Extended load range operation of GTs as a tool for controling electricity grid equipped with renewable energy suppliers.

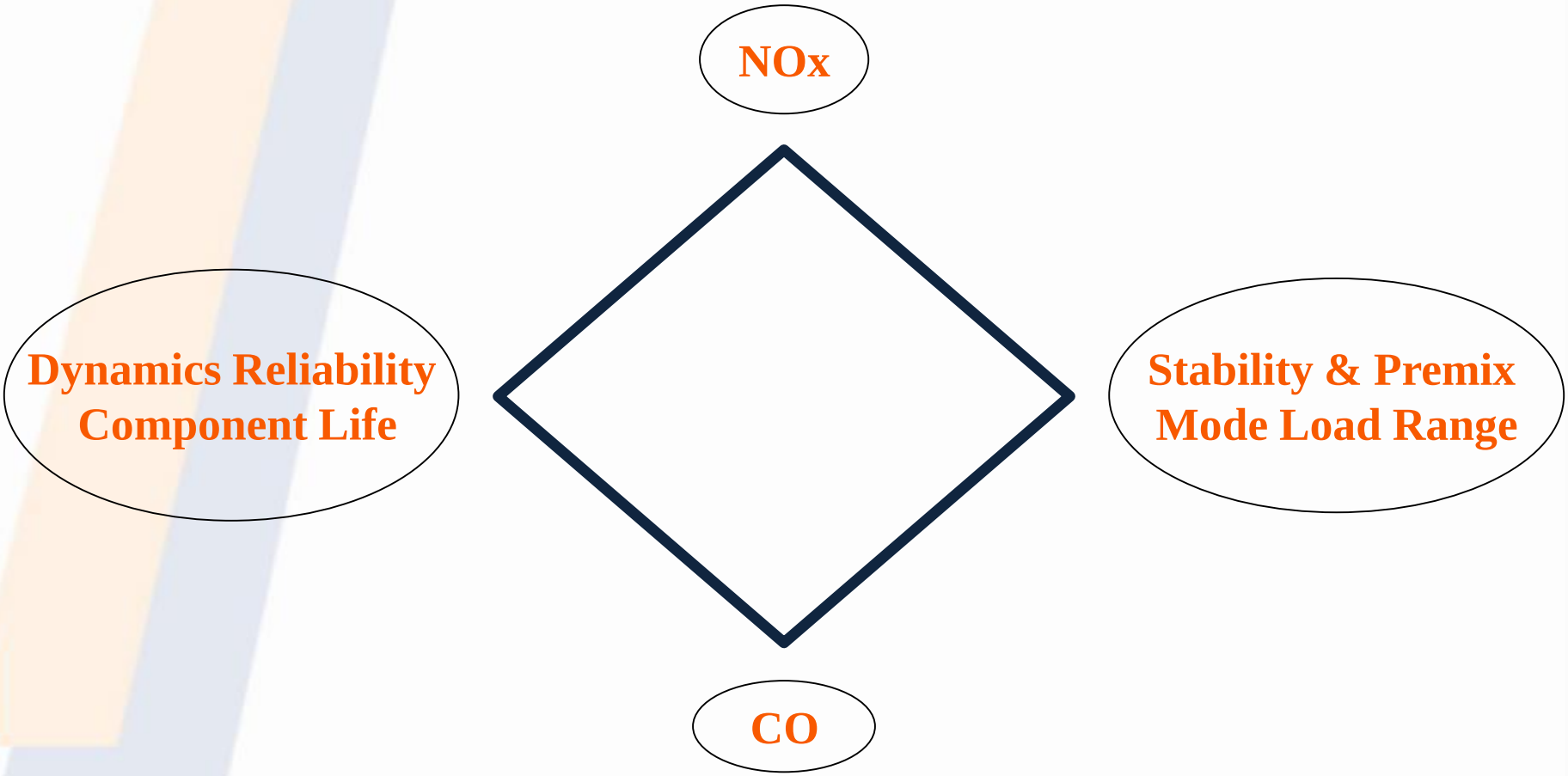
Boris Chudnovsky
Ilya Chatskiy
Alex Lazebnikov
IEC

THE 18th ISRAELI SYMPOSIUM ON JET ENGINES AND GAS TURBINES

Methodology of NOx emission reduction

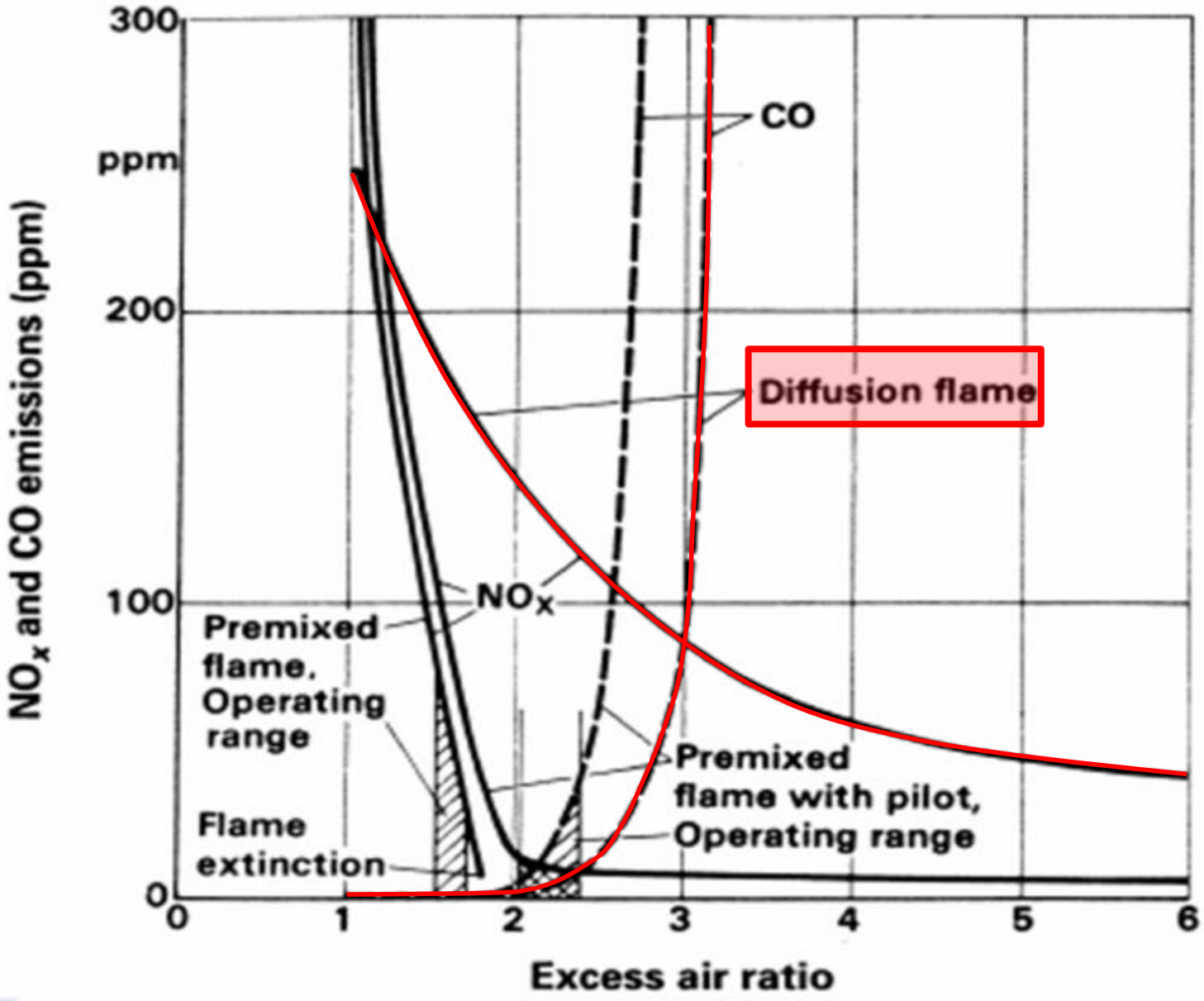
- Traditional methods of NOx reduction in combustion exists:
  - Modification of the firing system to Lean Premixed Combustion (**DLN** – **D**ry **L**ow **N**Ox)
  - Injection of water into the firing system (WLN – **W**et **L**ow **N**Ox)
  - Post combustion flue gas treatment to remove NOx (such as SCR systems – **S**elective **C**atalytic **R**eduction)

