MIDDLE EAST TURBOMACHINERY SYMPOSIUM

Case Study

Mysterious Trippings of NGL Turbo Expanders on Qatargas Mega LNG Train

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The World's Premier LNG Company

قطرغاز QATARGAS

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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

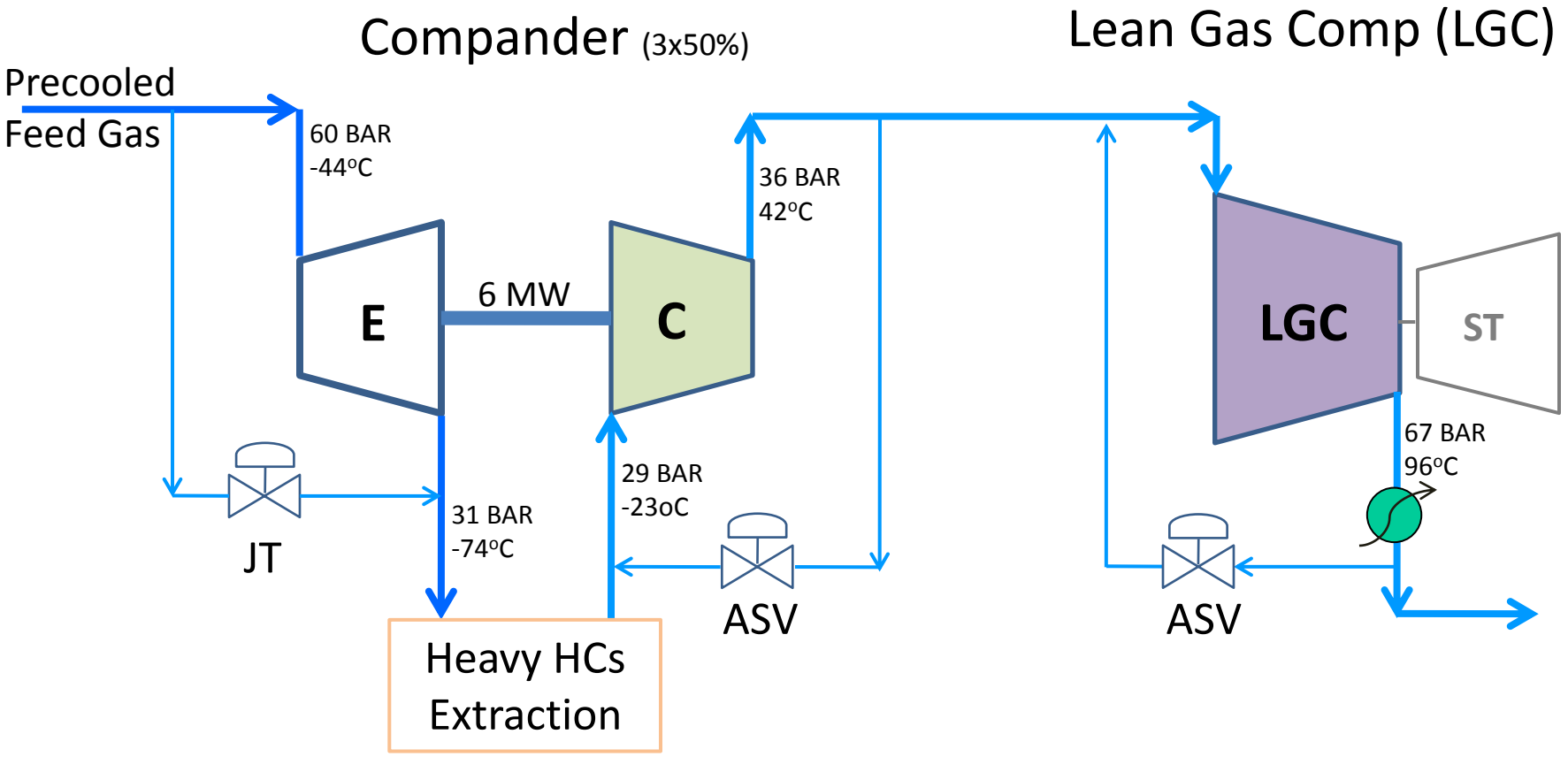
