Gas Transmission

Using Data for Smarter Operation of a Gas Transmission Network – keeping the gas flowing

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An Introduction to National Grid

National Grid owns and operates the high pressure gas transmission system across England, Scotland and Wales and the electricity transmission network in England and Wales (as well as operating the electricity transmission system in Scotland)

The gas natural transmission system comprises approximately 7500 km of buried high pressure gas pipeline operating at pressures up to 94 barg

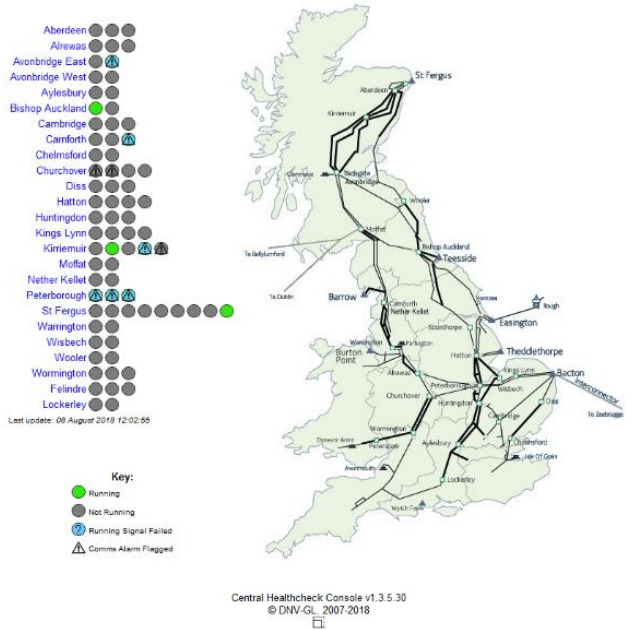
Gas compression resources are located across 23 compressor stations and 1 receiving terminal

The gas National Transmission System typically transports three times more energy than the electricity transmission system

Remote monitoring of a National Transmission Network

Solution Requirements

- 71 compressors
- 24 locations
- Mixed fleet of machinery
  - Gas turbines
  - Electric motors
  - Various OEM & age
- Most locations are remotely operated
- Continuous monitoring
  - Condition
  - Performance
  - Environmental
  - Reliability



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alert monitoring software

Functionality

- Interface with a wide range of local control systems
- Custom communications protocols, at least 10 second resolution of data points
- KPI reporting
- Real time calculation database
- Live gas composition (required for emissions calculations)
- Digital twin of every machine
- Alarm status on every machine
- Unlimited historian data
- Every tag in the country logged every 10 seconds since 2004
- Common data format
- Statistical calculations to give hourly, daily, monthly and annual reporting figures
- Dashboard displays

KPI Reporting

- Every start, stop, trip automatically recorded
- MTBF, start probability and MTTR calculated and reported on a monthly basis

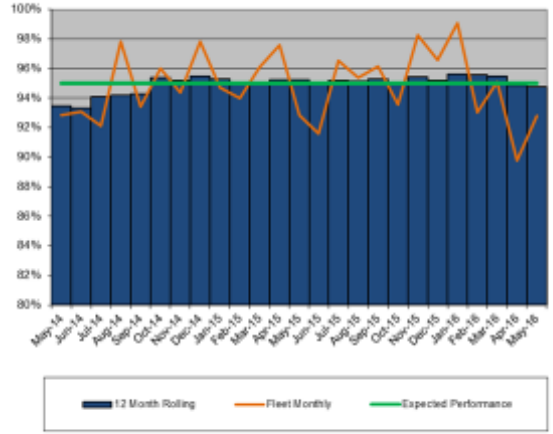
Gas Transmission Asset Management – Operations — **May 2016**

Compressor Start Probability (UKT-51)

Produced By: DNVGL, Simon Kidd
Responsible Manager: John Trounson

GGGGAA

R <90% | A >=90% <=95% | G >95%



Background Information
KPI is a measure in % of the number of times during the month that compressor units across the fleet start successfully.

