

Performance Upgrade of Siemens SGT-700 Gas Turbine for More Power and Higher Efficiency

SGT-700 previous named GT10C

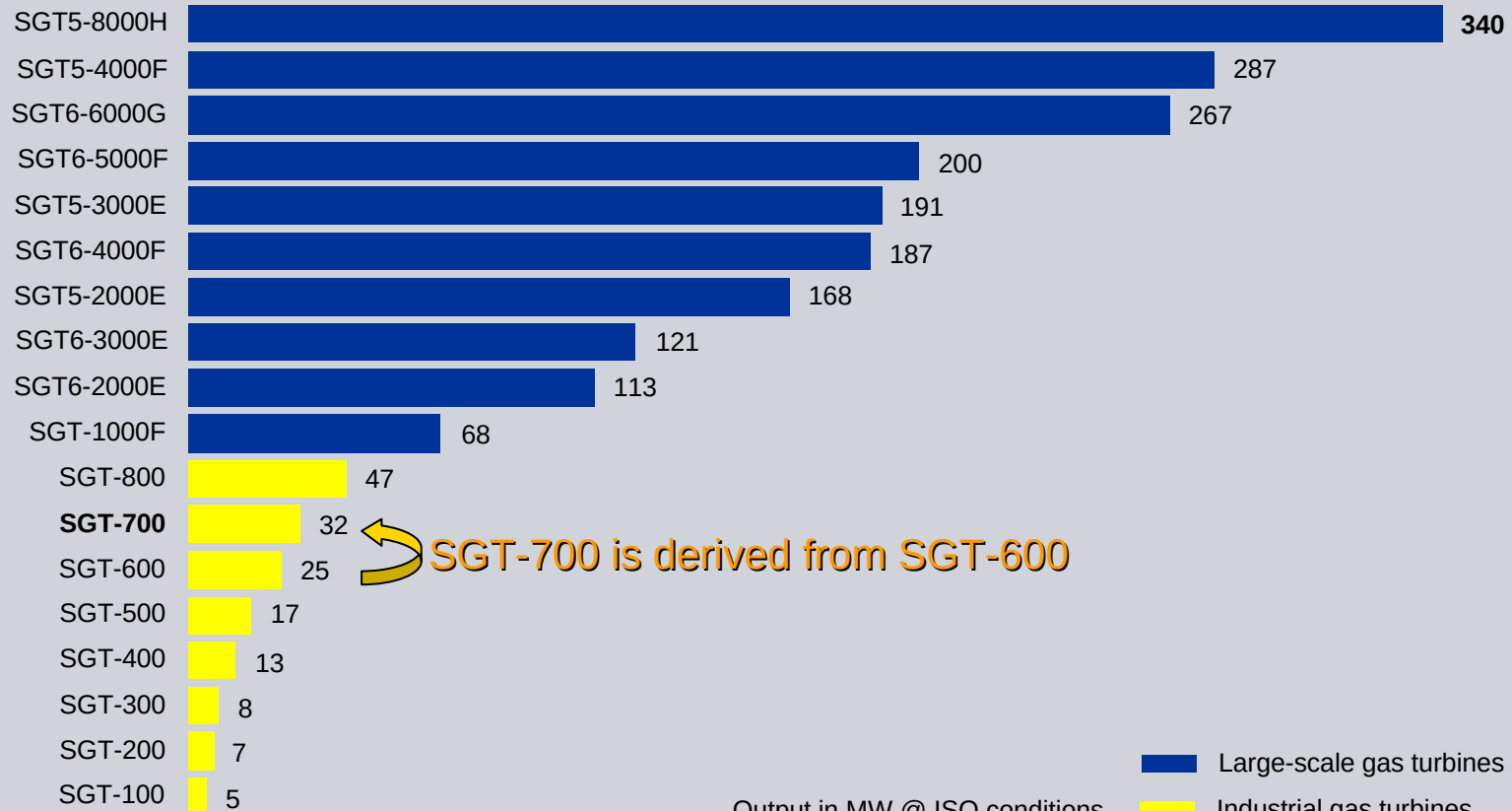
09-IAGT 301

Anders Hellberg, Product Manager, SGT-700

Siemens Gas Turbines

Complete product portfolio from 5 to 340 MW

SIEMENS



Output in MW @ ISO conditions

SGT-700 Development timeline

Based on SGT-600 design

Specification ready, 30 MW

Design, validation, manufacturing

New rating 32 MW

Siemens

Fleet leader
30 000 hours
Fleet
180 000 hours

1997

1998

1999

2000

2001

2002

2003

2004

2005

2006

2007

2008

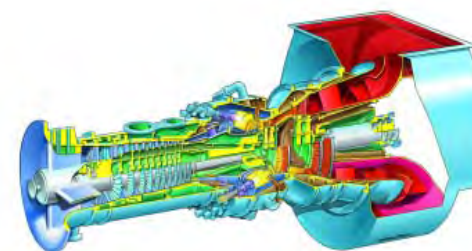
2009

Launch to market

1st unit started

1st unit sold

33 units sold



SGT-600 & SGT- 700:s spread worldwide

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SGT-700 Operating statistics

Average over a life cycle:
98,5% reliability, 97% availability

- including GT & auxiliaries
- not considering lease engine possibility.