Requirements for stable combustion

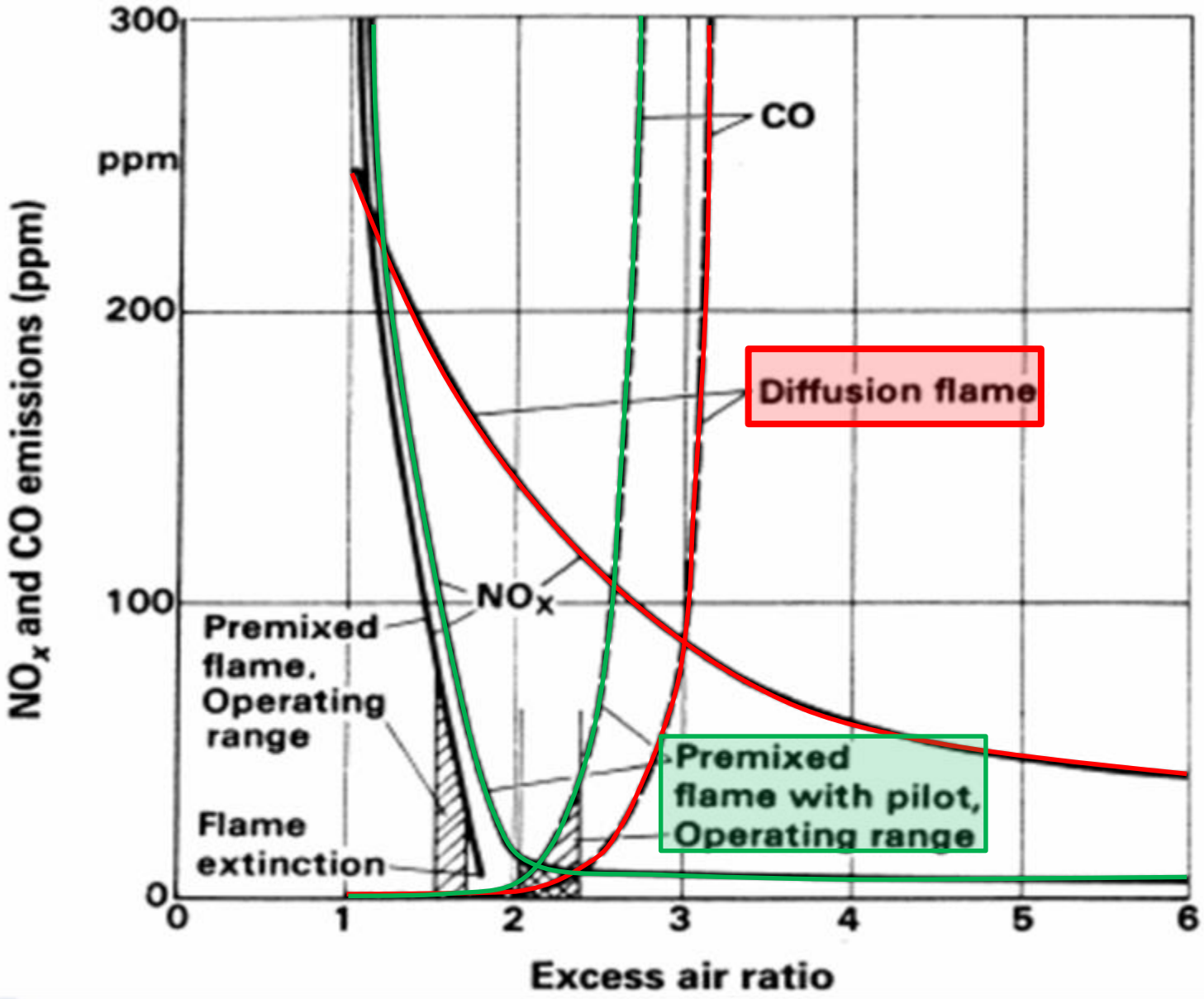


Design Technology – A Four Sided Box

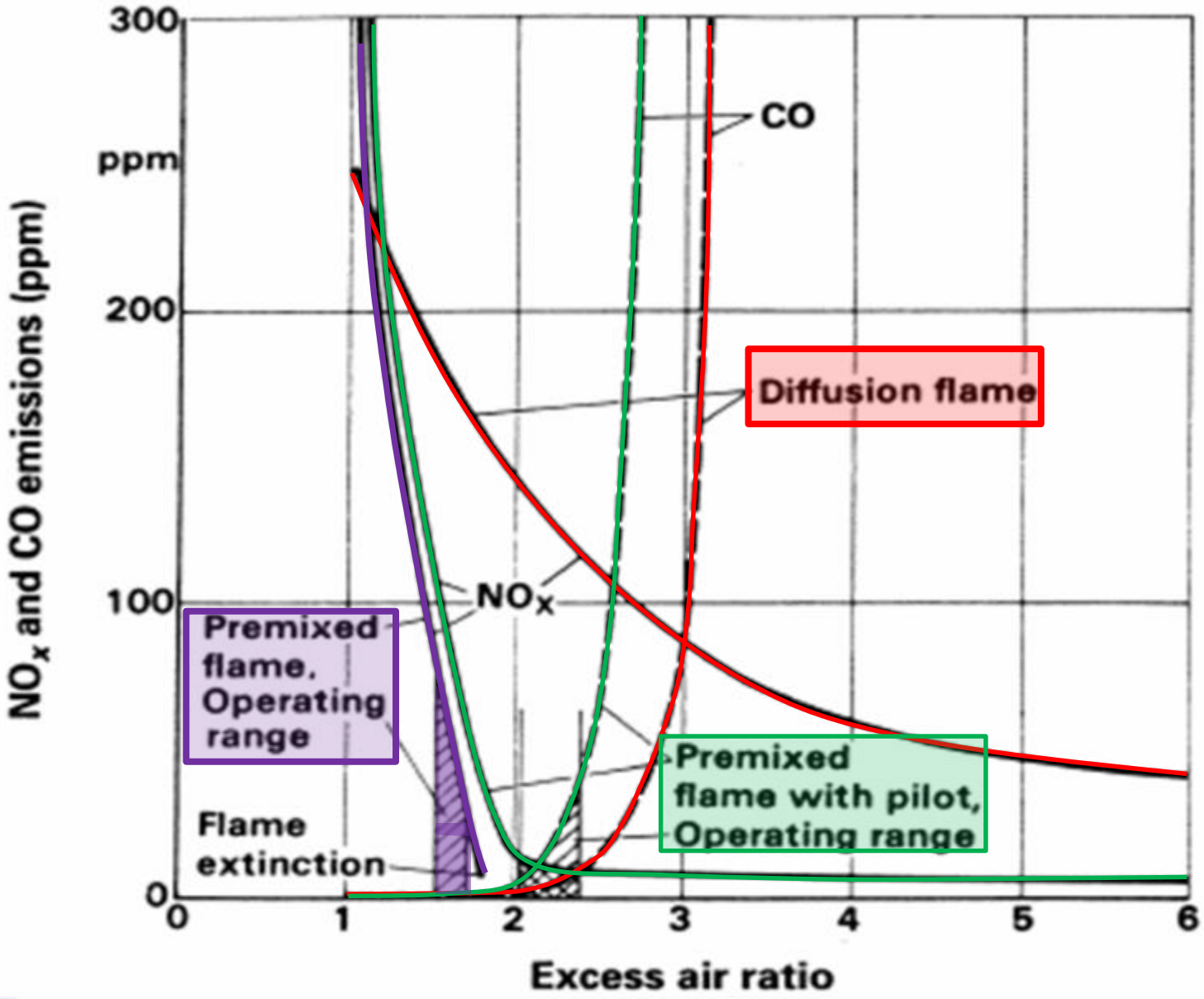
Emission formation in gas turbines



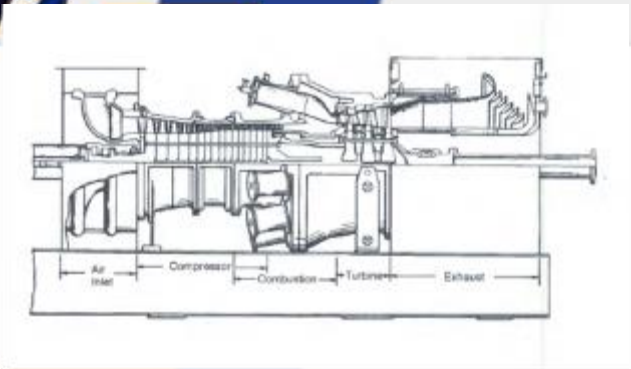
Emission formation in gas turbines

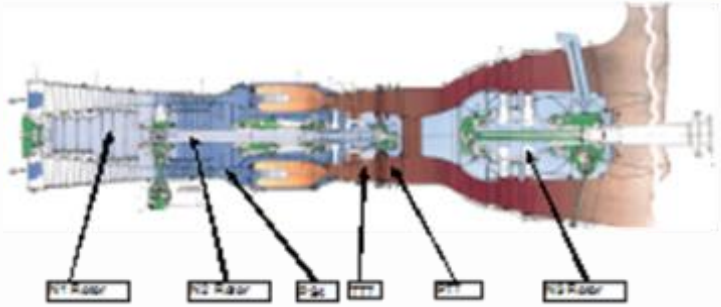


Emission formation in gas turbines



Diffusion flame combustors
General View

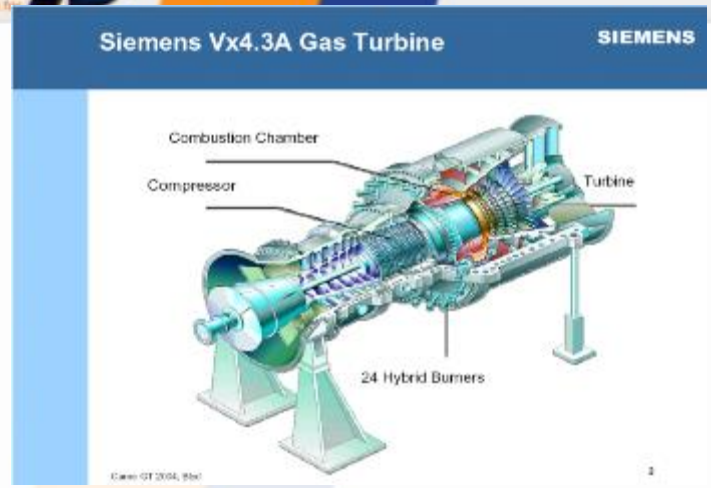


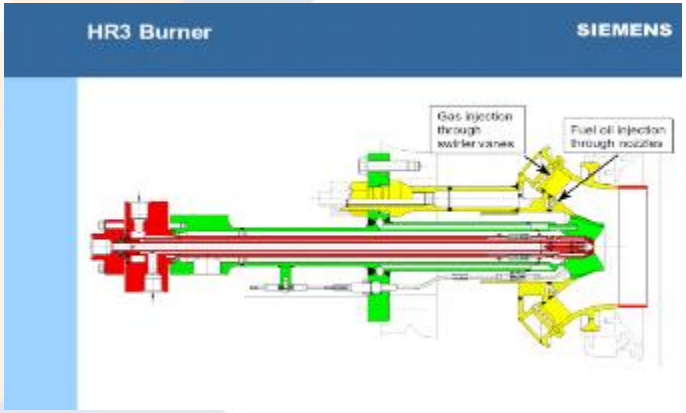