Current Analysis
There were 103 successful starts and 8 starting trips recorded across the fleet.

- AVONBRIDGE WEST UNITA 1 Trips: CDP valve position error
- BISHOP AUCKLAND UNITB 1 Trips: Other Station Failures - FMV failure
- KIRRIEMUIR UNITB 2 Trips: Compressor Seal, Seal Oil DP
- ST FERGUS UNIT1D 2 Trips: Control System, shutdown sequence failure
- ST FERGUS UNIT3B 1 Trips: Suspected common VSD trip
- ST FERGUS UNIT3B 1 Trips: Other Station Failures - Process Condition, discharge temp Hi

Monthly Scores: 93% (FYTD = 91%)
Target > 92%
Last Month: 90%

	Fleet
Start Trips	8
Successful starts	103
Start Probability	93%
12 month trend	95%
Start Frequency	29 hrs
12 month SF	30 hrs

NTS Area	Hours	Run Trips	Start Trips	MTBF (hrs)	Start Prob (%)	FYTD MTBF (hrs)	FYTD Start Prob (%)
Scotland	2505	14	8	179	89%	193	90%
West	134	0	0	134*	100%	151	86%
East	349	1	0	349	100%	518	100%

* No running trips recorded this month / financial year so quoted figure represents area run hours

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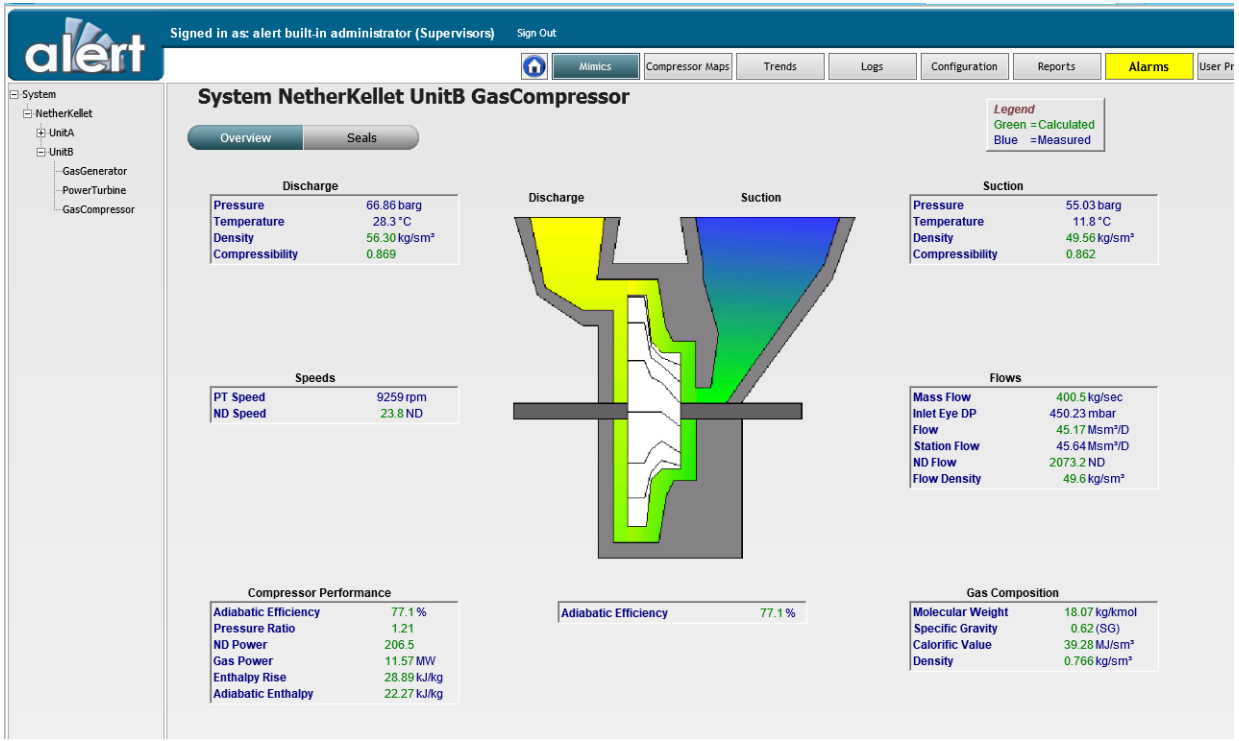
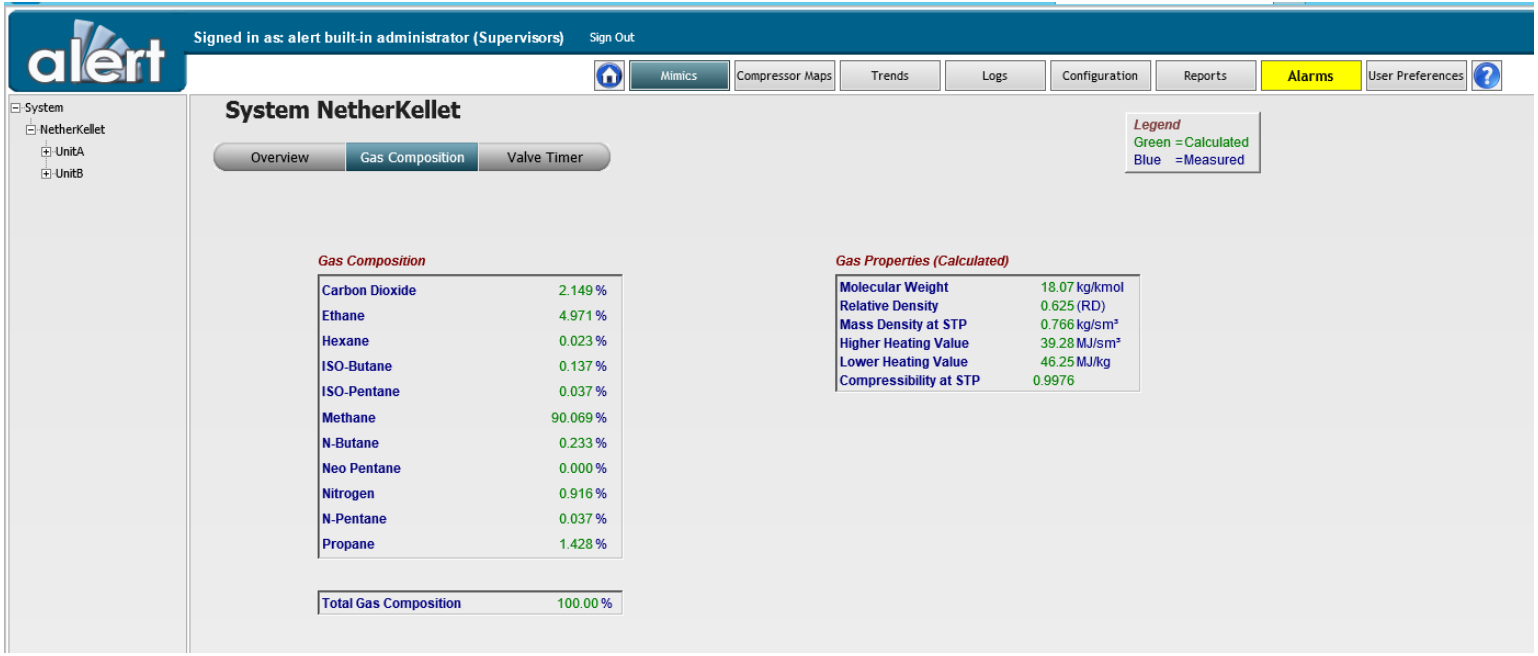
Real time calculations

