N-hance® Performance Filtration

Case Study

Over Six Years After Install... N-hance® Continues to Exceed Expectations

Customer:	Application:	Location:	Solution:
BP	Offshore Oil & Gas Production	UKCS	N-hance® Filtration

Customer Quote

"Since the AAF air filtration upgrade in 2017 we have had no more unplanned engine changes and have never water washed any of the engines!"

Tim Vickers
Rotating Equipment Engineer
BP Exploration & Production UK Limited
July 2023

Intake Filter House of GT2: Due to the location between decks, the feasibility of increasing the size of the air intake filtration system was limited.

Problem

Gas turbines operating in harsh offshore environments face some of the most challenging conditions for air intake filtration systems. Environmental challenges like fogs, mists, sea salt aerosols, hydrocarbons and other offshore airborne contaminants (as well as seasonal fluctuations) make the design of the air intake filtration system critical to offshore gas turbine performance and reliability.

The majority of air intake filtration systems installed on gas turbines in offshore applications comprise multi-stage bag systems operating at high air velocities, typically 5 m/s. The limitation of conventional air filtration technology has been that EPA filtration grade efficiencies have not been attainable at these high air velocities. Historically, the only way to upgrade to EPA filtration has been to replace the existing high velocity air intake filtration system with a much larger EPA filtration housing and on occasion this is simply not possible due to space constraints. However, where a system replacement has been undertaken, this poses significant project complexities such as lead time, planning, shipping, provision of craneage, scaffolding, extended shutdowns, hot work and manpower.

The BP Clair platform operates 3 No. Titan 130 gas turbines (GTs 1, 2 & 3) employed in power generation application to provide power to the asset. Each gas turbine was experiencing compressor blade fouling, corrosion and erosion, as well as turbine section hot gas path corrosion. This resulted in poor engine reliability, reduced availability and premature engine overhaul and/or replacement. All of which severely impeding the long term platform strategic planning for both production and maintenance.

In Nov-16 the poor filtration provided by the high velocity bag system resulted in a catastrophic failure of GT2 at only 1/3 of design life (<12,000 hours). The root cause of the failure being inlet guide vane seizure and in turn compressor section imbalance and ultimately blade liberation. This resulted in irreparable damage and a new replacement engine was required, incurring unplanned long-term shutdown and significant unbudgeted costs.

Major contributing factors:

1 I The existing original air intake filtration systems were high velocity (7,650 m^3/h per cell), with an inadequate filtration efficiency classification (G4 in accordance with EN779: 2012), leading to poor compressor protection against sea salt aerosols, salt in solution and hydrocarbons

2 I The high levels of hydrogen sulphide (H_2S) present in the sour gas fuel were mixing with salt laden intake air and leading to hot gas path corrosion of the turbine.

N-hance, the first in industry design high efficiency air filter will enable improved reliability, considerable cost savings and help to increase overall offshore asset efficiency.

N-hance filters were installed into the existing filter house with no hot work.

Solution

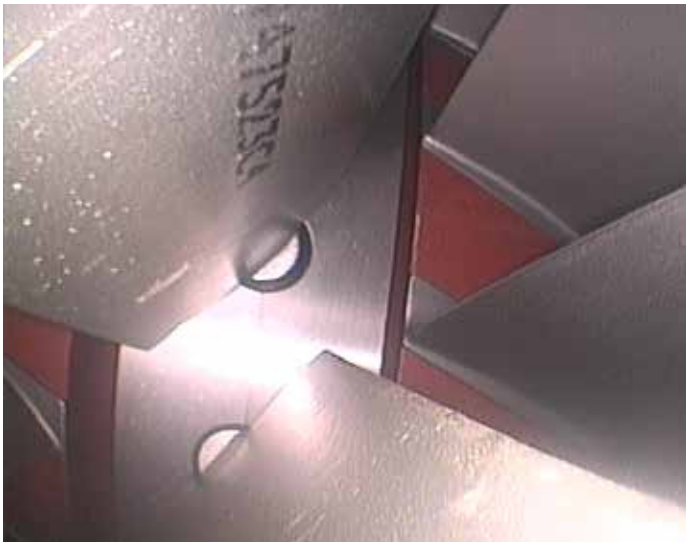
BP was aware that AAF International had developed a new EPA E12 high velocity filtration solution. Critically this could be installed within an existing high velocity housing and with no initial dP penalty, therefore negating the need for a larger housing replacement. As a consequence of this failure on GT2, BP was expediting the GT OEM for fast-track delivery of a replacement engine and approached AAF to determine if this new technology (N-hance®) could be urgently deployed in a field trial as a technology collaboration initiative.

The longstanding relationship between AAF and BP, stemming from joint development of AAF's HydroCel EPA E12 product in the early 2000s. This provided the operator with confidence in AAF's extensive EPA filtration operational experience offshore. The AAF HydroCel EPA E12 product has been the offshore industry's EPA benchmark since its introduction in 2003 and made the easy decision for BP to pilot AAF's revolutionary new N-hance® technology one of minimal risk.

The N-hance® filters and conversion parts were delivered to BP within 5 weeks of PO and commissioned along with the new GT2 engine on BP Clair in February 2017.

The first installation: All of the rear 'V' panels were installed at this point and four of the front 'V' panels.