Data last quarter

- Reliability 99,7%
- MTBF 1893 hours

This level is backed up with long term measurement on the SGT-600 and SGT-700. SGT-600 has the same basic design and package as SGT-700



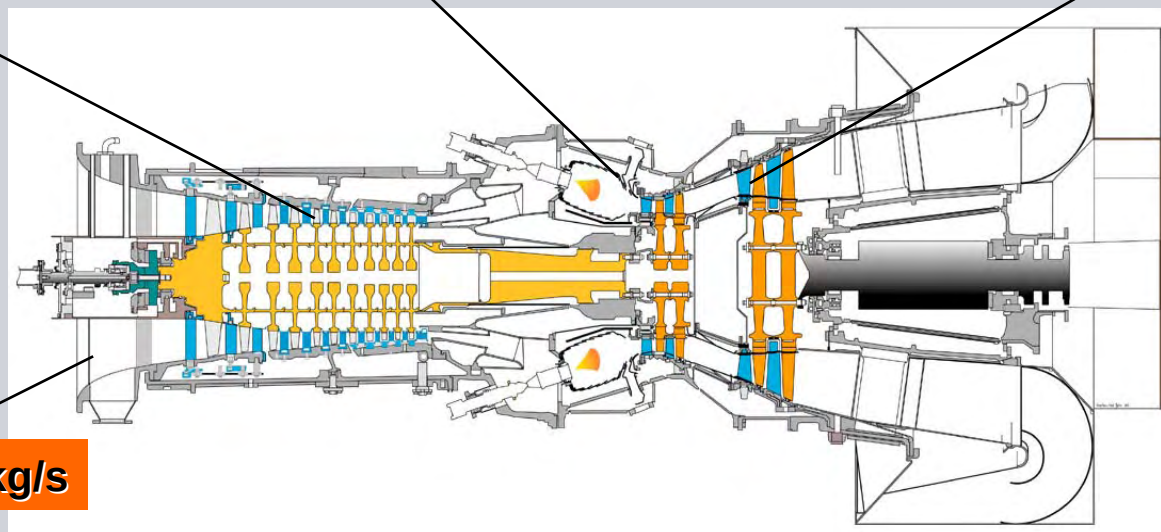
SGT-700 Performance

11 stage compressor
- pressure ratio 18:1

3rd generation DLE technology

- NO_x on gas 15 ppmv (15% O₂)
- NO_x on liq. 42 ppmv (15% O₂)

Power turbine
6500 rpm

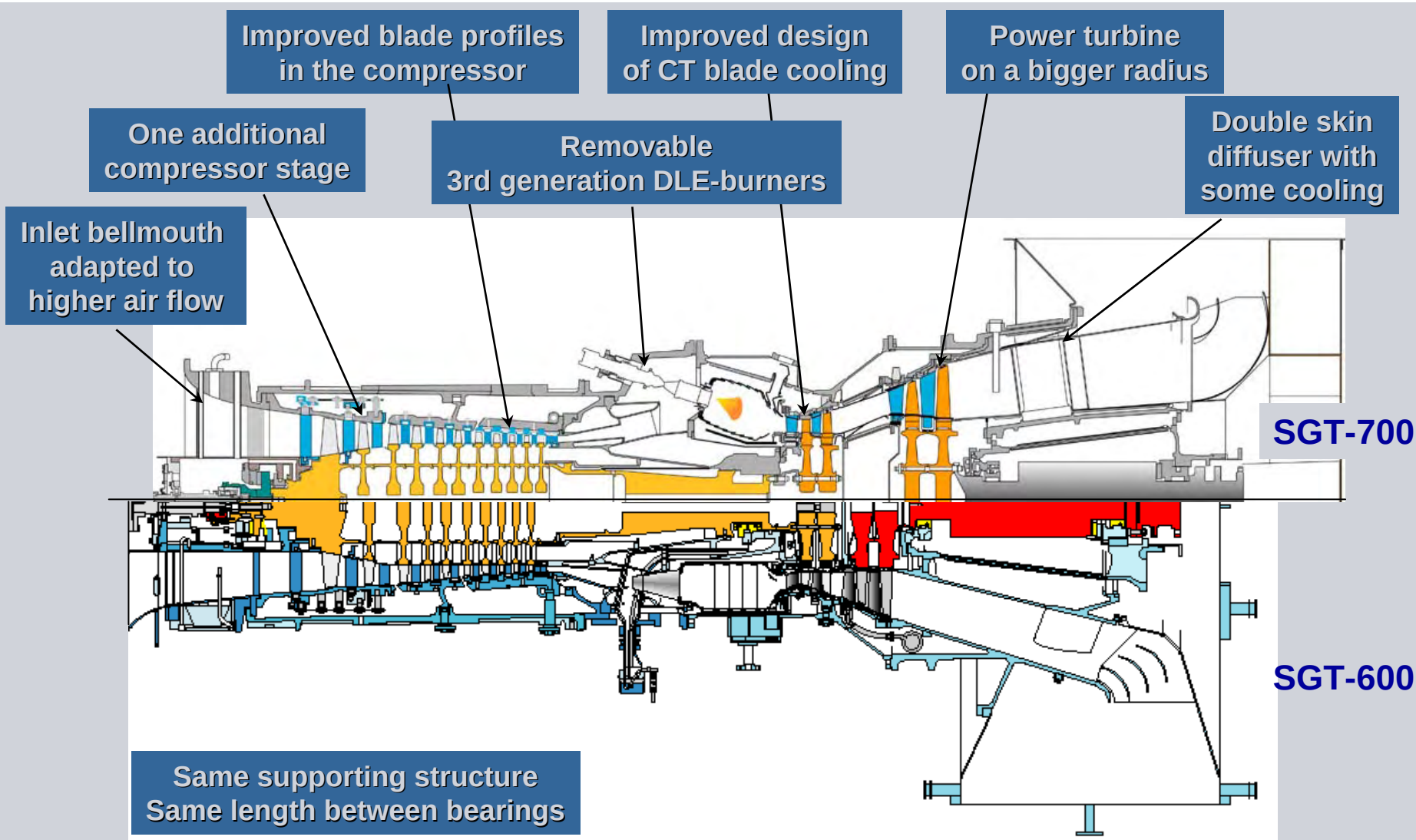


Mass flow 92 kg/s

Mature rating (shaft)

