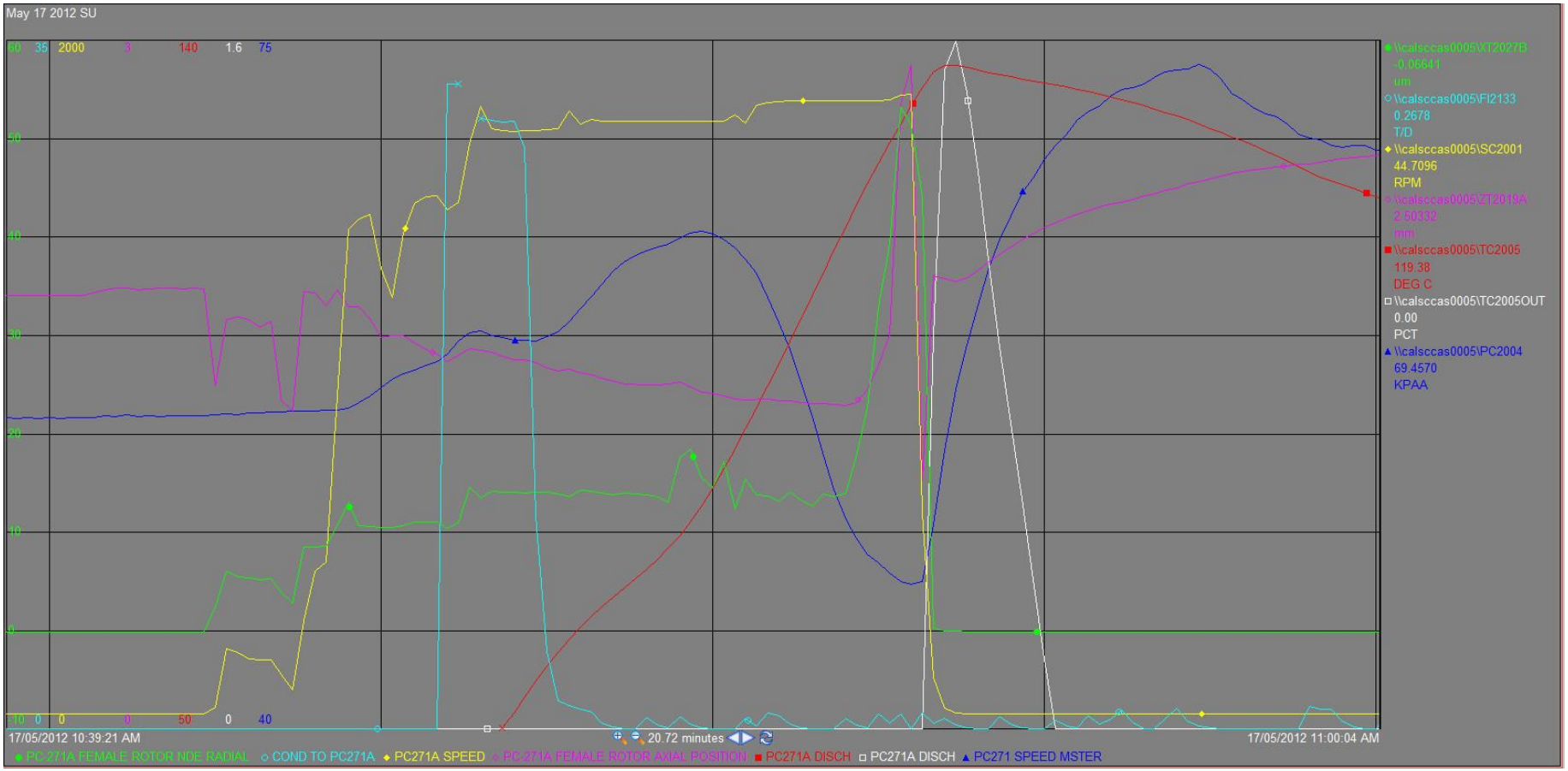
Q&A

Backup Slides

Start-up Data from April 29th, 2011 Before Changes



Process Data from Failure on May 17th, 2012



Process Data from November 15, 2011 – After Changes