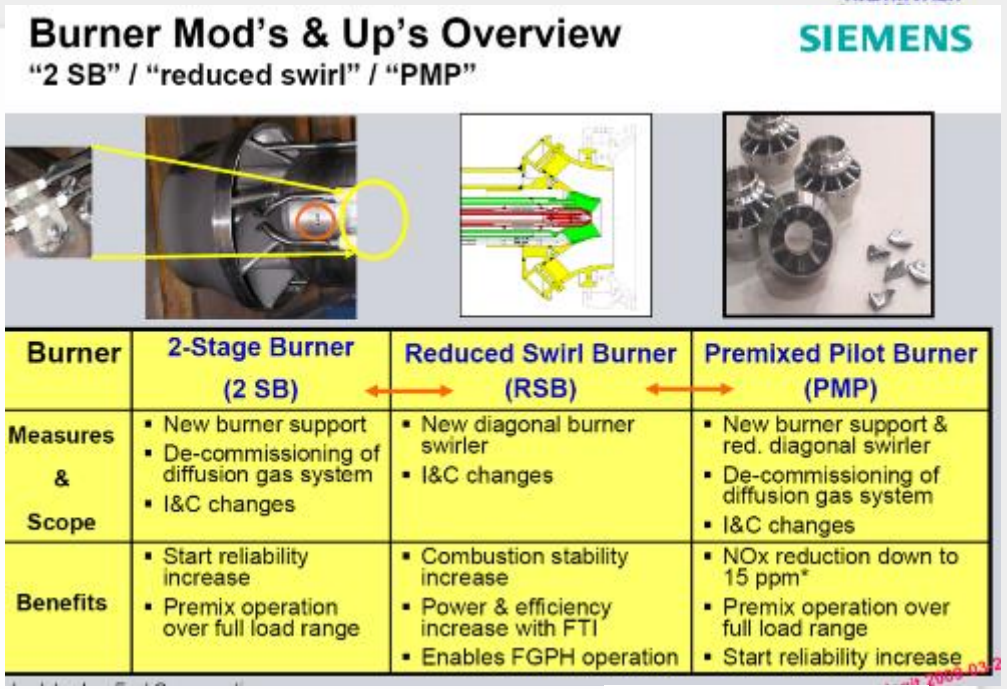
Frame 6 GE GT

50 MW P&W FT4 GT

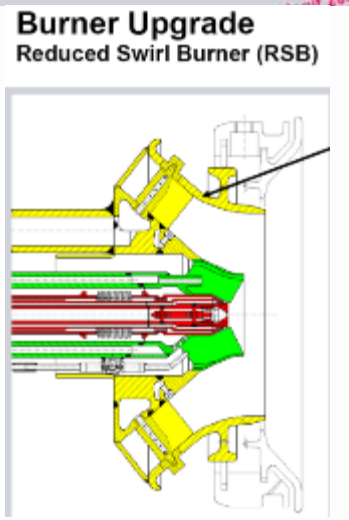
Lean Premixed Combustion Siemens





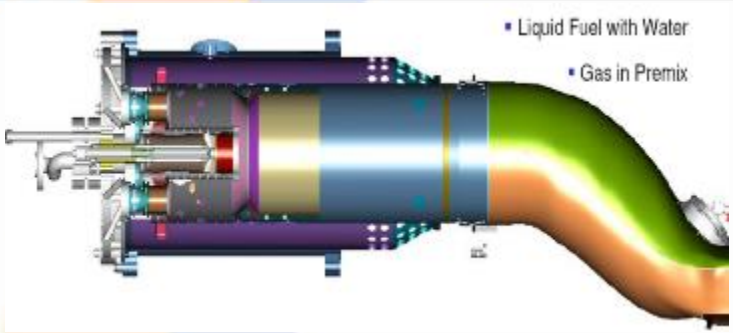


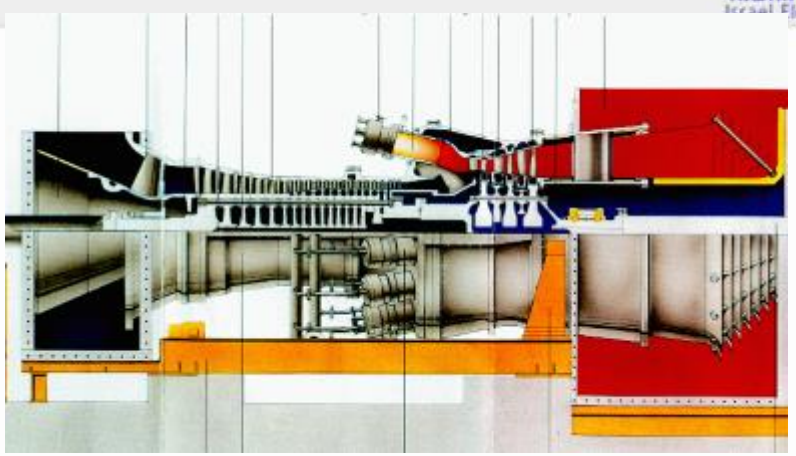
Upgraded firing system

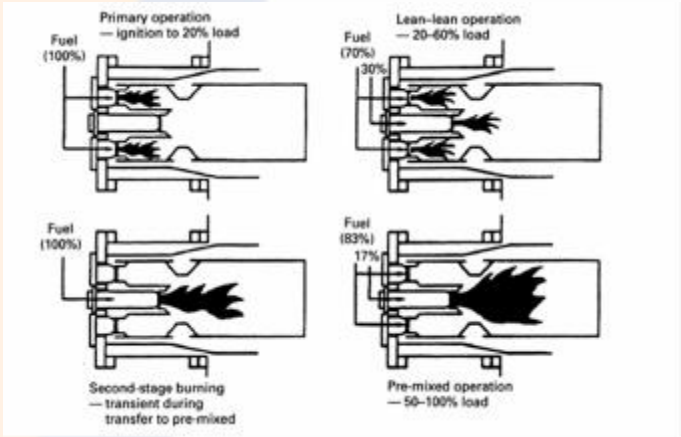


Siemens GT and Burner General view

Lean Premixed Combustion GE



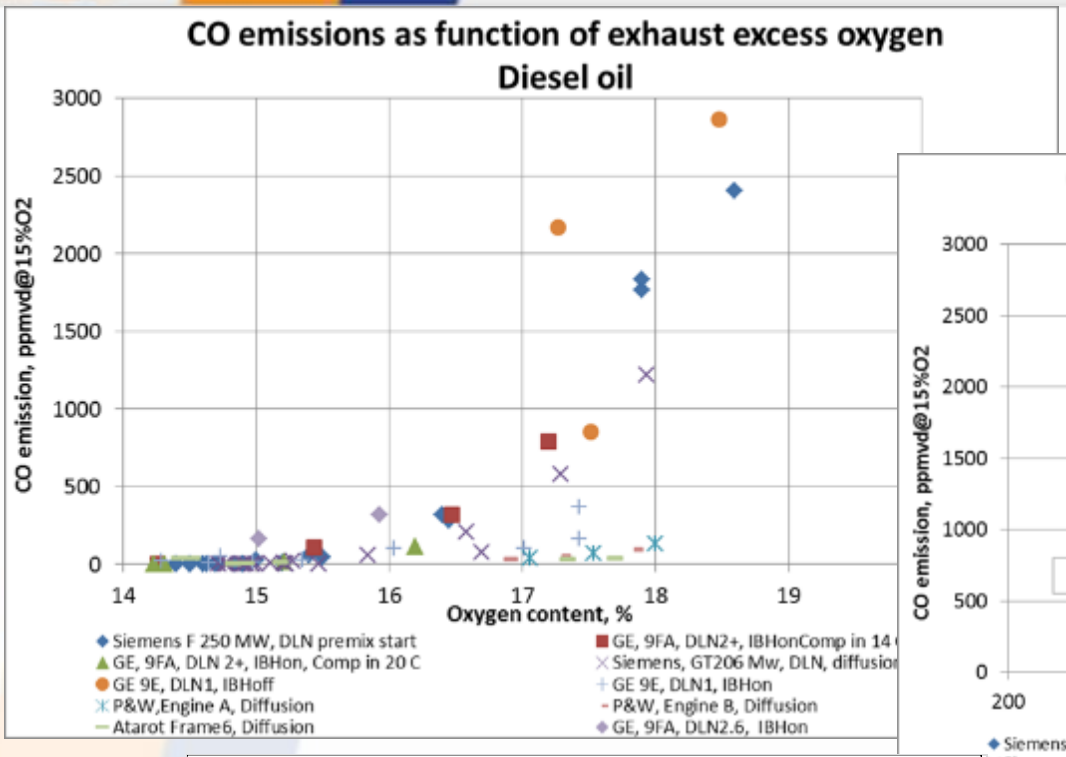


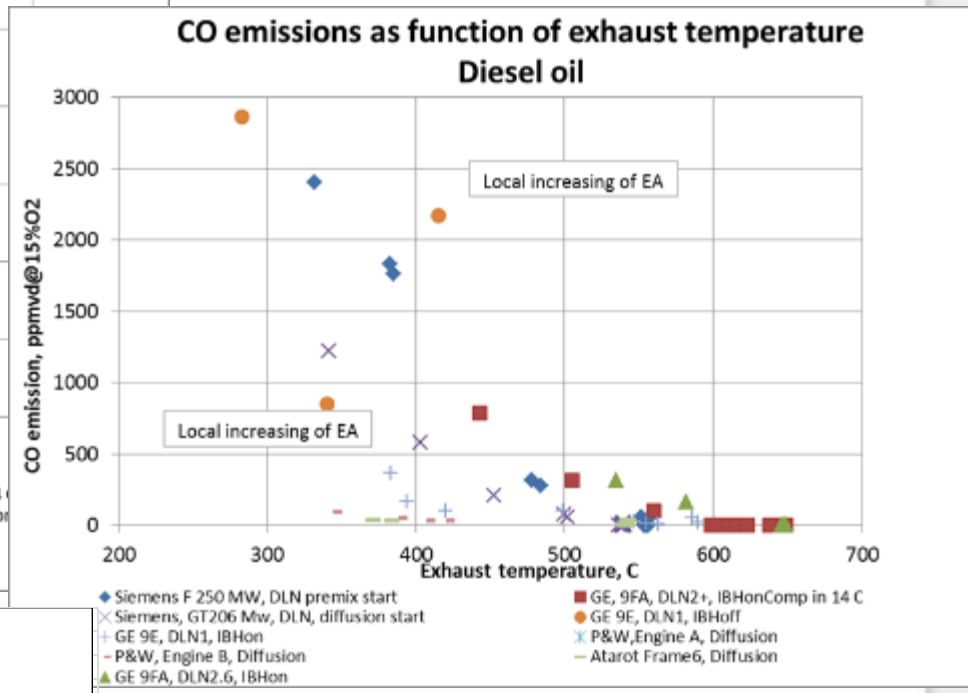


