Case Study on remote diagnostics in resolving random vibration on a steam turbine

Sankar Ganesh – GE
Muhammad Zeeshan Iqbal – GE
Presenter/Author Bios

Sankar Ganesh:
Sankar is the Lead Engineer for GE Bently Nevada Machinery Diagnostics Services for Qatar and Kuwait.

He received a Bachelor of Mechanical Engineering from Bharathidasan University, India, in 1993.

Over 20 years experience in vibration field and 9 years with GE Bently Nevada, including rotating equipment balancing, vibration analysis, diagnostics and root cause analysis. Published case studies in METS and Turbomachinery symposium.

Muhammad Zeeshan Iqbal:
Zeeshan is Remote Monitoring Engineer for GE Bently Nevada in the Middle East and Africa.

Zeeshan holds a Bachelor of Mechanical Engineering from NED University of Engineering & Technology.

Over 10 years of field experience in condition monitoring, including vibration analysis, infrared thermography and oil analysis. Monitoring machines that are hundreds of miles away, Zeeshan’s key objective is to support customers with proactive monitoring to maintain high machinery availability.
Abstract

This case study narrates an incident of random vibration spikes which occurred in year 2014 on one of the steam turbine bearings of a propane refrigeration compressor train. The random vibration spikes caused the turbine high vibration to trip leading to a train shutdown. This case study outlines how the random vibration spikes were successfully diagnosed through remote monitoring center, the root cause for the high vibration trips, and finally how it was mitigated. The case study also discusses lessons learned with respect to the discovery methodology using expert system available at site, and the importance of monitoring key operating parameters.
Contents

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• Machine description
• Data analysis
• Initial analysis & recommendations
• Machine inspection results
• Subsequent failure analysis & conclusions
• Results after maintenance
• Lessons learned
Steam Turbine Driven Propane Refrigeration compressor

- Only one machine per train
- Machine upset will bring down the train production

Random vibration excursions for two months on Steam turbine Non Drive End Bearing

- Tripped 7 times due to Intermittent high vibration spikes
- Plant vulnerable to production loss
- Customer approached Remote Monitoring Center for analysis and recommendations
Machine Description

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine Type</td>
<td>Condensing Type Impulse Reaction (11 stages)</td>
</tr>
<tr>
<td>Turbine Rating</td>
<td>35341 HP</td>
</tr>
<tr>
<td>Speed</td>
<td>3850 RPM</td>
</tr>
<tr>
<td>Calculated critical Speed</td>
<td>2100 RPM</td>
</tr>
<tr>
<td>Coupling</td>
<td>Turbo Tooth Coupling</td>
</tr>
</tbody>
</table>
Data Analysis

- Direct Vibration trend shows random vibration excursion at ST NDE bearing
- Sudden increase in vibration crossing the alarm and trip values
- No correlation with the process parameters
- Direct vibration at ST DE bearing has little effect
Abnormal behavior - significant phase angle change during vibration increase
Significant change in the orbit shape and amplitude due to change in balance condition due to thermal bow.
Minor change in shaft centerline noticed with the vibration increase
Thermal bow effect of rub

High spot

Heavy spot

1X orbit

Rubbing spot

Seal

New high spot and rubbing location

Increased 1X orbit

Effective unbalance

mrΩ²

α₀

mrΩ²

α₀

mrΩ²

Effective unbalance

mrΩ²

α₀

mrΩ²

 Thermal bow effect of rub
Remote Monitoring engineer concluded the rubbing issue is most likely due to carbonized oil buildup in the oil deflector and seal area based on the past experience with similar machines.

Recommended Action Items:
Inspect oil/steam seal areas for rubbing marks due to deposit built-up of carbonized oil.
Machine Inspection Results

ST Non Drive End Bearing

Carbonized deposits at NDE seal area

Rubbing Marks on the shaft

*Rubbing marks at the seal area and oil carbonization was found.*
Further analysis at site revealed that the gland condenser was not in service for the past two months.

Absence of gland condenser introduced steam leakage near the bearing which led to the formation of oil carbonization.

Gland condenser was put back in service after the cleaning of oil carbonization deposits.
Results after maintenance

No vibration excursions after the maintenance (Trend stable)
Lessons Learned

✓ **Reduced Maintenance Cost and Down Time**
  ▪ Quick analysis using the expert system remotely.
  ▪ Accurate analysis by experts helped reduce maintenance down time (Unnecessary trouble shooting with the machine internals avoided).
  ▪ Presence of online diagnostic system helped to plan machine shutdown for maintenance with minimal impact on the production.

✓ **Operational issues**
  ▪ Absence of gland condenser in service
Thank You...

Questions??