Installation Reference

- 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

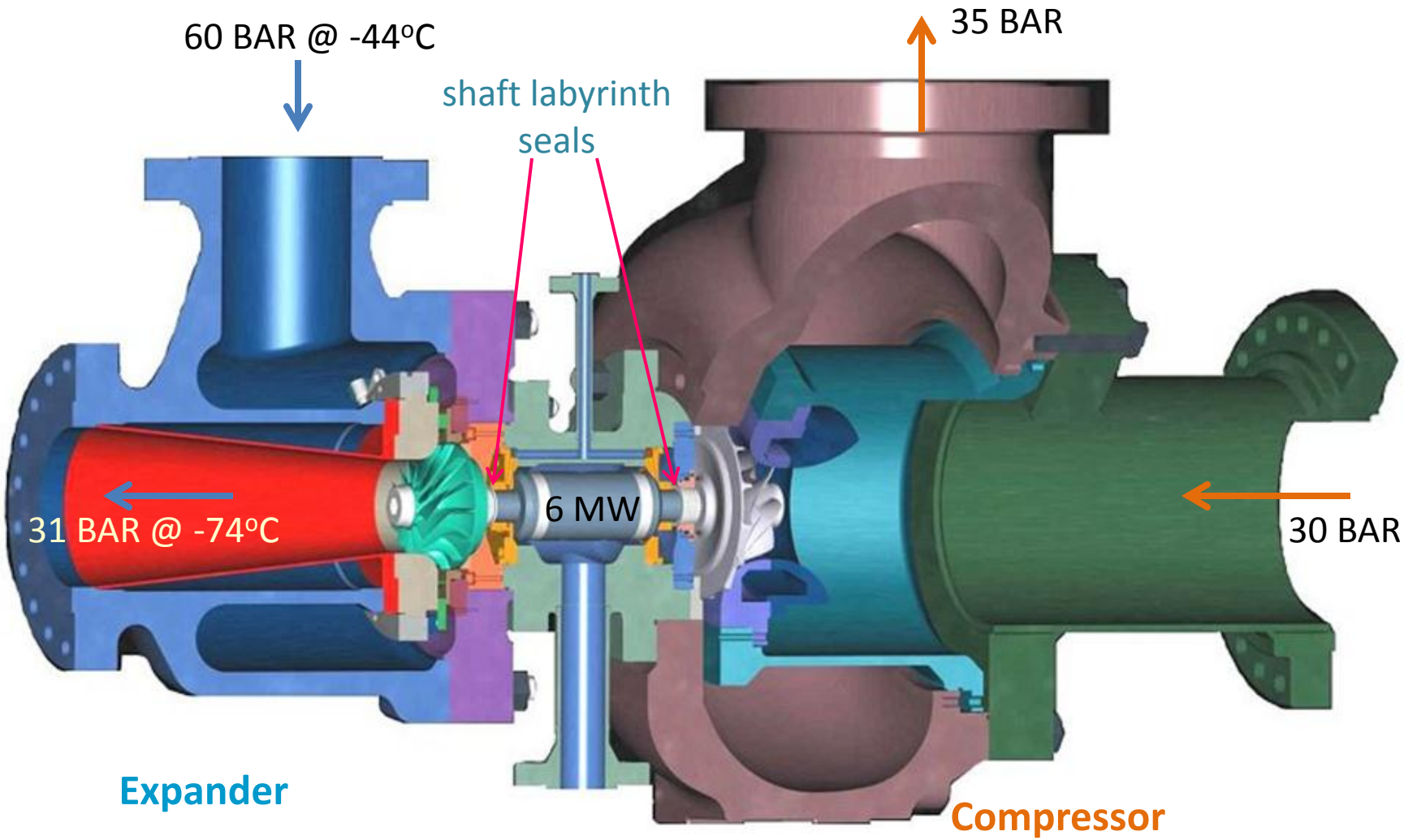
- The NGL turbo expanders cool down the natural gas feed through isentropic expansion for removal of heavy hydrocarbons (C2, C3, C4,….).
- Turbo expanders will also be referred as Companders (Compressor-Expander unit).

