Case Study
Mysterious Trippings of NGL Turbo Expanders on Qatargas Mega LNG Train

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Problem Statement

- Both the in-service NGL turbo expanders tripped simultaneously during normal plant operation.
- Cause was “magnetic bearings trip”
- Companders’ rotors remained levitated with the status “Rotation Allowed”
- JT came in action as expected to keep the train in operation.
- There were three trips in 10 days time on same cause
Installation Reference

• The turbo-expanders are installed in Qatargas which is the world’s largest LNG producing company with a total production capacity of 42MTA.
• Qatargas operates four mega trains, each producing 7.8 MTA of Lean LNG (LLNG).
• The mega trains were commissioned within the last 3-1/2 years.
Purpose of NGL Turbo Expanders

- The NGL turbo expanders cool down the natural gas feed through isentropic expansion for removal of heavy hydrocarbons (C2, C3, C4,....).
- Turbo expanders will also be referred as Componders (Compressor-Expander unit).
Purpose of NGL Companders

Precooled Feed Gas

Compander (3x50%)

Lean Gas Comp (LGC)

Acronyms: ASV (Anti Surge Valve); JT (Joule Thomson Valve); HCs (Hydro-Carbons)

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NGL Turbo Expanders

Expander:
- 60 BAR @ -44°C
- 31 BAR @ -74°C
- Shaft labyrinth seals
- 6 MW

Compressor:
- 35 BAR
- 30 BAR

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NGL Turbo Expanders

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NGL Turbo Expanders Bearings

Magnetic Bearings

Aux Bearing

0.18 mm

Expander

Rotor

Compressor

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Problem Description

• Both the in-service expanders tripped simultaneously during normal plant operation.
• Expanders’ rotors remained levitated with the status “Rotation Allowed”
• Cause of trip:
  • “Magnetic Bearings Trip” (ESD log)
  • “Excess Position” on compressor side (AMB)
  • “Surge Failure” (AMB log)
• JT came in action as expected to keep the train in operation
• There were three trips in 10 days time on same cause
Compressors surged before trip
Findings

- ASC trends/logs confirmed that the companders surged before trip while the inlet parameters were steady.
- Event logs showed that ASV of downstream LGC opened and closed back (within 2sec) just before the companders’ trip.
Further Findings

- ASC of the downstream LG Compressor did not send any opening command to the ASV.
- However, DVC of the ASV was found receiving open/close signal while the ASC output was zero.
- Repeated Common Fault alarms from the LGC ASC.
Analysis

• LGC ASV was opening & closing back (in less than 02 sec) without demand from the AS controller.
• Above action blocked the flow of companders on compressor side forcing them to surge.
• During this upset, the aerodynamic forces on the rotor were too high for the AMB system to keep the rotor in acceptable position.

Result: Companders trip on “excess position” on compressor side
Acronyms: ASV (Anti Surge Valve); JT (Joule Thomson Valve); HCs (Hydro-Carbons)
Probable Causes

Common Observations for all the three trips

1. ASC Common Fault Alarms
2. ASV Not Close
3. ASV Open

Acronyms: DVC (Digital Valve Controller); ASC (Anti Surge Controller)
Probable Causes

- Loose field connections
- Ground fault
- Faulty LGC AS controller Analogue Output (AO) card of LGC anti surge controller
Resolution

- Replaced AO card of LG compressor AS controller
- No loose connections found
- No ground fault found

No Alarms, No Trips since more than a year

Most Probable Root Cause: Faulty AO Card
Challenges Faced

• Very fast event \(\Rightarrow\) DCS trends were not helpful
• Different make AS control system for Companders and LGC
  \(\Rightarrow\) not possible to trend variables on one screen
• Event logs from various systems *DCS, ESD, ABM, ASC of Companders & LGC*
• Event logs out of time synchronization
• No data historian for AMB \(\Rightarrow\) no trends
• LGC ASC historian \(\Rightarrow\) only for last 24hrs
• ASVs \(\Rightarrow\) no position feedback (DVC trends were available for 15 mins only)