BOILER FEED WATER PUMPS PERFORMANCE LOSS

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Presenter

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• 13 years of experience in maintenance, retrofits, and upgrades of Gas Turbines, Compressors and Pumps in natural gas facilities.
• Previous publications at 6 major worldwide conferences
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RGX2 Steam Condensate System

Steam condensate system set up at RGX2:
• Total of x6 Boiler Feed Water Pumps (x4 steam turbine driven pumps and x2 motor driven pumps).

Operating philosophy N+2:
• x4 in service and x2 Stand by operation.
RGX2 Steam Condensate System

Pump specifications:

- Rated capacity 750 M3/hr
- Rated power 1.7 MW
- Differential head 680m
- Horizontally split casing
- 4 stage with double inlet impeller
RGX2 Steam Condensate System

New pump before installation

Old pump at skid in RGX2
Problem Summary

• One pump experienced high thrust bearing temperature alarm after 16 months of operation

• The thrust bearing was replaced twice during the following 6 months without identifying the root cause

• System operation indicated low pump performance

• During the 25 months of operation, thrust bearing temperature again reached high alarm level and pump was found seized upon inspection
Troubleshooting History

Historical Records:
Unit 92-P261A historical events shown on a timeline

Pump’s thrust bearing temperature increase due to bearing degradation over one year – alarm level reached (85 deg C)
Troubleshooting History

Unit 92-P261A - Vibration readings:

- **Pump D.E** radial vibration
- **Pump N.D.E** radial vibration
- **Turbine** D.E & N.D.E radial vibration

**Plot-0**

- **Turbine D.E/N.D.E VAH & VAHH** is 25/37 Mm PK-PK
- **Pump D.E/N.D.E VAH & VAHH** is 50/70 Mm PK-PK

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Unit 92-P261A – Failure

Thrust Bearing failure signs:

- Scored and smeared thrust pads
- Smeared Journal pads
Unit 92-P261A - Failure

Cavitations' damage on 1st stage

Casing erosion

Cavitations' damage
Unit 92-P261A – Failure

RCFA initiated August 2011 and completed Oct. 2011

Casing erosion

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Performance Deterioration

Optimum performance

Deteriorated performance

Other pumps performance

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RCFA-Unit 92-P261A

RCFA – Findings:

• Root Cause (Human) - Incorrect material specification of the pump casing for boiler feed water service led to major damage of casing inner walls and rotor parts

• Contributing Factor 1 (Latent) – Insufficient online monitoring of pump performance due to inadequate instrumentation prevented effective pump health monitoring

• Contributing Factor 2 (Latent) – Inadequate surveillance program for boiler feed water conditions led to a possible corrosive environment within pump flow path
RCFA-Unit 92-P261A

RCFA – Recommendations:

• Immediate action: Purchase x6 new BFWPs with 12%Cr Stainless Steel casings (A487CA6NM) and replace the existing pumps with carbon steel casing (A216 WCB)

• Medium action: Revise Equipment Strategy to perform bi-monthly online performance monitoring task including steam condensate dissolved oxygen and PH levels to ensure remaining within specification

• Long term action: Improve online monitoring:
  - Digital discharge pressure transmitter
  - Install flow measurement devices on the discharge and recirculation line
Operational Risk Mitigation

Contracts Dep.  Electrical and Instrumentation Eng.

Manufacturing Dep.  Rotating Machinery Eng.

Maintenance

Recovery Team

Asset Management  Supply Dep.

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Operational Risk Mitigation

Integrated Repair plan:

• x3 pumps repaired between Oct. 2011 and March 2012
• x2 pumps were repaired used spare parts supplied from third party as fast repair.

• System reviewed for equipment reliability (Turbines, Motors, Automatic Recycle Valves, Instruments etc.) and corrective actions taken as appropriate

• Frequent measurement of discharge and recycle flow using clamp flow meter to assess pump performance

• Long term - Installation of x6 new pumps with stainless steel casing (procurement and installation time-14 months)
Recommendations Results

- Performance for the repaired 3 units as interim solution was similar to OEM design.
- Ultimate replacement of all pumps by new stainless steel casing's units results in operating the BFW system with reliable units as per OEM design.

Optimum performance
Lessons Learned

• Follow API610 guidelines during procurement (material specifications versus fluid service)

• Improve datasheet and specification review during project FEED and procurement

• Improve online monitoring instruments required during plant design
Questions?

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Backup
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## Operational Risk Mitigation

### Integrated Repair Plan

<table>
<thead>
<tr>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
<th>Finish</th>
<th>Resource Names</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
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<tbody>
<tr>
<td>1 Mitigation Plan for exposure without healthy spare BFWP</td>
<td>16 days</td>
<td>10/26/11</td>
<td>11/16/11</td>
<td>Team 1</td>
<td>11/27</td>
<td>12/11</td>
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<td>2 Procurement of x6 new BFWPs</td>
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<td>5 eMWO for CU Service Engineer</td>
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<td>6 Write QA/QC check list for vendor BFWP repairs</td>
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<td>7 Award CU contract for repair services</td>
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