Purpose of NGL Companders

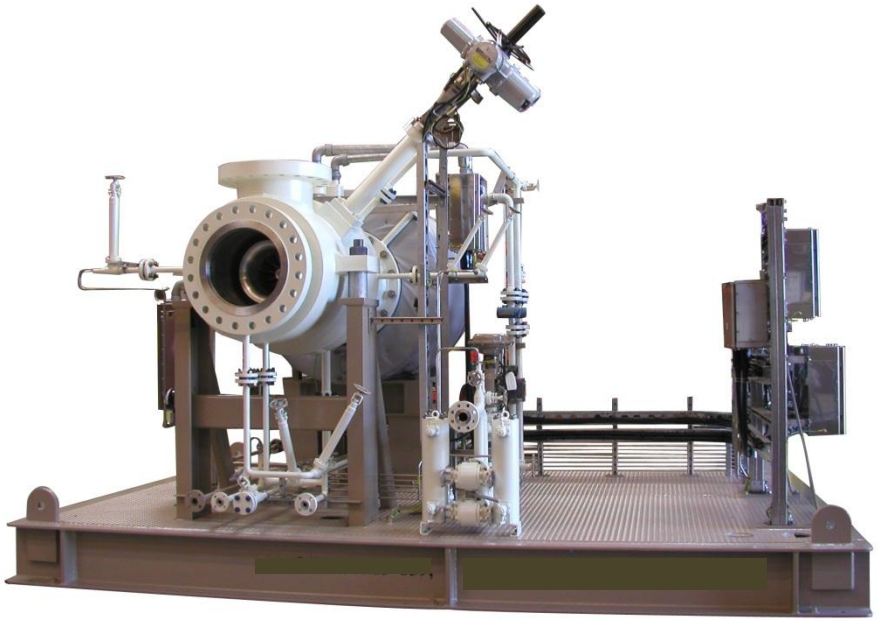


Acronyms: ASV (Anti Surge Valve); JT (Joule Thomson Valve); HCs (Hydro-Carbons)