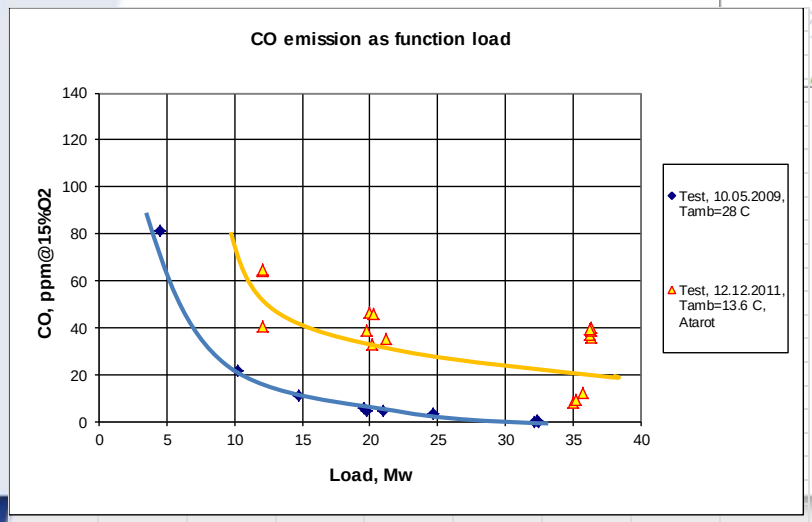
DLN2.0+ **DLN2.6+**

9E DLN1 GT General view **9F DLN2 GT General view**

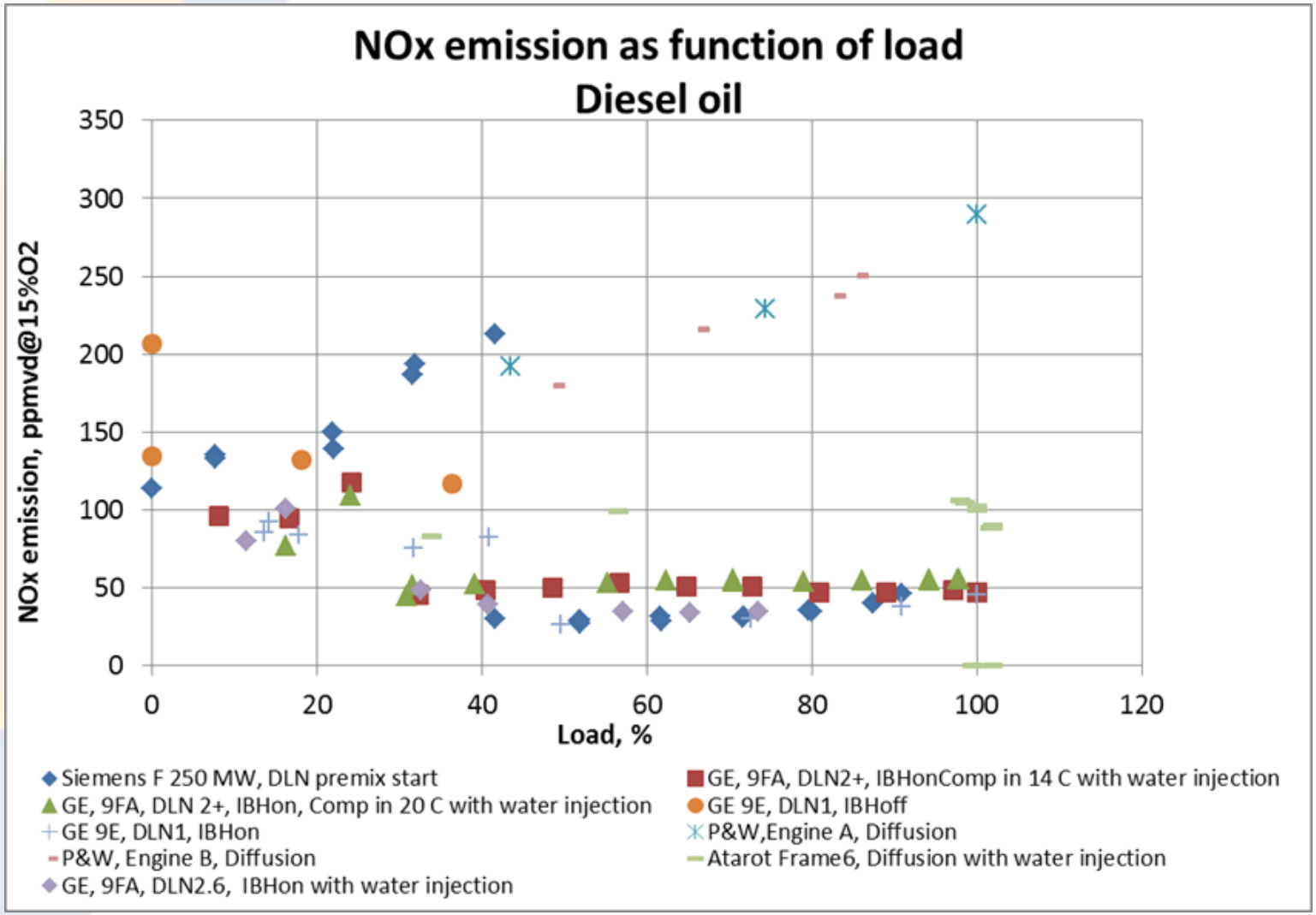
Gas Turbines Emissions



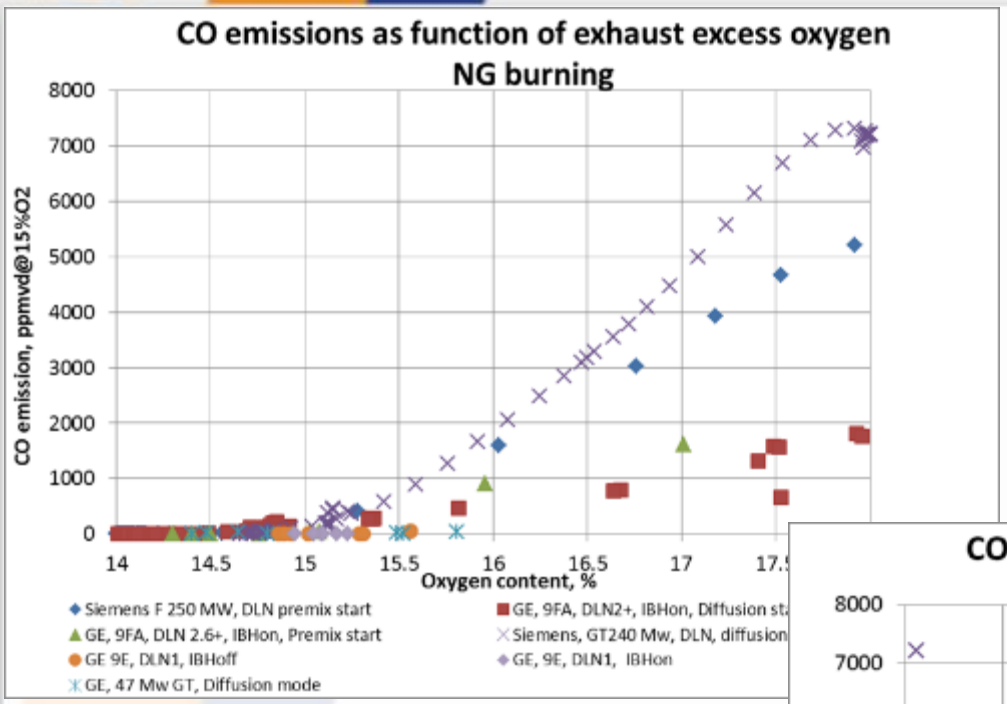


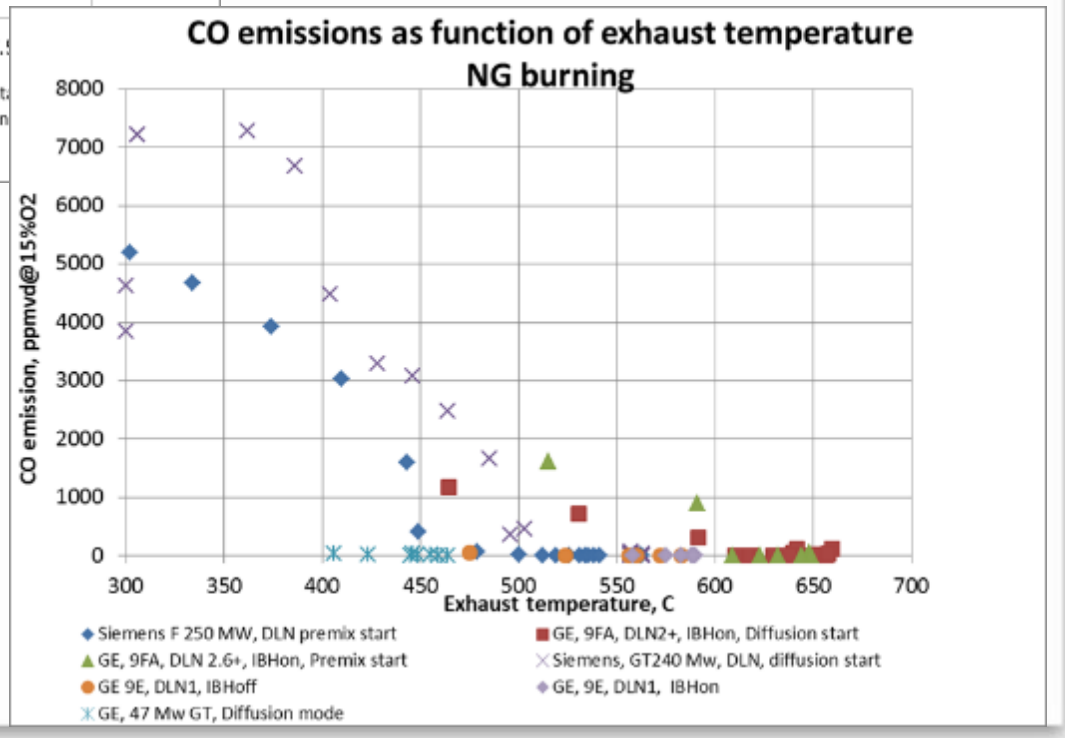


Gas Turbines Emissions

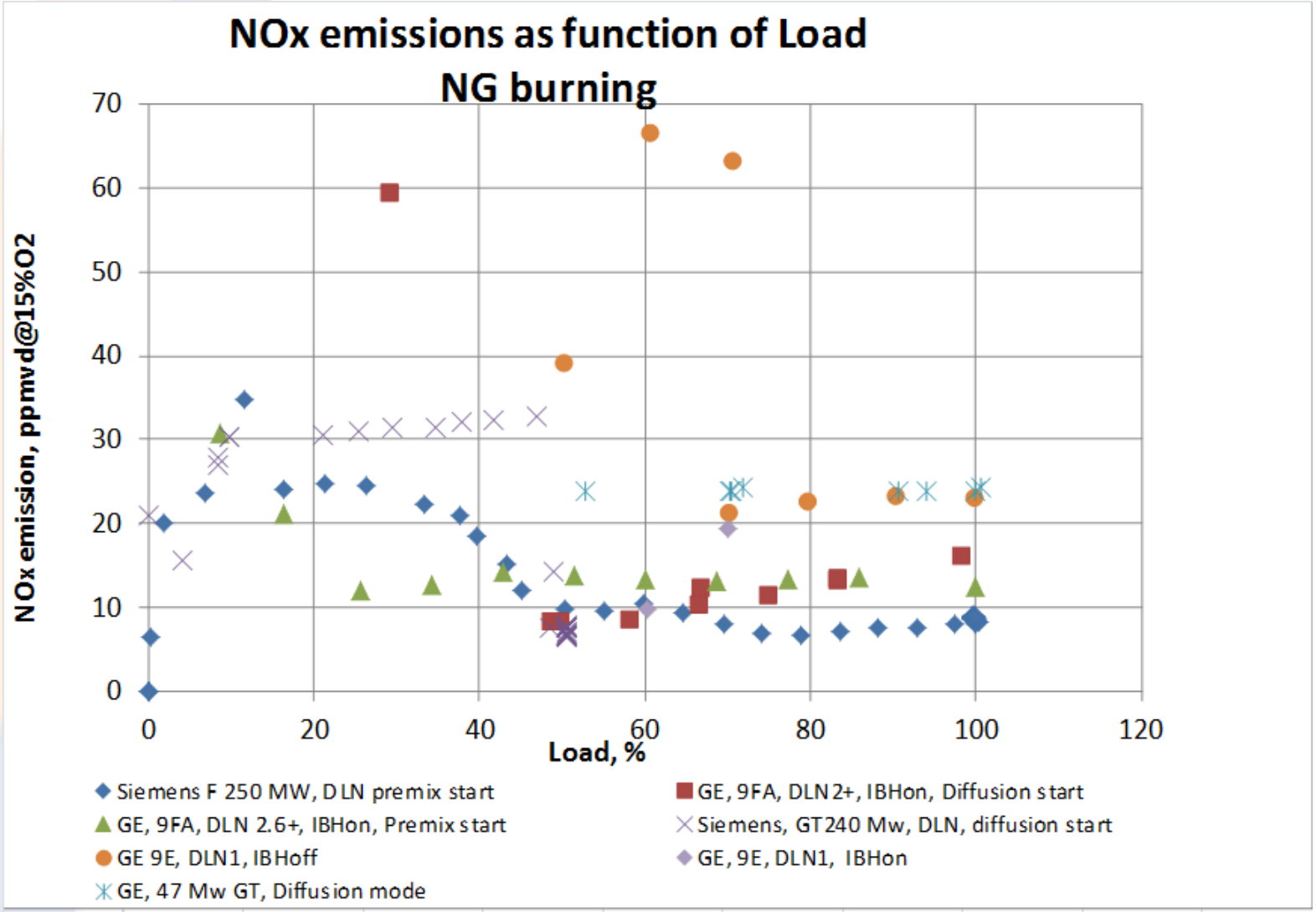


Gas Turbines Emissions

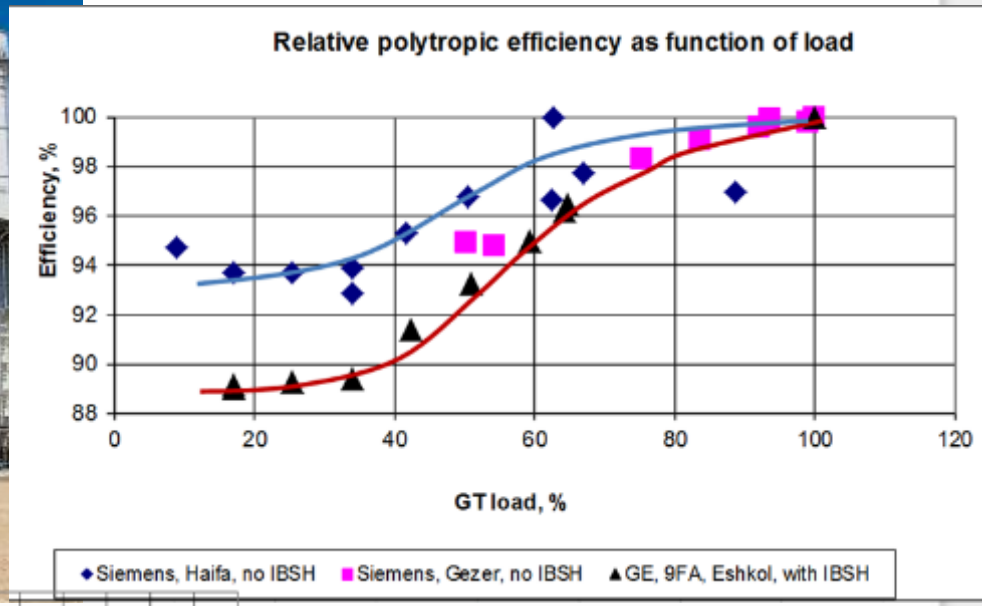


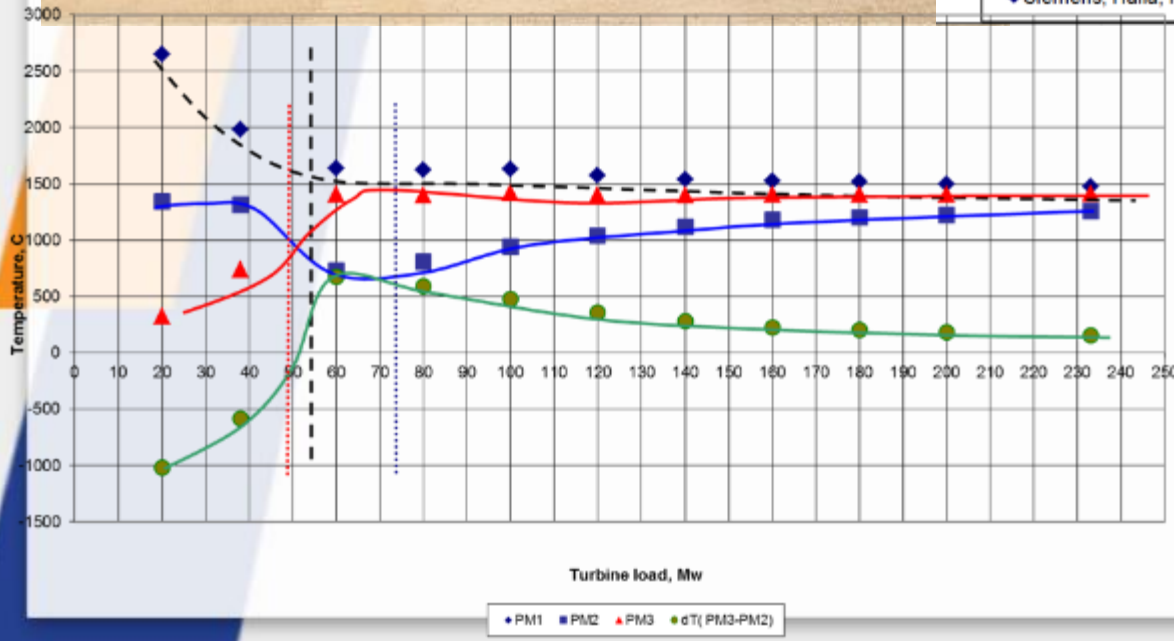


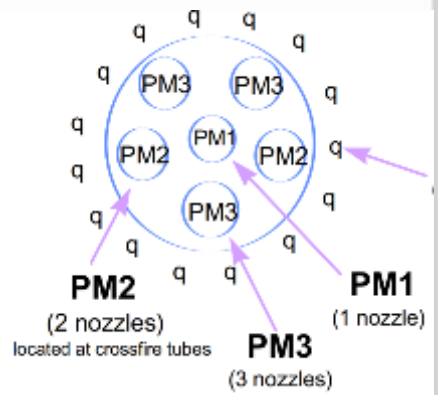