- Adding value to data
- GT and compressor performance
- For example:
- Suction T&P, discharge T&P, flow, gas composition ➔ compressor efficiency



Live gas composition

- Gas composition monitored
- Gas quality & gas properties calculated for standard and operational conditions



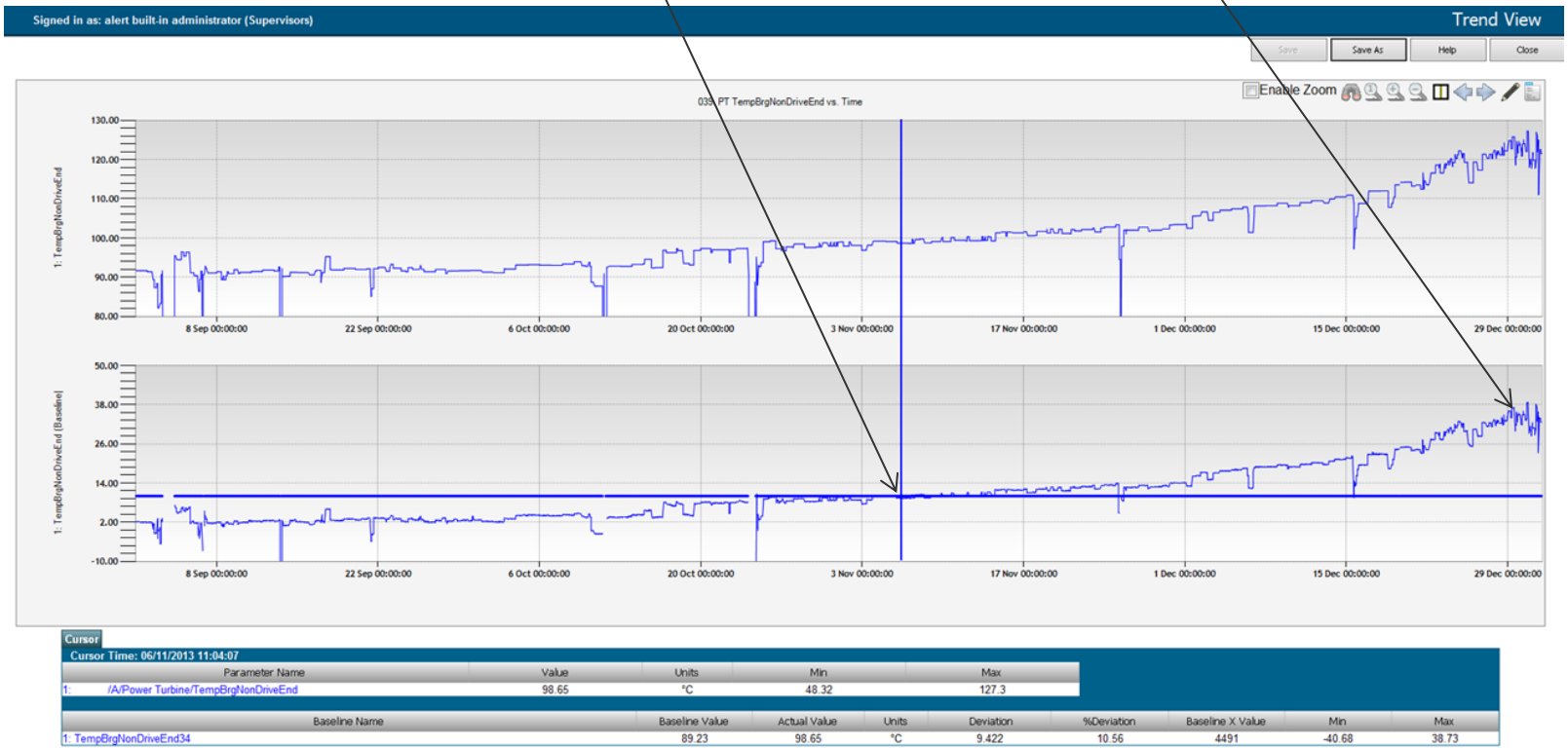
Digital Twin

- For every key parameter, digital twin gives expected values at current ambient and operational conditions
- Key parameters include instrumented mechanical and calculated performance tags
- Allows accurate assessment of any degradation in performance and assessment of the value of any maintenance interventions (e.g. blade washing)
- Provides early warning of any mechanical degradation thus helping improve maintenance planning
- Allows effective condition based maintenance instead of simple time based maintenance