Power,	32,0	MW
Efficiency	37,4	%
Exhaust temp	528	°C

SGT-700 versus SGT-600



Dry Low Emission performance (no change)

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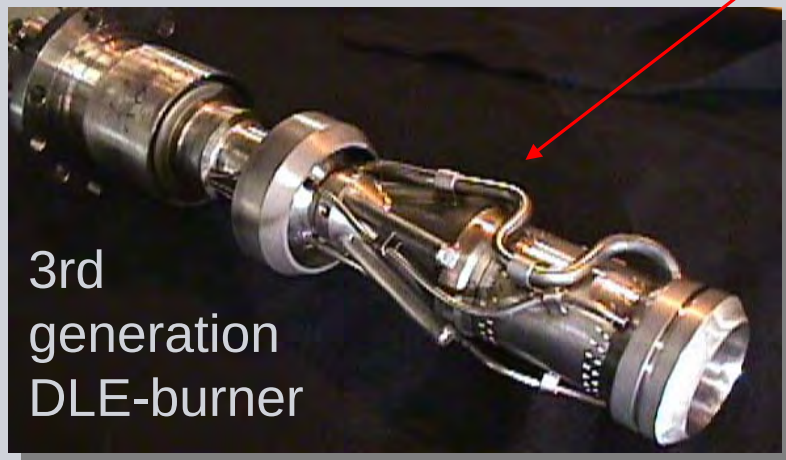
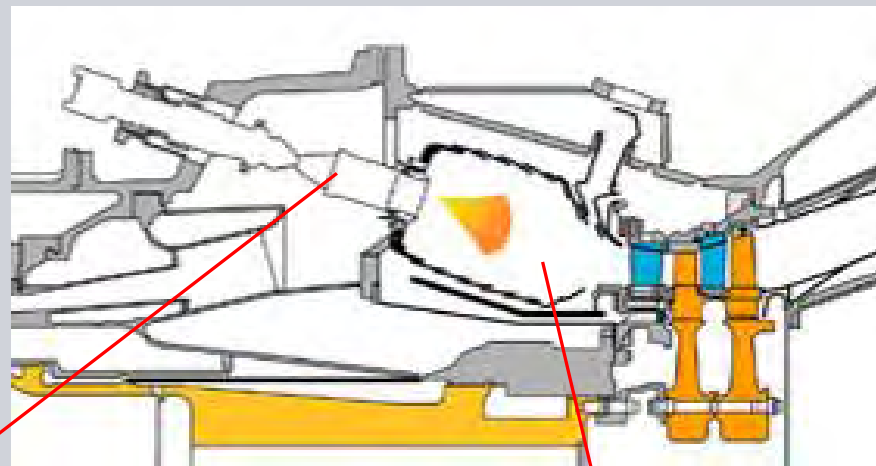
3:rd generation DLE

Gas fuel operation

- 15 ppm NO_x, dry

Liquid fuel operation

- 42 ppm NO_x, dry



Film-cooled
sheet metal
combustor
based on SGT-
600 design

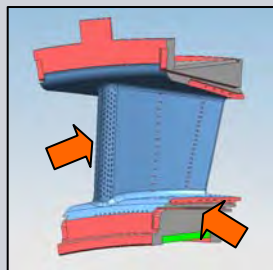


No change for new rating

A. Hellberg

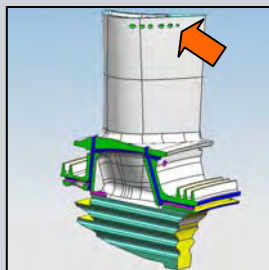
Modifications for SGT-700 mature 32 MW power

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Turbine Vane 1

- Film cooling air holes optimized



Turbine Blade 1

- Changed pos of tip cooling holes



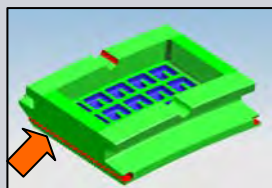
Turbine Vane 2

- Cooling air optimization
- Improved sealing



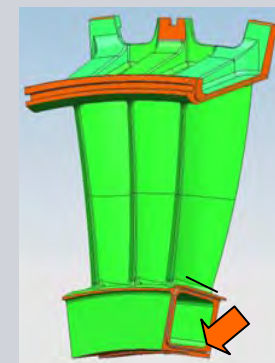
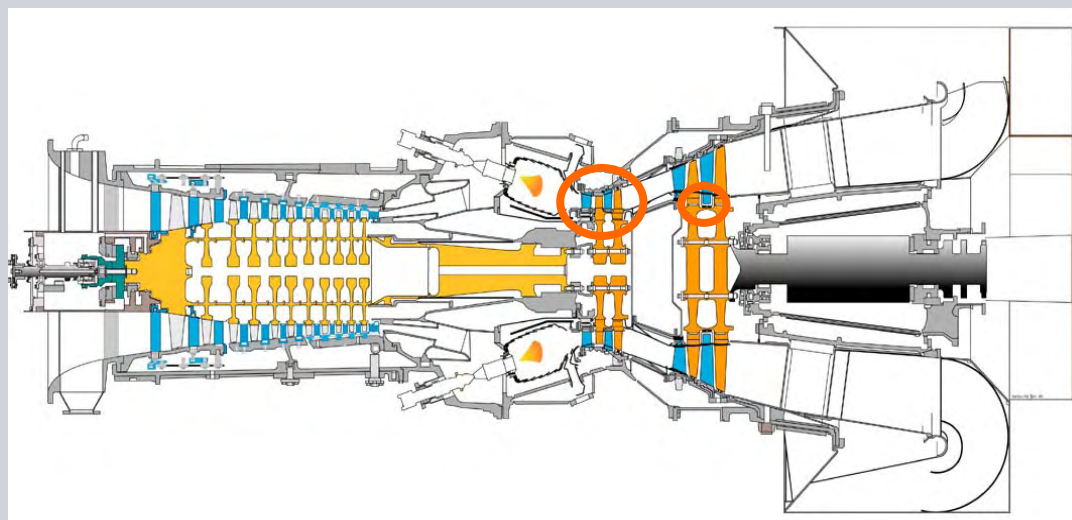
Turbine Blade 2