Gas Turbines Emissions



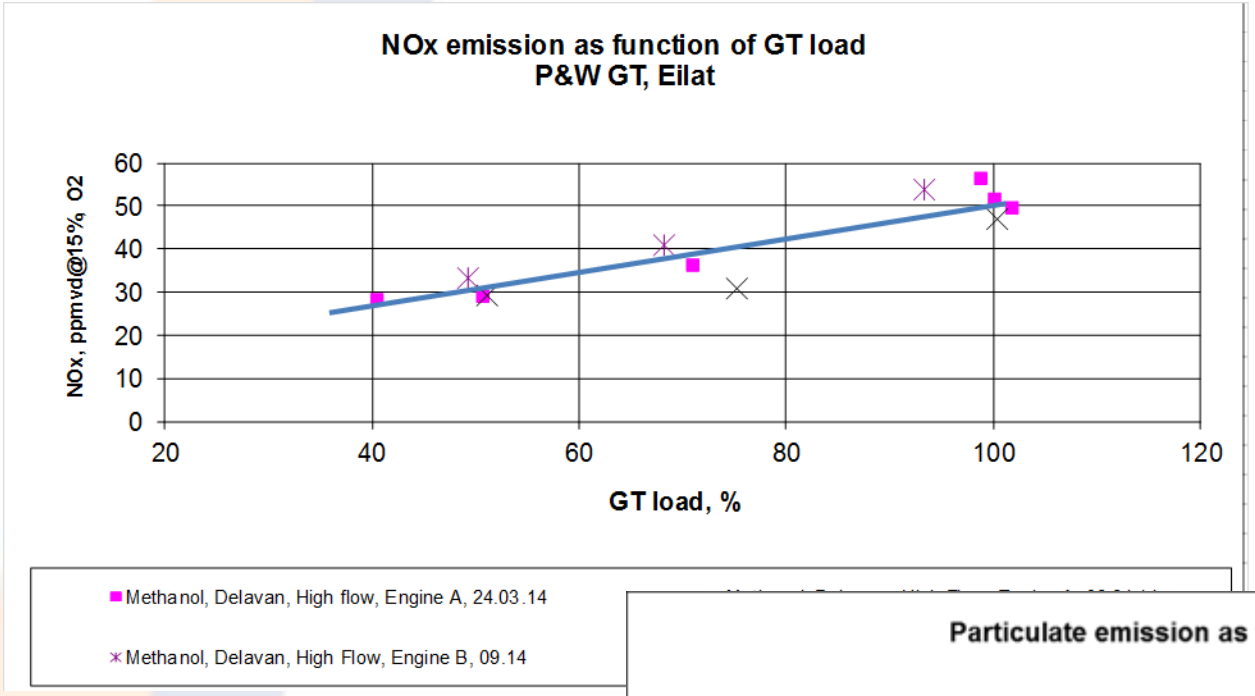
Gas Turbines Emissions

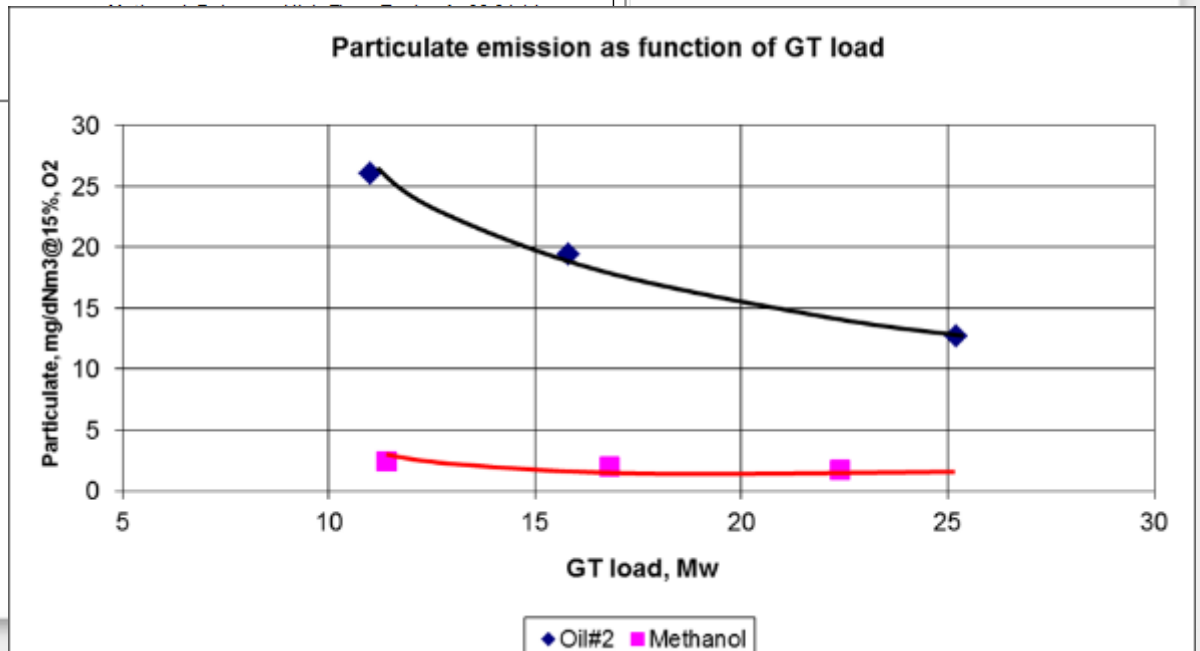




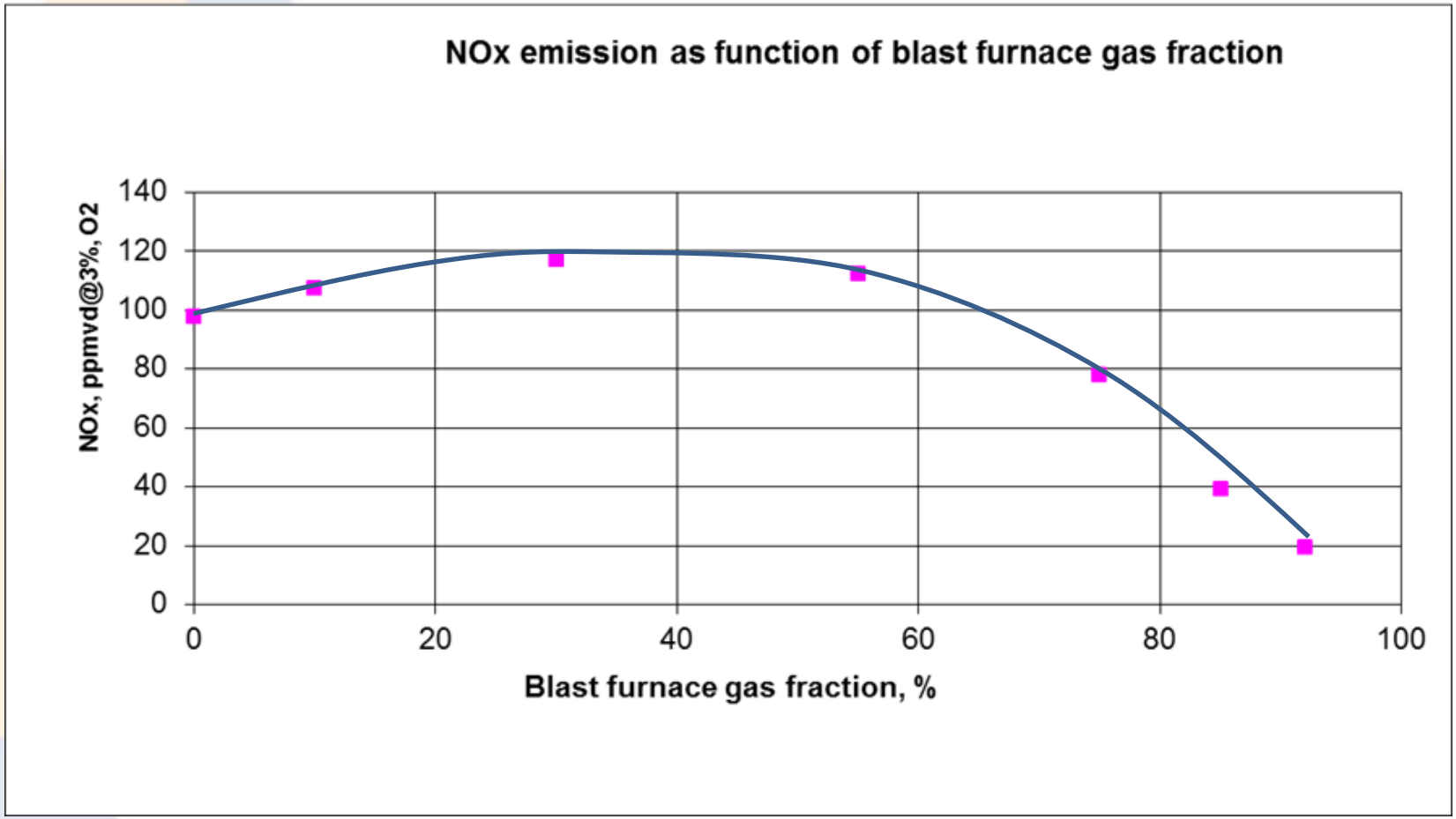


Gas Turbines Emissions
Methanol and LFO Firing

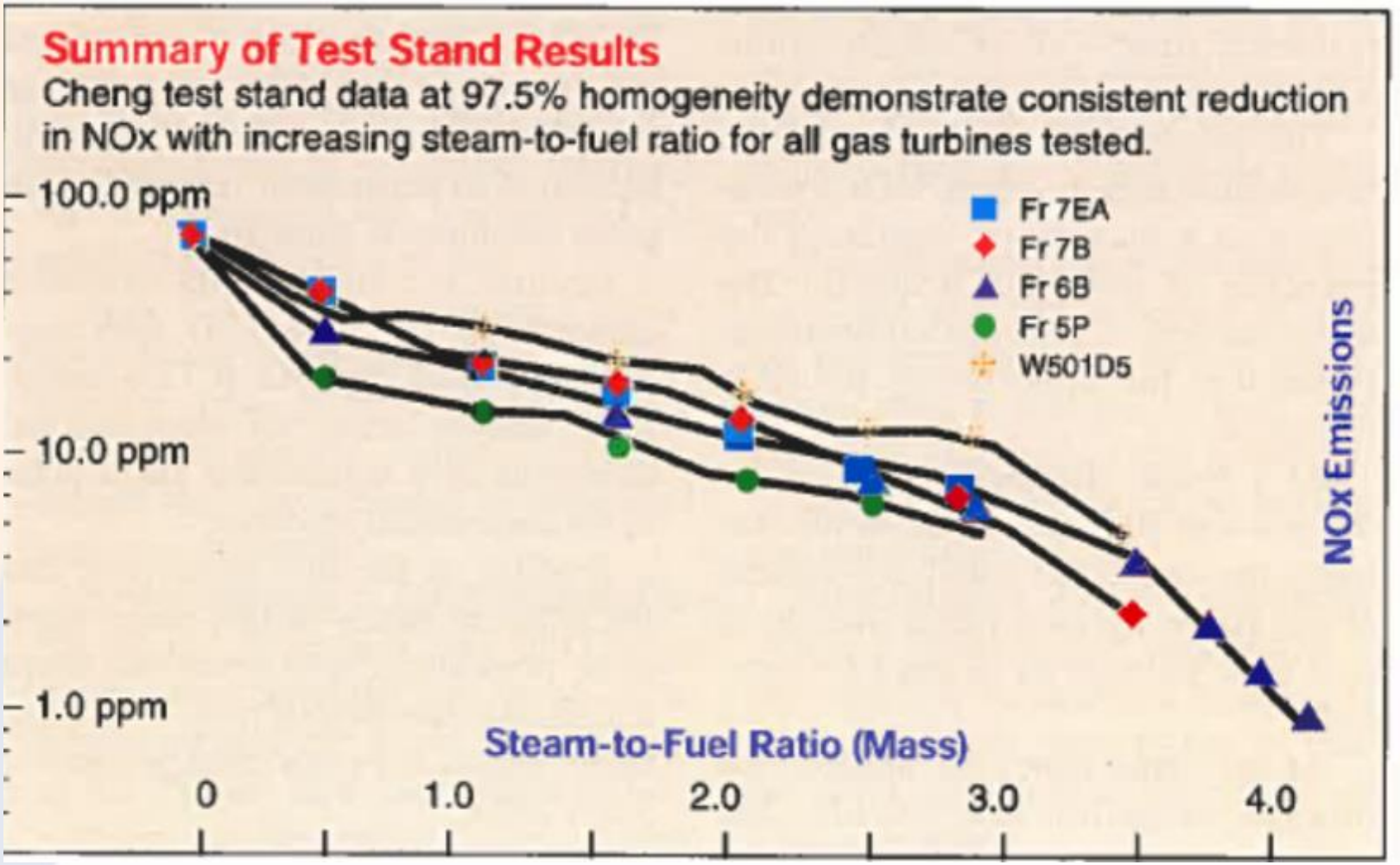




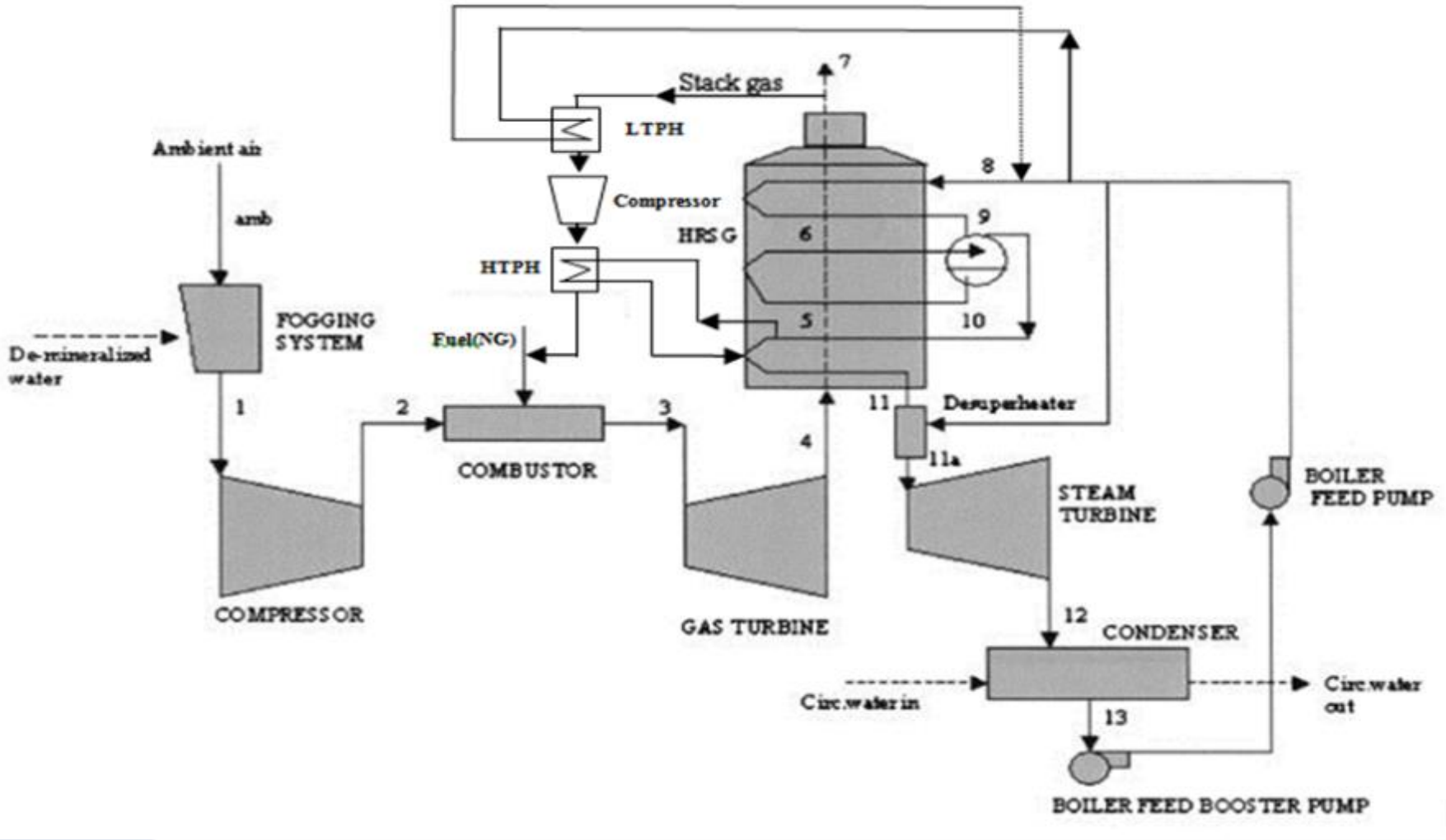
BFG Firing


NOx emission as function of blast furnace gas fraction
NOx, ppmvd@3%, O2
140
120
100
80
60
40
20
0
0
20
40
60
80
100
Blast furnace gas fraction, %