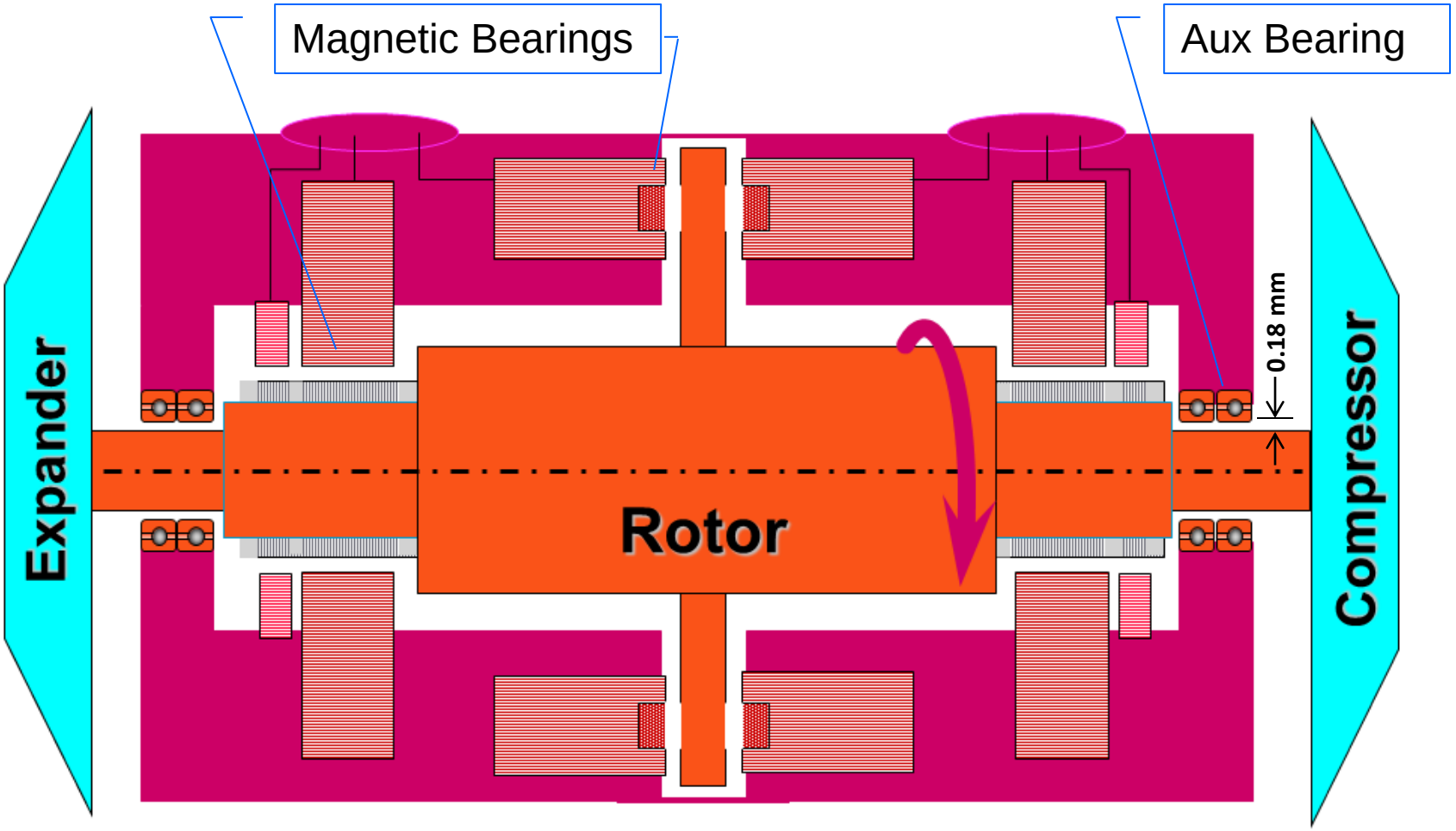
NGL Turbo Expanders



NGL Turbo Expanders



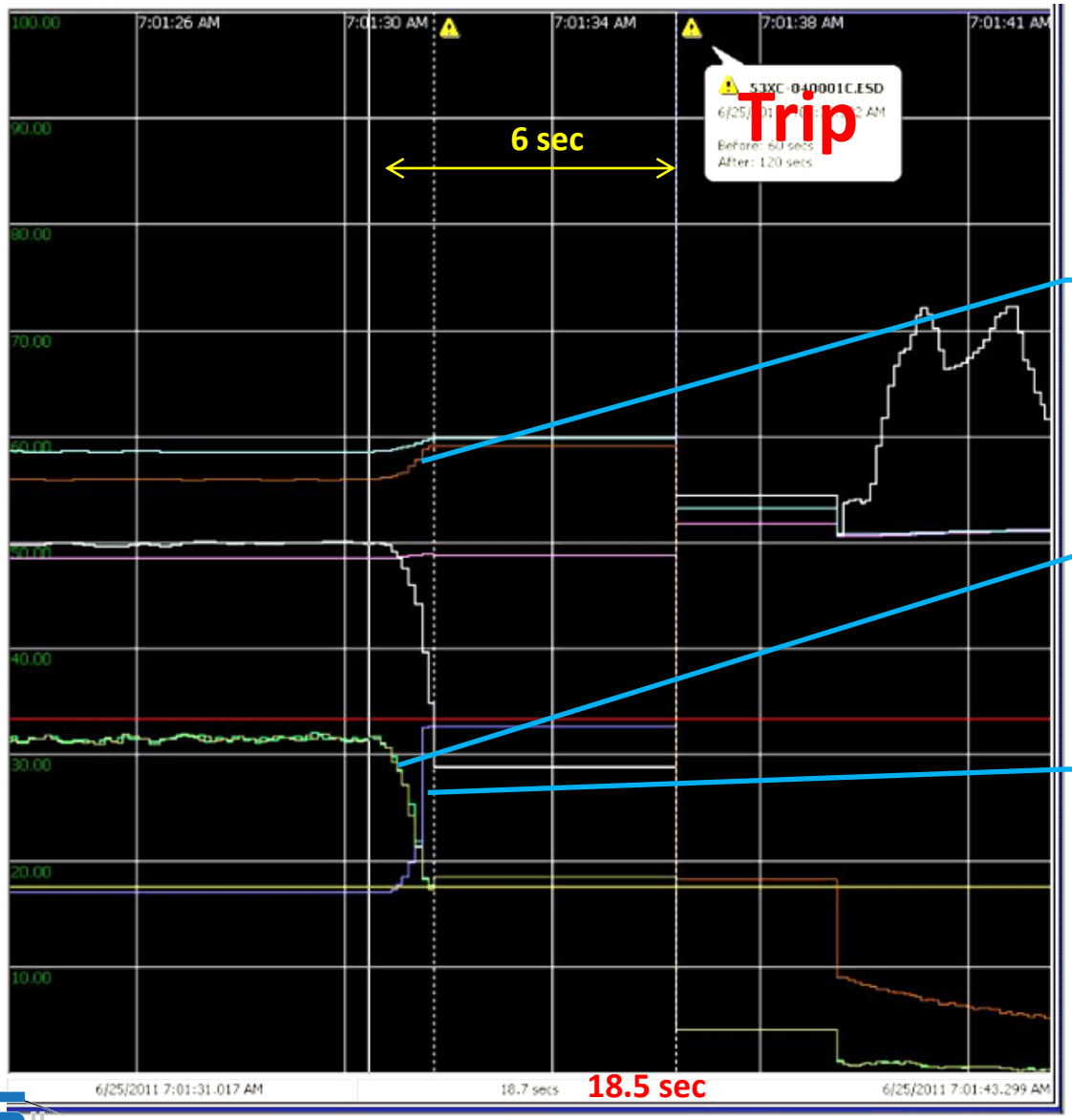
NGL Turbo Expanders Bearings



Problem Description

- **Both the in-service companders tripped simultaneously during normal plant operation.**
- **Companders' 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