Bearing Temperature - Digital Twin

Temperature deviation reported

Bearing replaced



Case Study – Performance degradation, wash scheduling

- Wash scheduling traffic light system developed for operator display
- Additional fuel usage and costs tracked and displayed
  - Current example £387/hour - £9,288/day - £65,016/week - £260,064/month - £3 Million/year
  - System tracked £173k extra fuel used when wash required
- Wash run hours tracked and next wash estimated
- Better planning of wash outages

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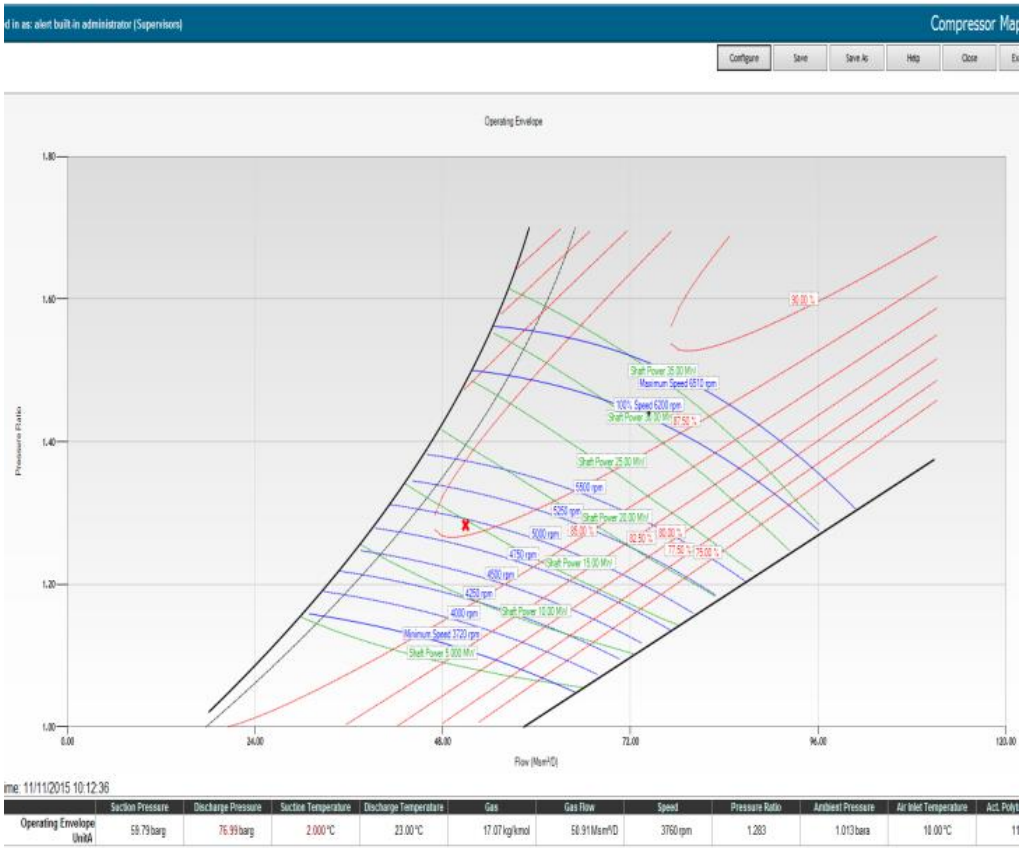
Compressor Map