Gas Turbines Emissions
Steam Injection



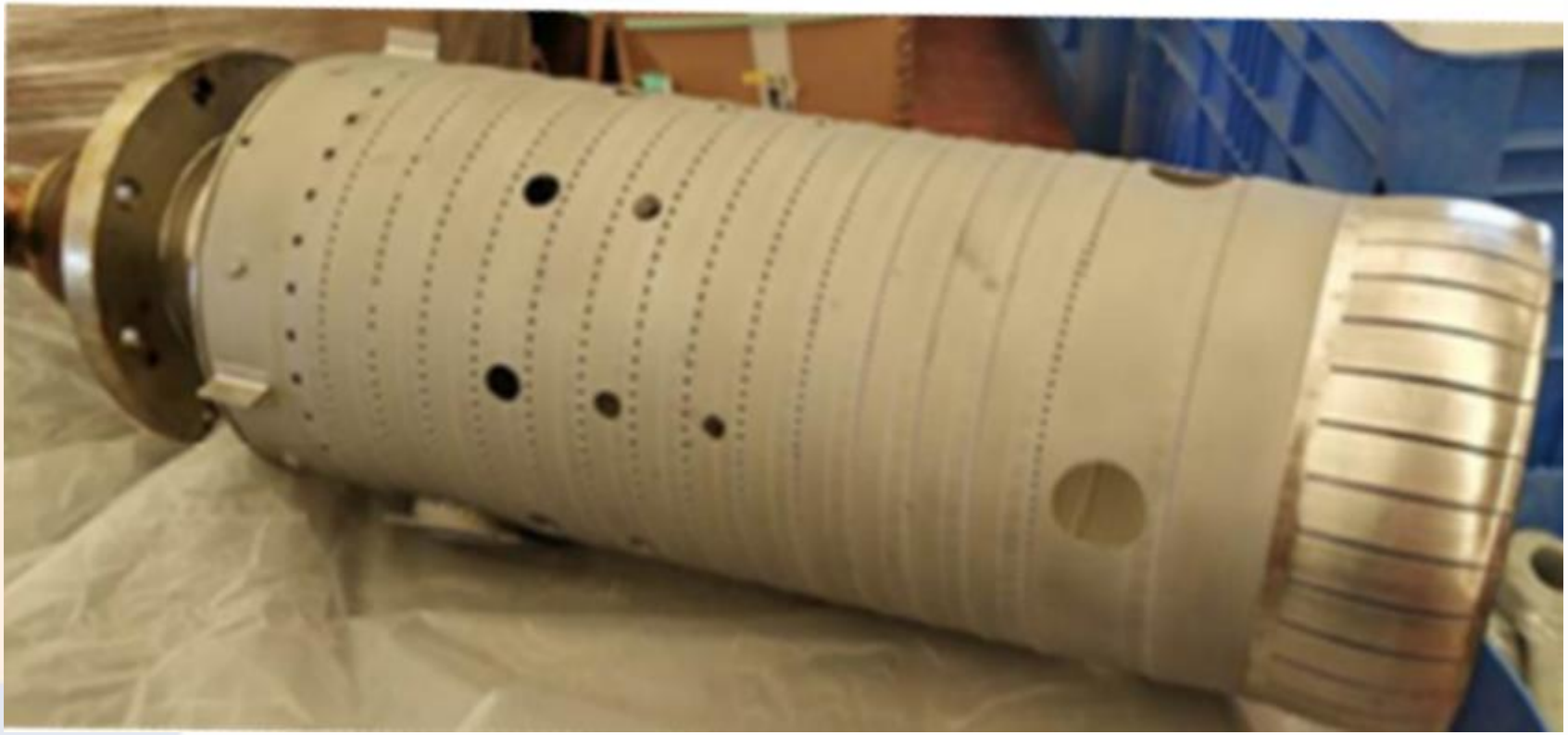
Proposed combined cycle arrangement



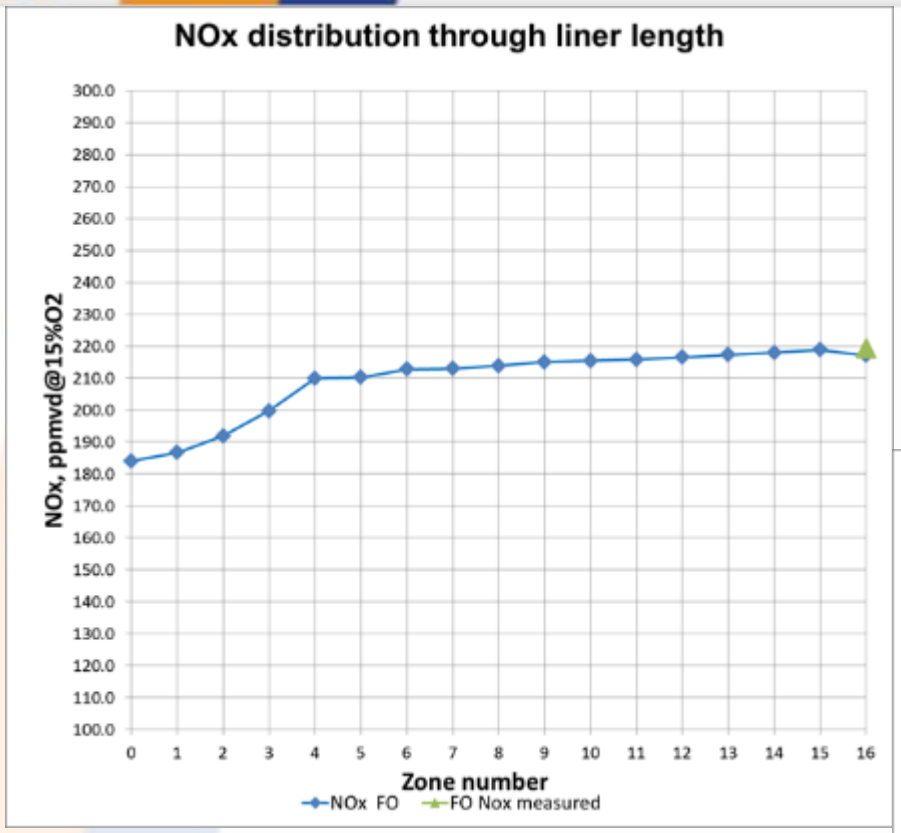
Simulation Steps

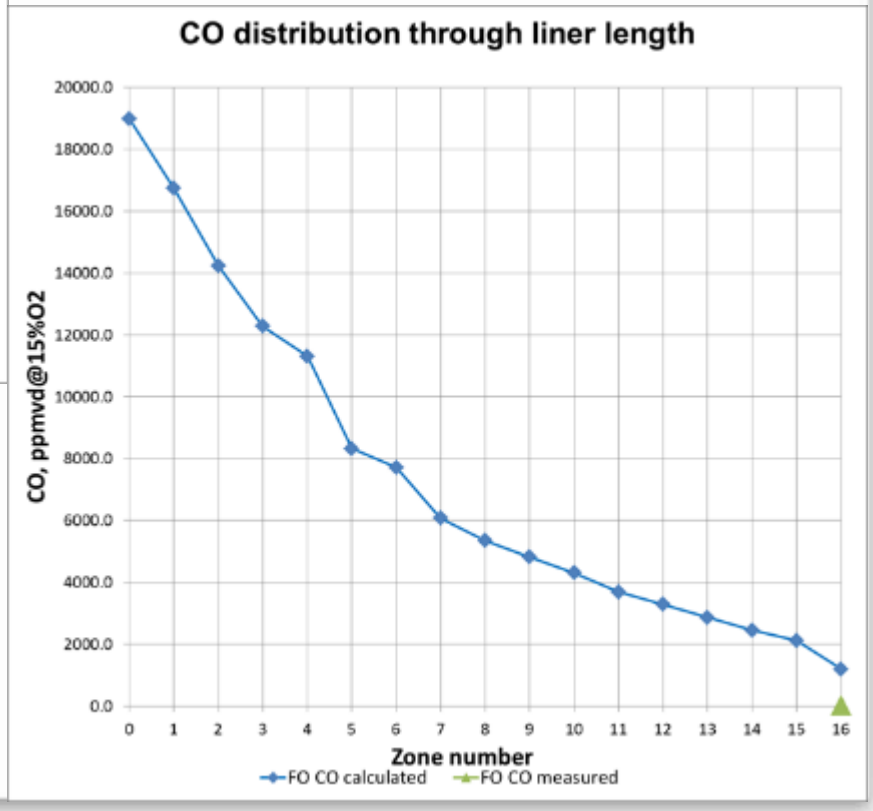
- Step 1 – Thermal balance and heat transfer calculations throughout the length axis of the combustor including (local values of burnout, O2, Flue Gas temperatures and main flue gas constituents).
- Step 2 – Chemical Kinetics modeling and initial operation and validation to fit measured data Firing LFO/NG.
- Step 3 – Optimizing to reach the best Emissions vs. performance and combustion stability effect.