- No change



Heat Shield 1

- Changed pos of sealing strip



Turbine Vane 4

- Additional sealing strip inner platform

Higher power and efficiency

The compressor turbine efficiency have been improved by:

- Reduced cooling air from areas which has been over cooled
- Improved sealing - reduced leakage

*Reduction of cooling air and leakages
gives more air to combust and more
flow through vane 1*

*Higher power and efficiency without
increase of firing temperature.*



SGT-700 Verification

Verification test 1:st unit 2001-2002

- Performance, component life and emissions

Turbine temperature 2003

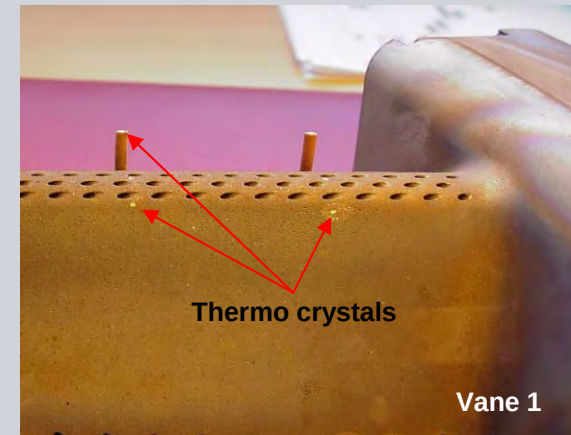
- Thermo crystal test, detailed information

Fleet leader passes 20 000 hours 2007

- No remarks

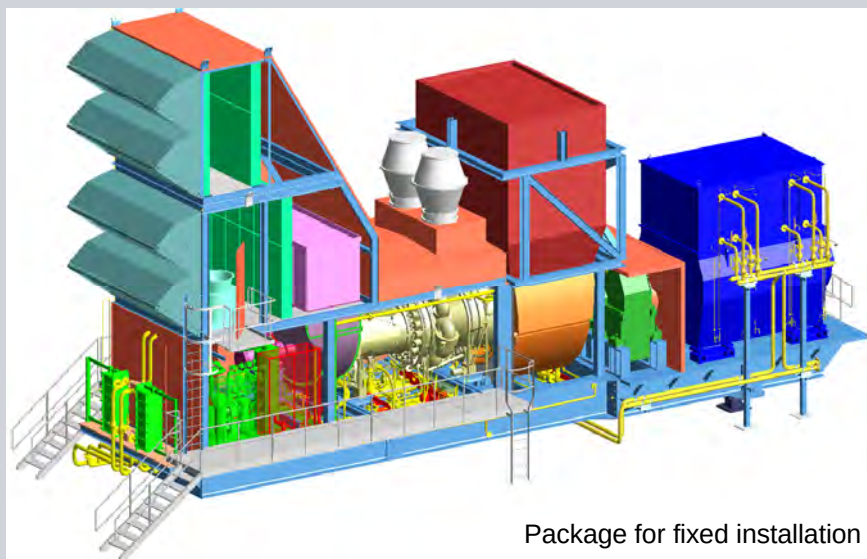
Mature rating test 2008

- Stable combustion on all loads and transients
- Power, efficiency and emissions confirmed
- Function of cooling system confirmed
- Component design validated

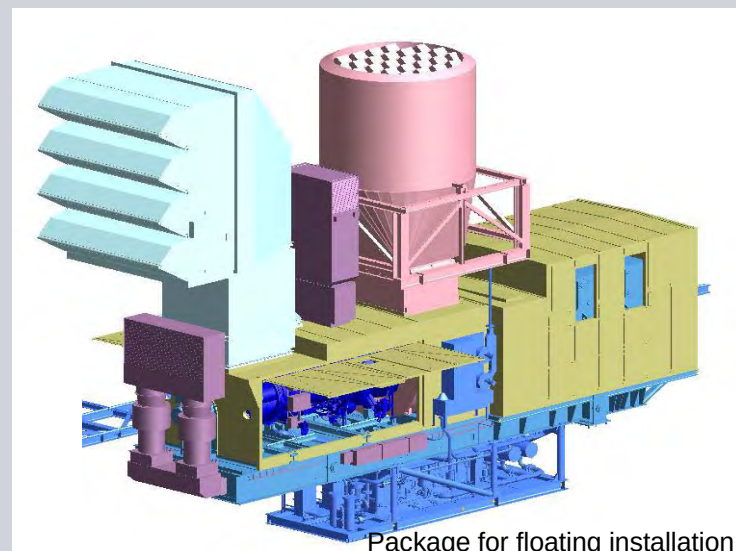


Package improvements for SGT-600/700 Features

- 24h GG exchange for increased availability
- Commissioning time on site decreased
- Reduced weight and footprint
- Improved API fulfilment
- Solution for roll & pitch
- Same package for SGT-700 and SGT-600
- Several standard options to meet different requirements