- Real time and user simulation options
- Accurate understanding of compressor performance
- Surge / choke margin tracking



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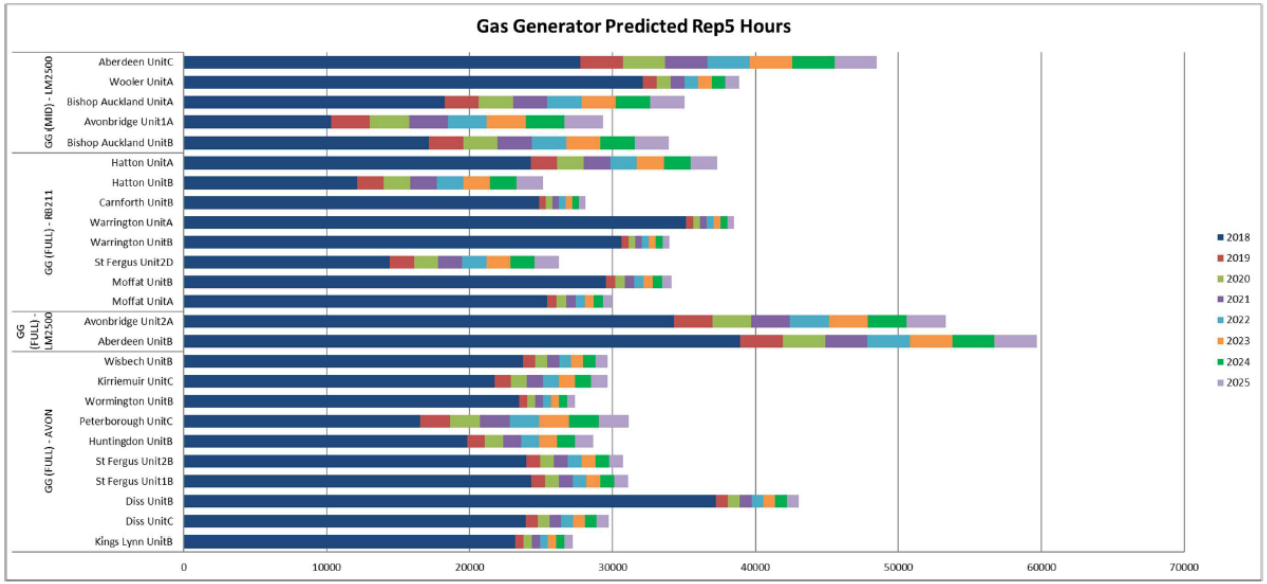
Long term maintenance planning

- Accurate age of every machine – using hours, starts and trips
- Accurate future operational forecast of different sites based on historical demand
- Calculate current hours and expected hours at the end of each year in the future to predict overhaul periods and budgets and allow setting up of effective overhaul contracts



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Environmental reporting

- Dashboards give real time values of every reportable emissions parameter (e.g. NOx, CO)
- Alarms generated for any predicted hourly limit exceedances
- Immediate notification of any permit breaches – e.g. loss of communications
- Helps to avoid the severe penalties which can be imposed for deviations from permits
- Annual reporting information available in Excel format at click of a button

Historical data assessments

- Following a major failure – how do we know this won't happen again?
- Big data analytics
- Relevant data already stored and in a common format

Historical data assessments

- Fatigue failure assessment
- Comparison of life of failed unit to every other comparable machine in the fleet
- Identify data driven outliers following failure investigation
- Risk assessment of remaining fleet

- Data supported discussion with OEM following “choke” related failure on a relatively new unit
- Followed by assessment of rest of fleet

Future Research

- Trip predictor research
- Will a gas turbine start when we need it to?
- Will a machine still be running in an hour?
- What is our real time risk of failure to supply?
- Data available – every start, stop, alarm, trip of every machine for 14 years. Every reading of every parameter every 10 seconds
- Using machine learning to build algorithms to predict trips and failed starts

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