Combustor for simulation validation – GE Frame 6B

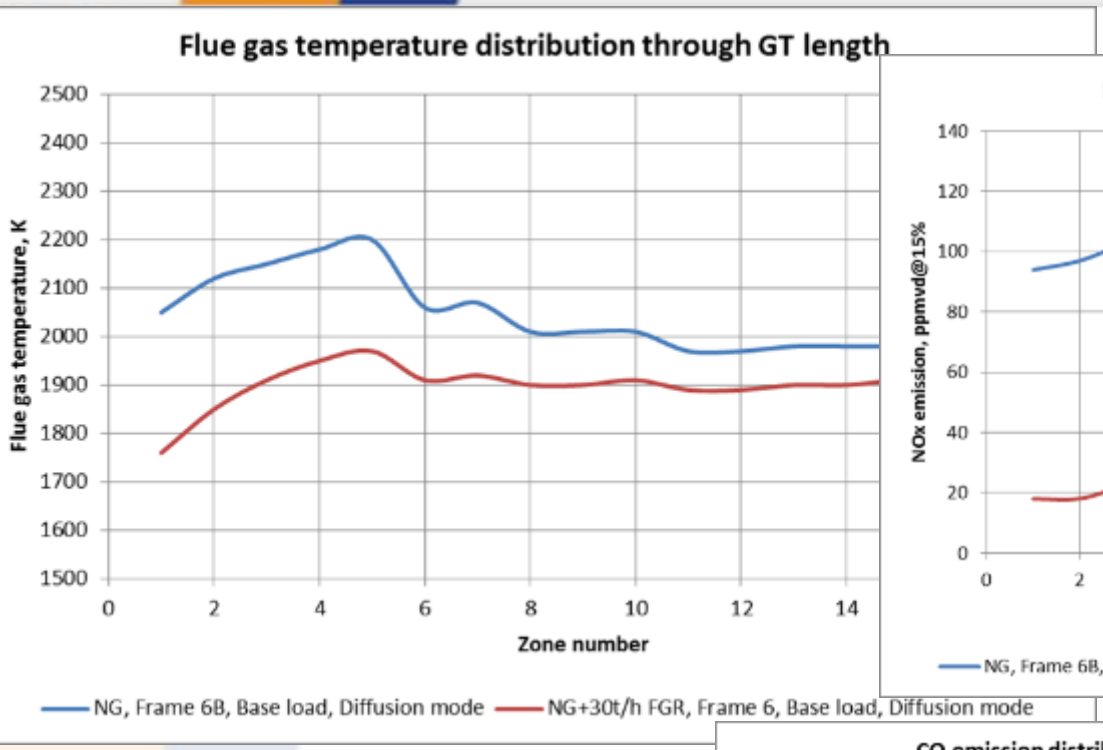


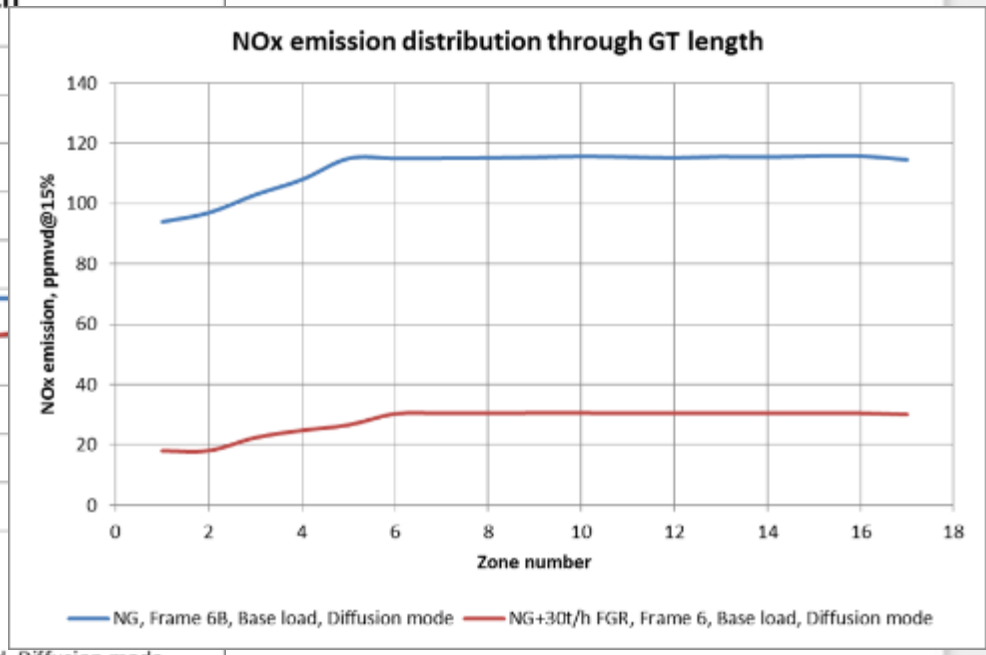
Emission Validation Results

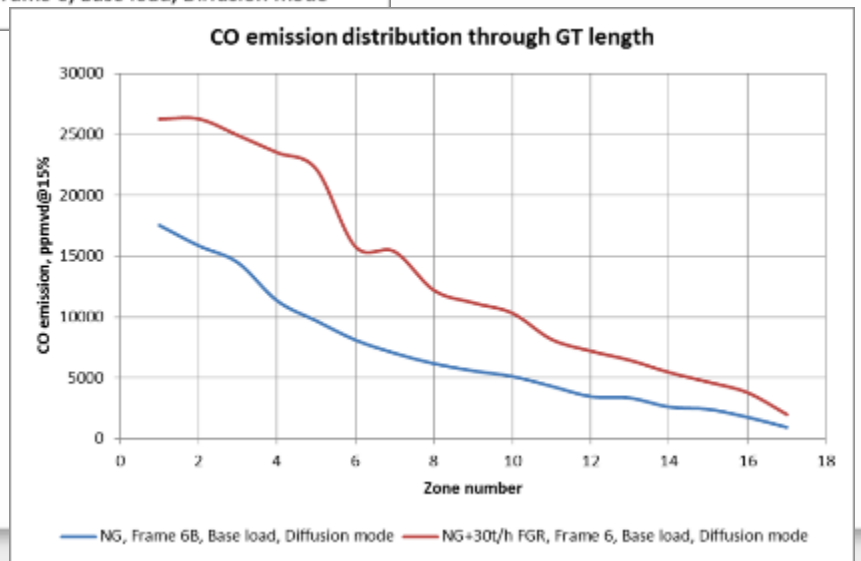




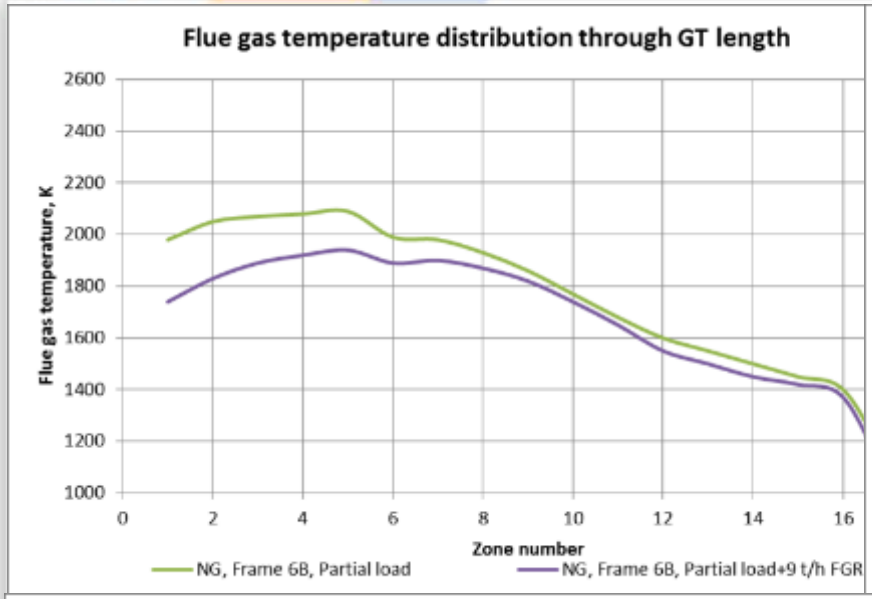
Frame 6 simulations results at base load