Trends from Compander ASC



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

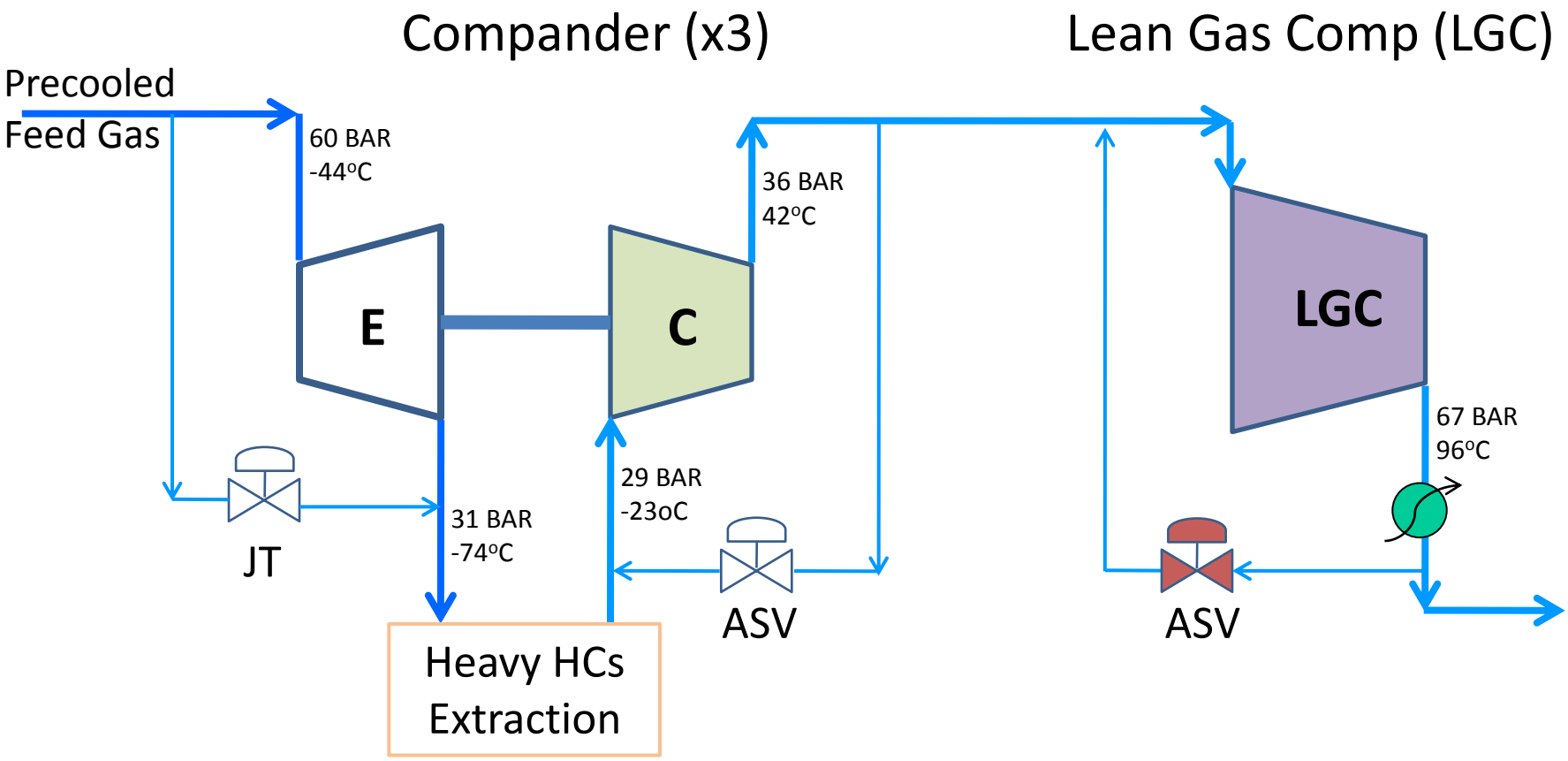
- ASC of the downstream LG Compressor did not send any opening command to the ASV.
- However, DVC of the ASV was found receiving open/close signal while the ASC output was zero.
- Repeated Common Fault alarms from the LGC ASC.