Prior to 2017: Engine protected with low efficiency filter bags. Borescope has completed after 2,813 operational hours.



Post 2017: Engine protected with N-hance filters. Borescope has completed after 8,285 operational hours with zero offline water washes.

Successful Outcome

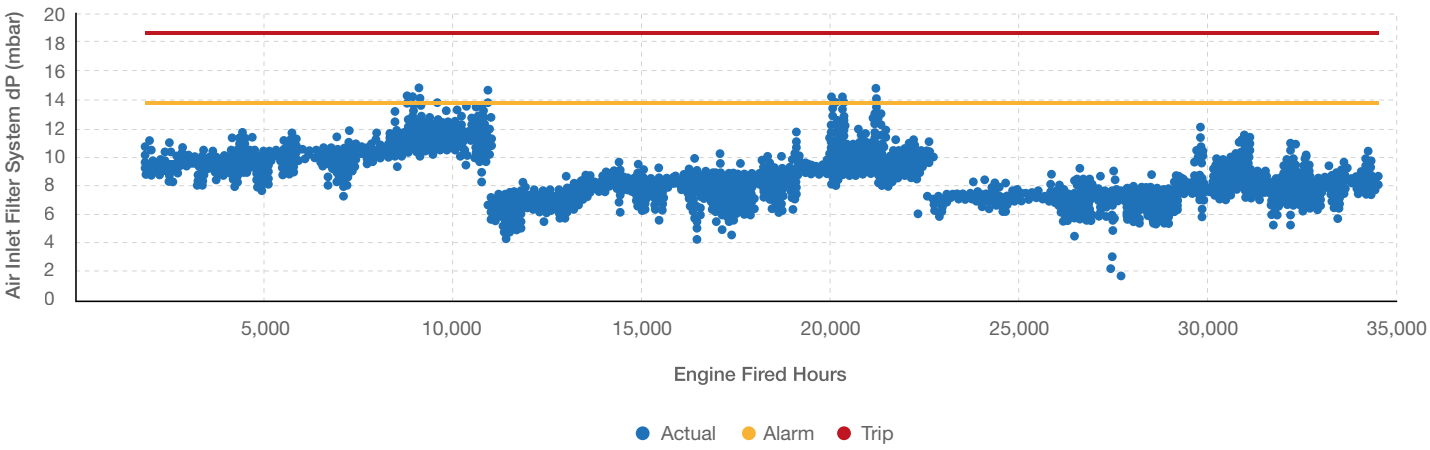
Conversion in 2017 was successfully completed without incident and upon start-up system pressure drop was confirmed to be equivalent to the original GT OEM high velocity bag system. At the time of writing GT2 has been installed with N-hance filters (three sets in total, each set installed for approximately 11,500 hrs - see graph below for details) for 6½ years and operated successfully for 35,000 hrs since commissioning with zero water washes (online or offline).

After the upgrade the unit was borescoped at 8,285 hrs and feedback from the BP Rotating Equipment Engineering Team Leader stated, “We’ve just completed an inspection on Clair GT2 and it’s spotless. I know that won’t be a surprise to AAF but it’s a tremendous improvement for us.”

Summary of 35,000 operational hours:

- Zero online or offline compressor water washes
- Reliable GT operation with no unplanned shutdowns.
- System pressure drop has remained stable, even during periods of sustained elevated RH / fog. In the month of Jun/Jul 2017, RH was consistently above 95% with no GT alarm or trip.
- Pressure drop has remained stable over the 35,000 hours.
- Engine cleanliness has allowed operating hours to reach 35,000 hrs without water washing, in comparison the previous engine failed after 12,000 hrs!

Offshore Field Trial Data: 15 MW Gas Turbine



- Initial Dp equivalent to high velocity air filter bags.
- Stabilised pressure drop over prolonged operational period with fluctuating ambient conditions and adverse winter weather.

Features & Benefits

Challenge	Performance
Engine cleanliness	Assured EPA E12 efficiency
Media	Advanced hydrophobic and oleophobic
Drainage	Improved performance over existing offshore solutions
Water barrier	Gaskets, media and construction tested and proven
Pressure drop	Equivalent to existing high velocity bag system
Lifetime	>12 months
Installation	Fits within the existing high velocity housing – no hot work required
Materials	Corrosion resistant, suitable for the offshore environment

35,000 Hrs Later

Over six years after the original installation and BP still never water washed the engine!

The Borescope was completed after 35,000 hours of operation since the N-hance filtration upgrade.

Economic Benefits to the Operator

- Reliable power generation preventing lost production due to trip
- Increase in engine availability resulting from a reduction in unplanned downtime and shortened shutdown periods
- Retained power output (compressor efficiency) and heat rate
- Elimination of GT failure at 1/3 of design life
- Total cost of ownership significantly reduced
- Lower emissions

"The upgrade project has enabled improved reliability, cost savings and will feed into the reformation of outdated air filtration standards as well as playing a part in helping to achieve offshore asset efficiency of 90%."

Acknowledgments: AAF would like to acknowledge and thank the team at BP, namely Andrew Sharples, Tim Vickers and Laura Steedman. The results of the N-hance® upgrade were so profound that the BP Asset team were presented with an internal people's choice award for innovation and improved reliability.