Package for fixed installation

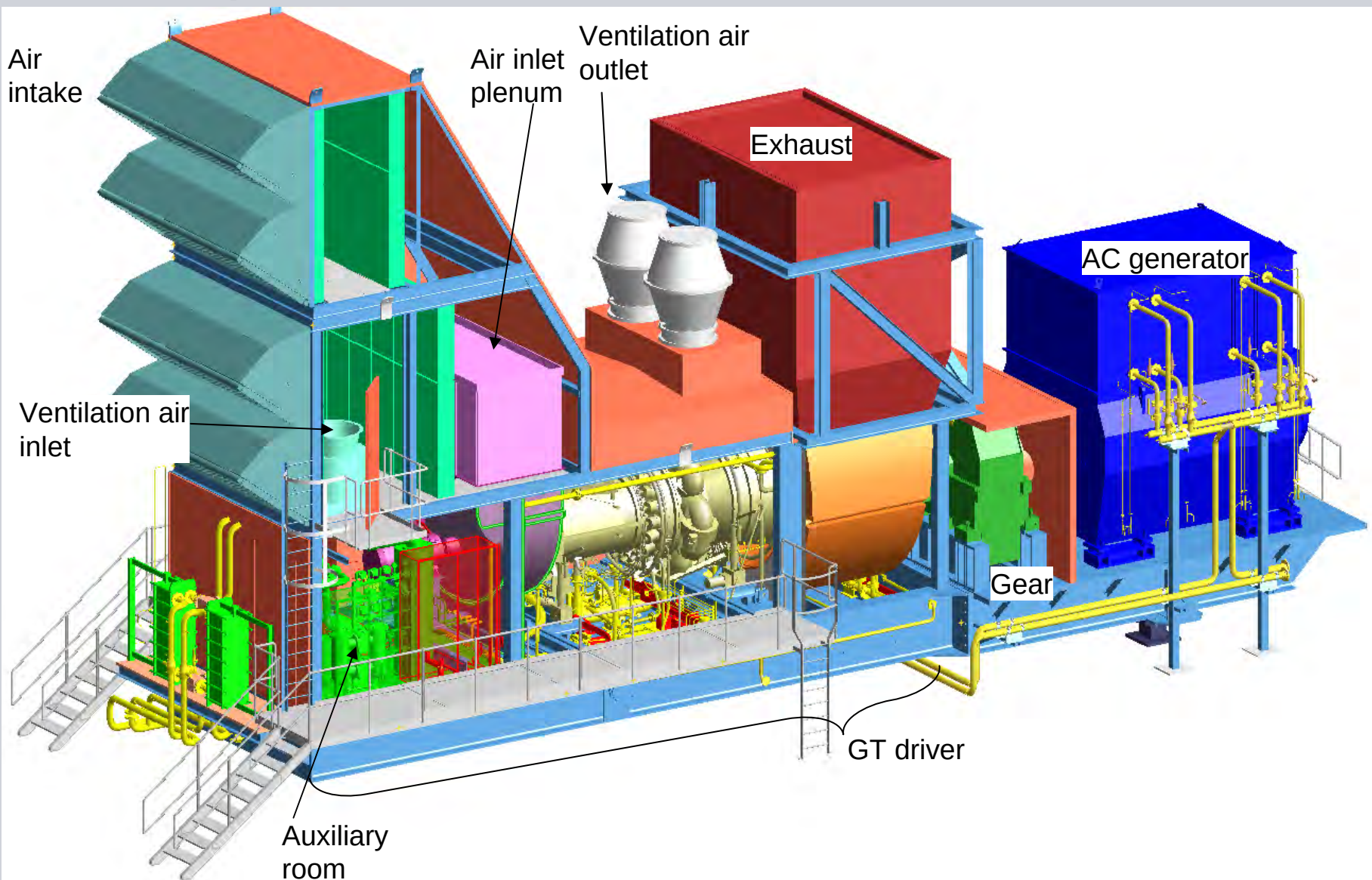


Package for floating installation

SGT-600/700 Package

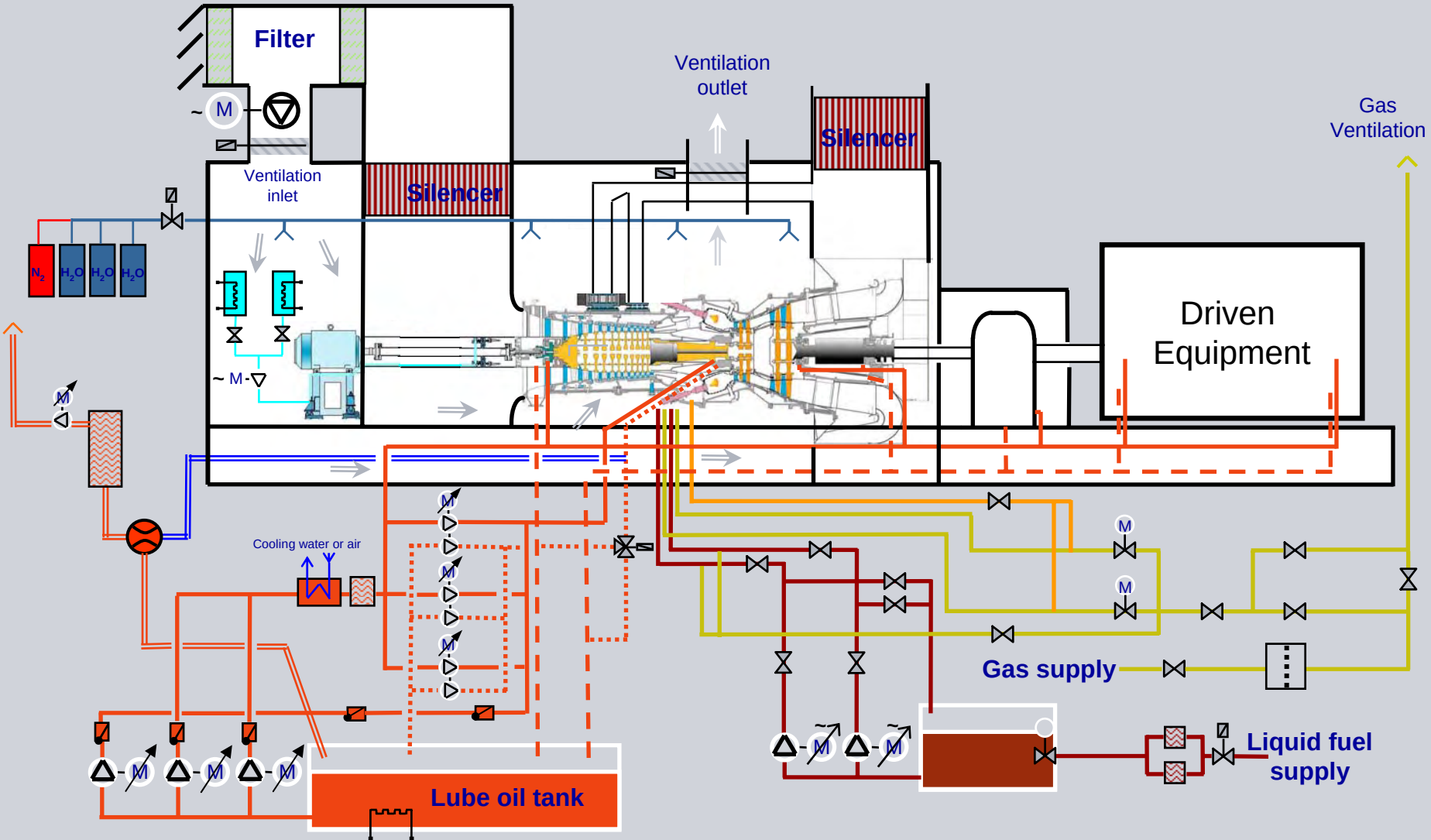
Main components

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SGT-600/700 Package, Process diagram

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Maintenance plan