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.**

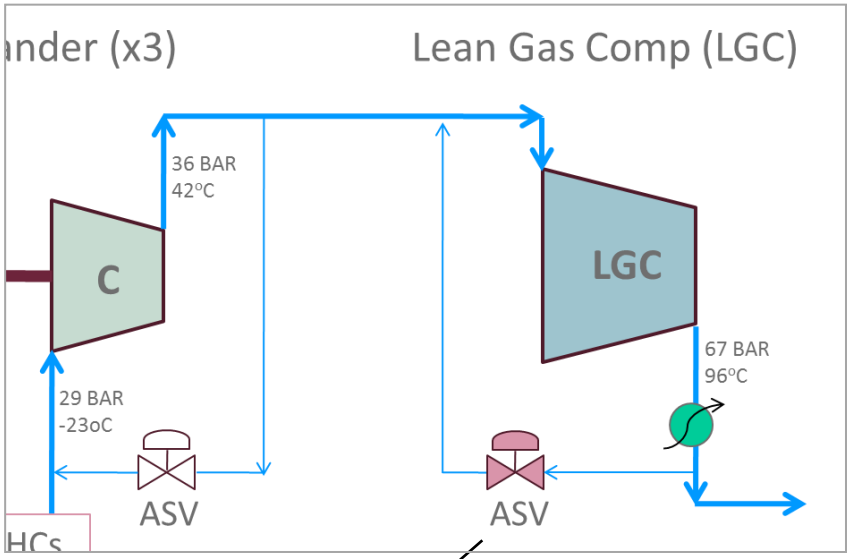
Result: Companders trip on “excess position” on compressor side

NGL Companders & LGC



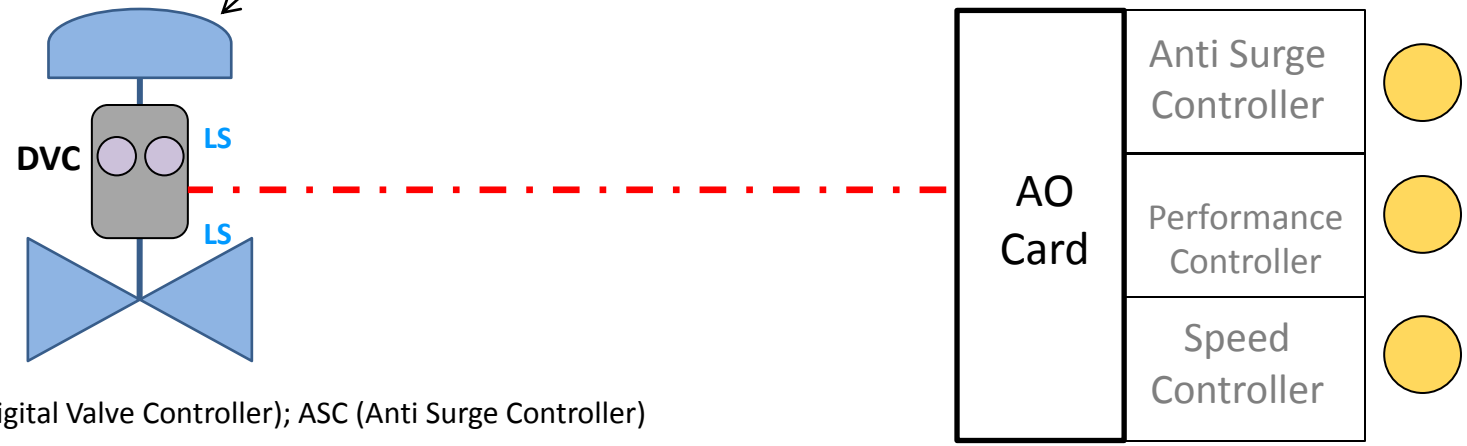
Acronyms: ASV (Anti Surge Valve); JT (Joule Thomson Valve); HCs (Hydro-Carbons)

Probable Causes



Common Observations for all the three trips

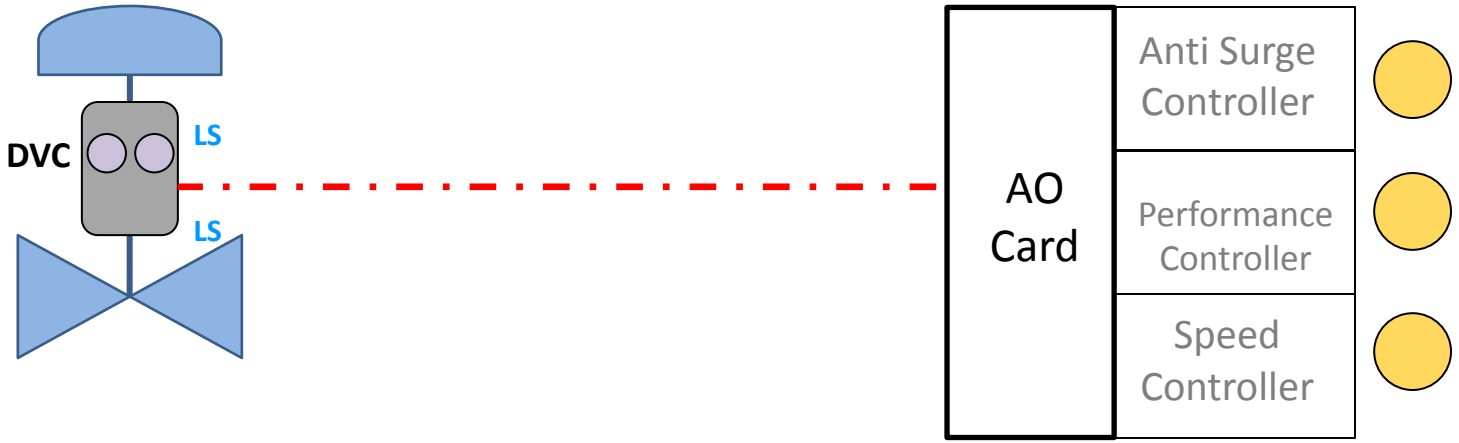
1. ASC Common Fault Alarms
2. ASV Not Close
3. ASV Open



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

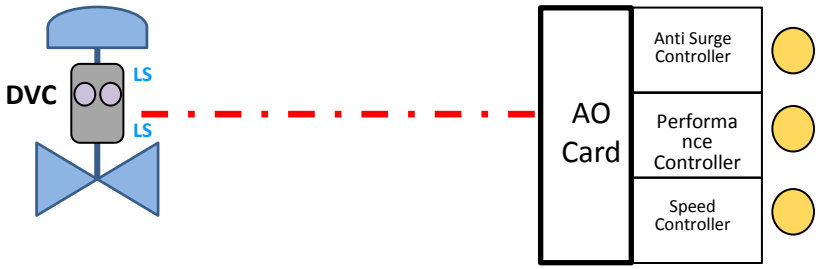
Probable Causes

- 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 ⇨ DCS trends were not helpful**
- **Different make AS control system for Companders and LGC ⇨ 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 ⇨ no trends**
- **LGC ASC historian ⇨ only for last 24hrs**
- **ASVs ⇨ no position feedback (DVC trends were available for 15 mins only)**

Thanks

Any Questions?