Based on operating conditions

- Maintenance at site or local workshop
- Gas Generator exchange at 24 h

EOH = Equivalent Operating Hours

H = Operating hours

C_x = Stress factor

C_f = Fuel factor

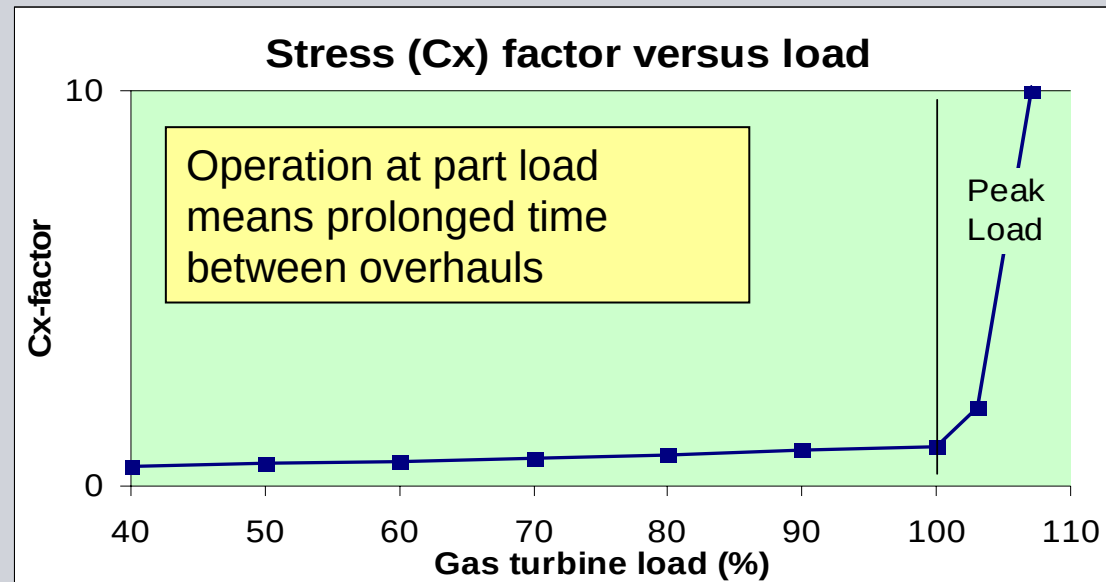
EOC = Equivalent operating cycles

C_n = Start and stop factor (1-10)

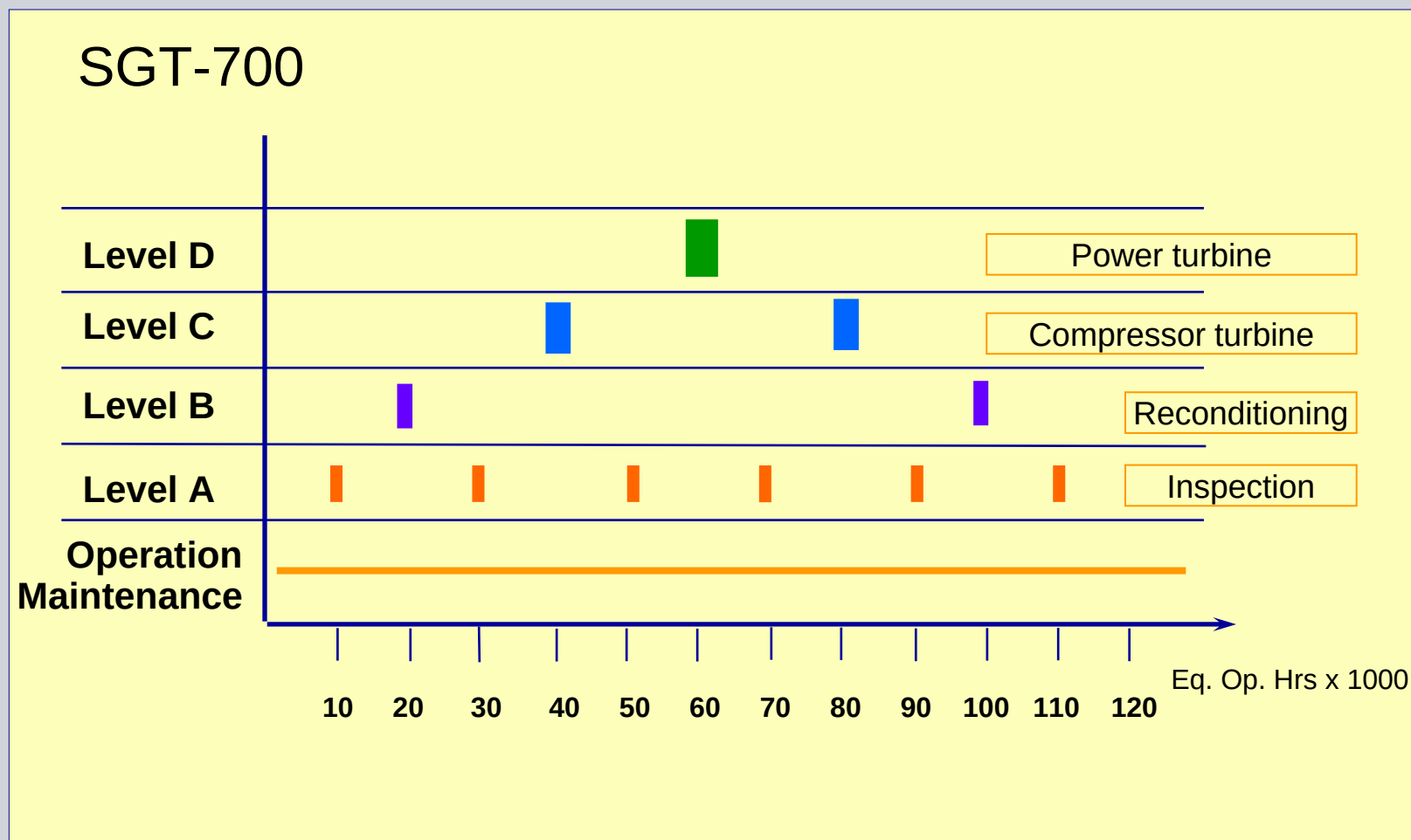
N = Number of start/stop cycles

$$EOH = C_x \cdot C_f \cdot H + 5 \cdot EOC$$

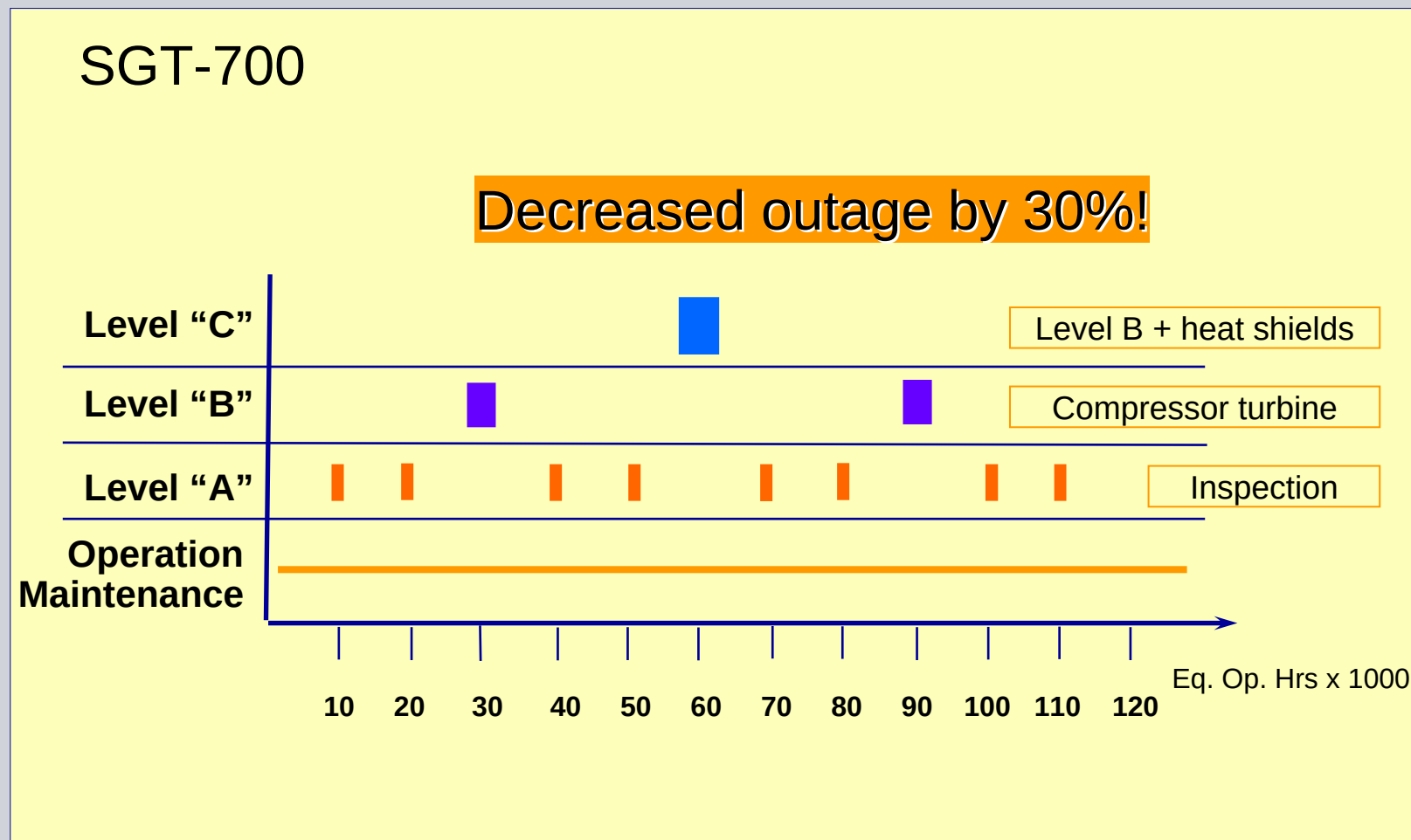
$$EOC = C_n \cdot N$$



Basic Maintenance Plan



Extended Intervals Maintenance Plan



SGT-700 Fuel flexibility

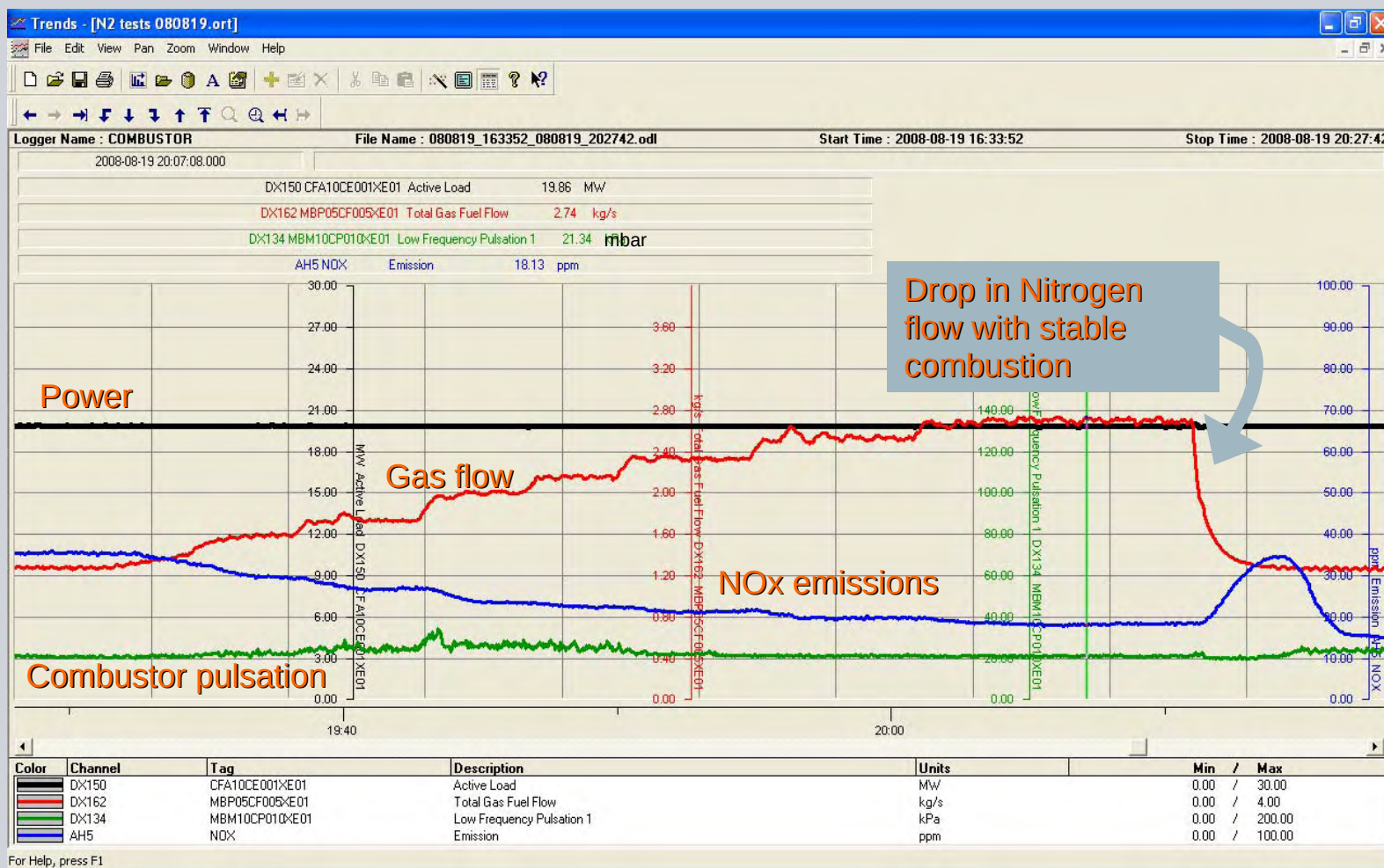
Engine and test equipment

Operation on Nitrogen rich gas

- The test was performed with a standard SGT-700 gas turbine with standard DLE combustion system.
- No modifications were made on the gas turbine
- Minor software changes in control system was made to handle varying fuel composition during test.



Results 20 MW (40% nitrogen)



Summary

- 👍 New rating, 32 MW
 - 👍 Higher efficiency, 37,4 %
 - 👍 Robust DLE system
 - 👍 Single lift package, pre-assembled
 - 👍 Fuel flexibility
 - 👍 Improved Maintenance
 - 👍 Excellent fleet experience
 - 👍 New rating in operation
- ➔ More Power
 - ➔ Less fuel consumption
 - ➔ Reliable
 - ➔ Short time at site
 - ➔ Proven
 - ➔ Less downtime
 - ➔ High reliability

– Efficient, Environmental and Economic Power



Thank you for your attention!