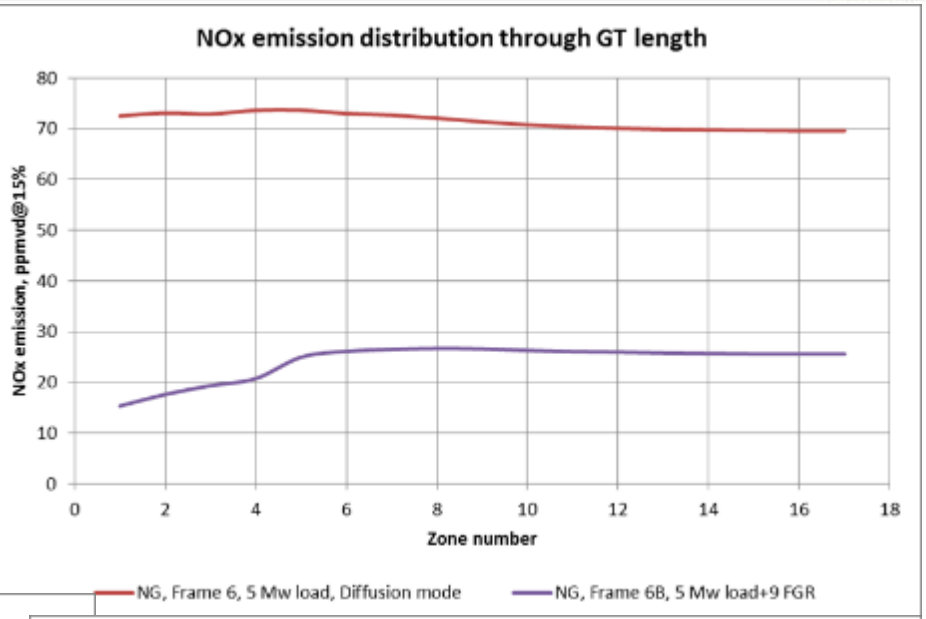


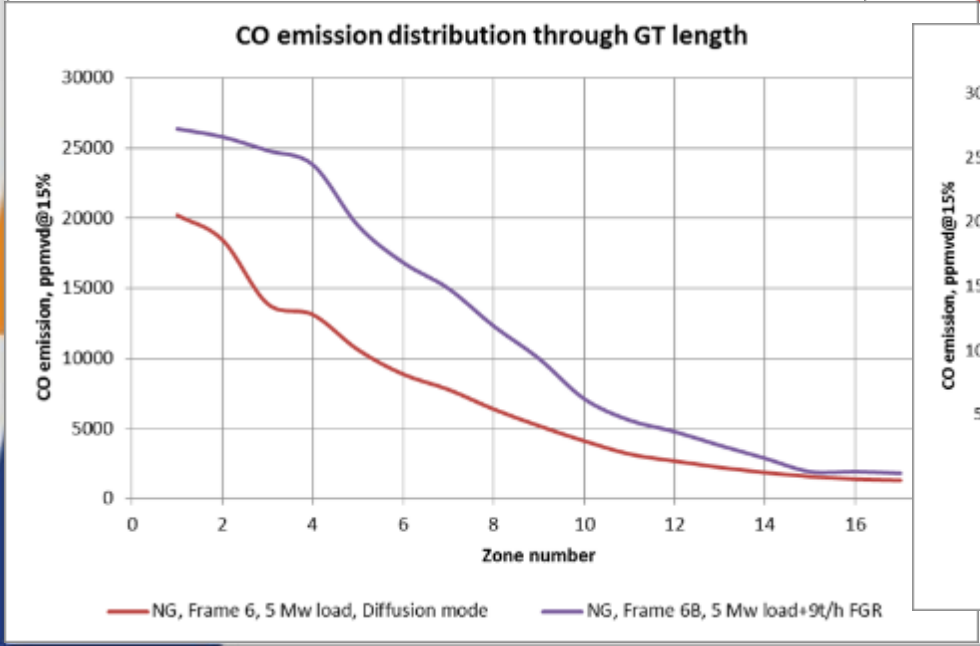


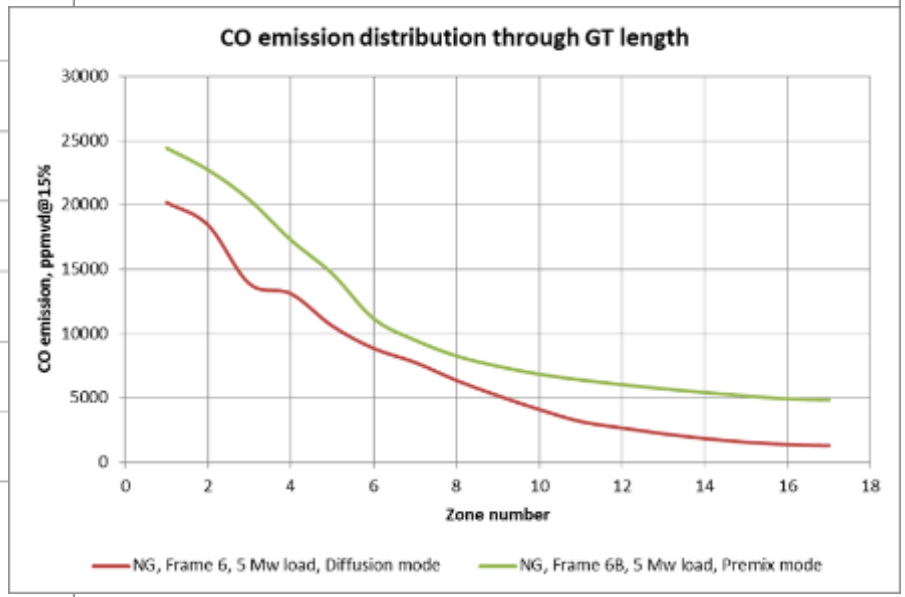


Frame 6 simulations results at part load

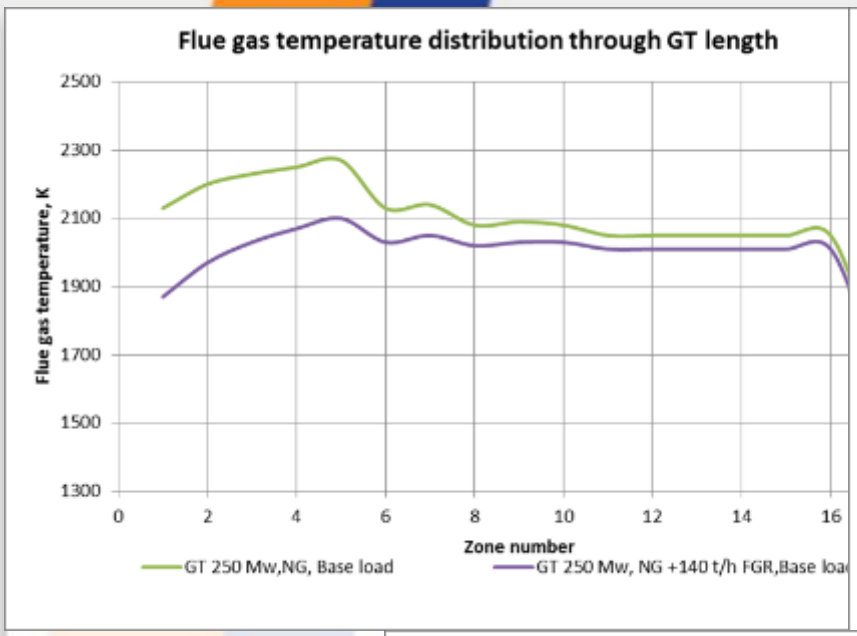


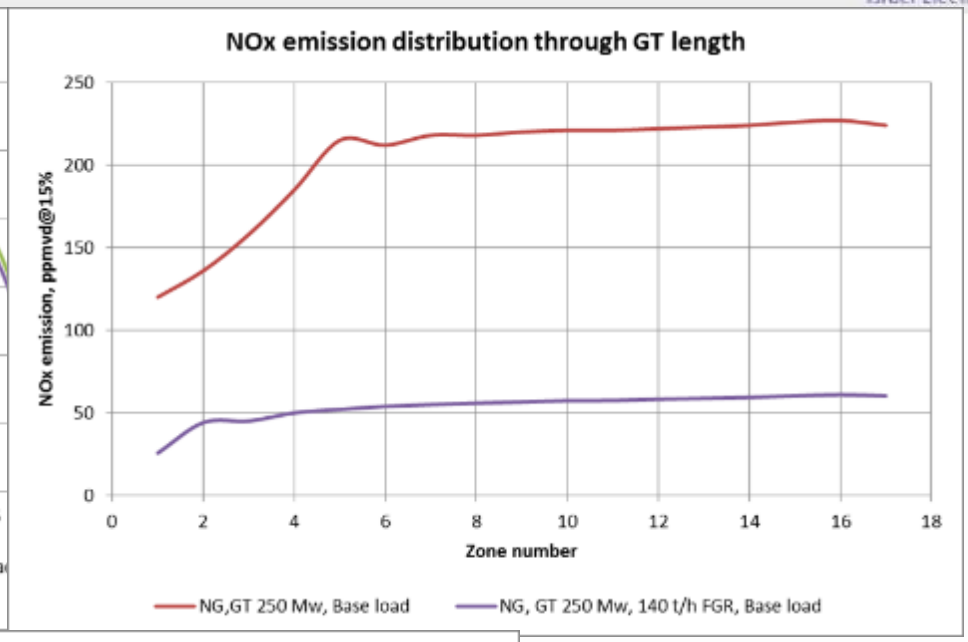


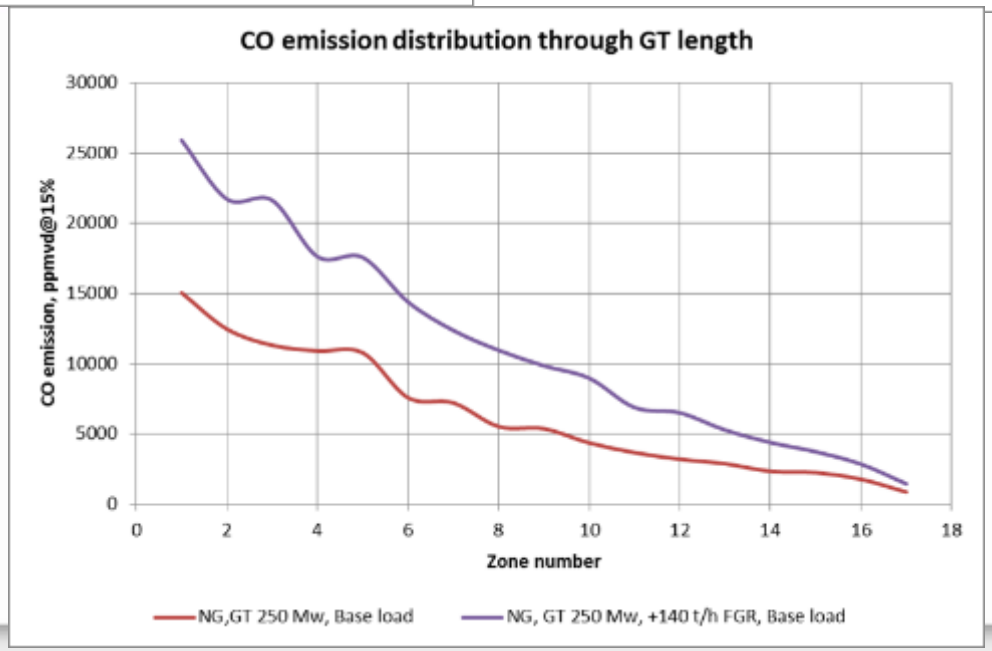




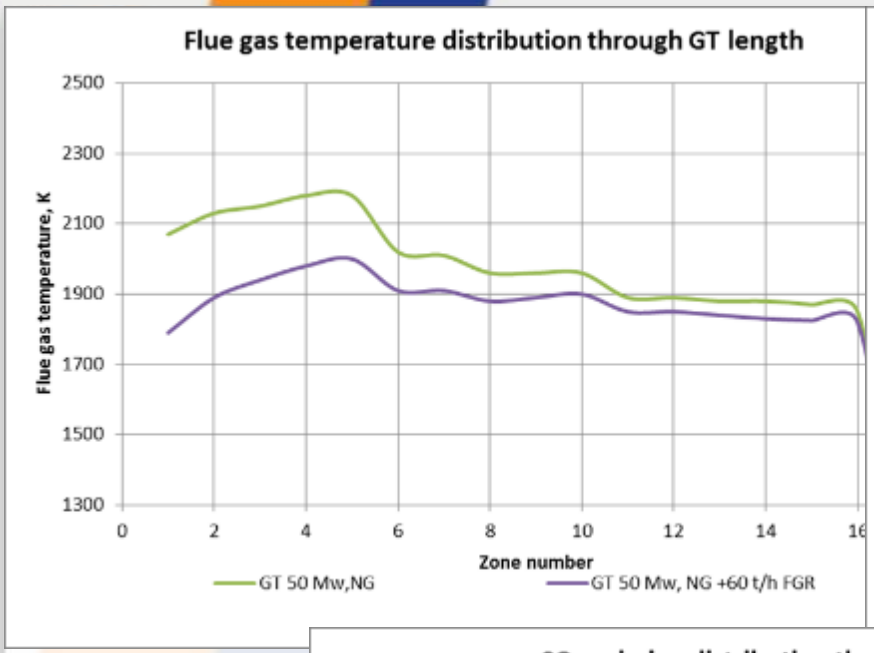
Large “F” GT simulations results at base load

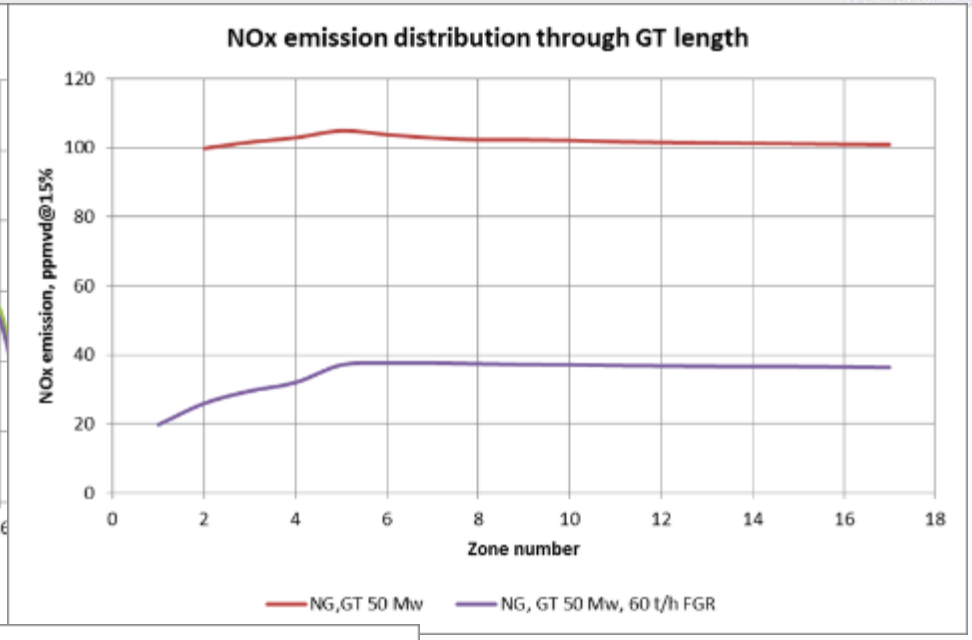


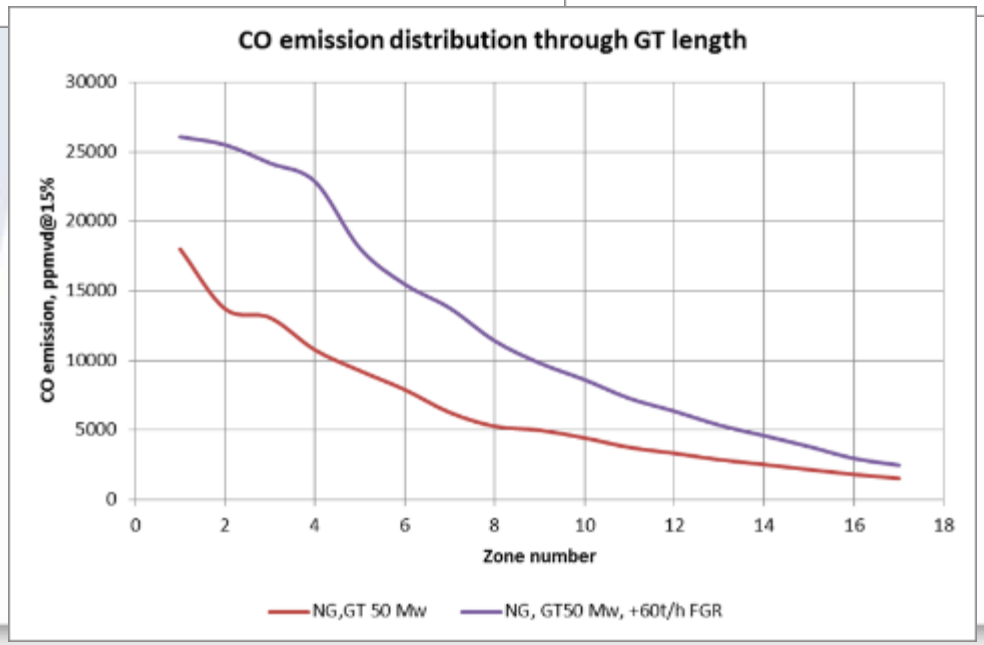




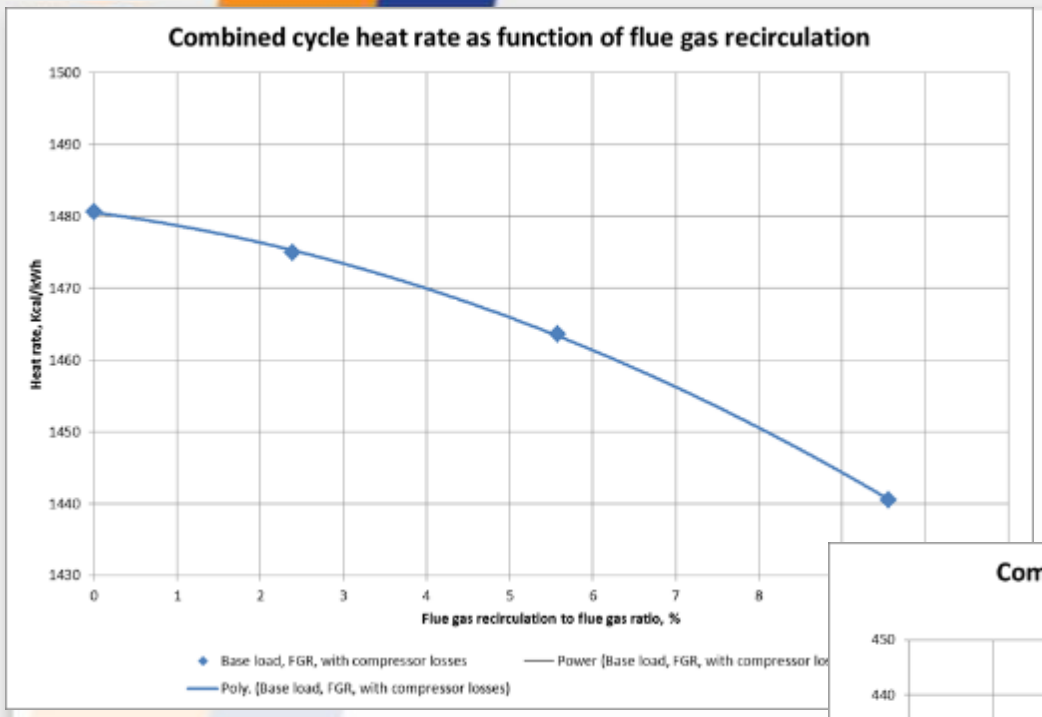
Large “F” GT simulations results at part load

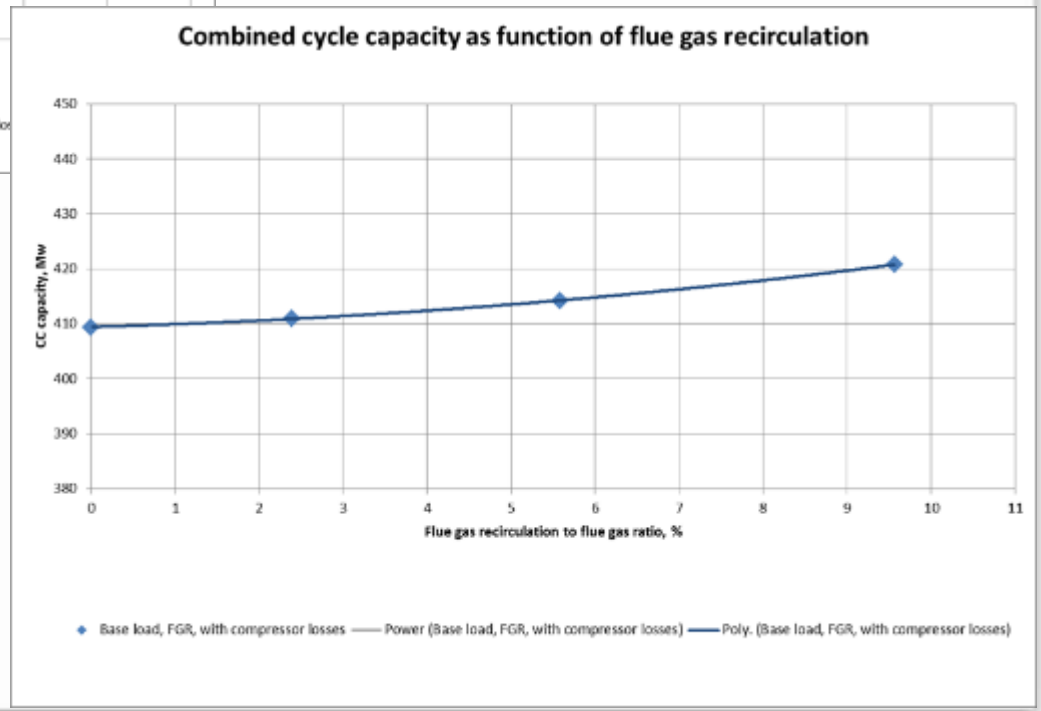




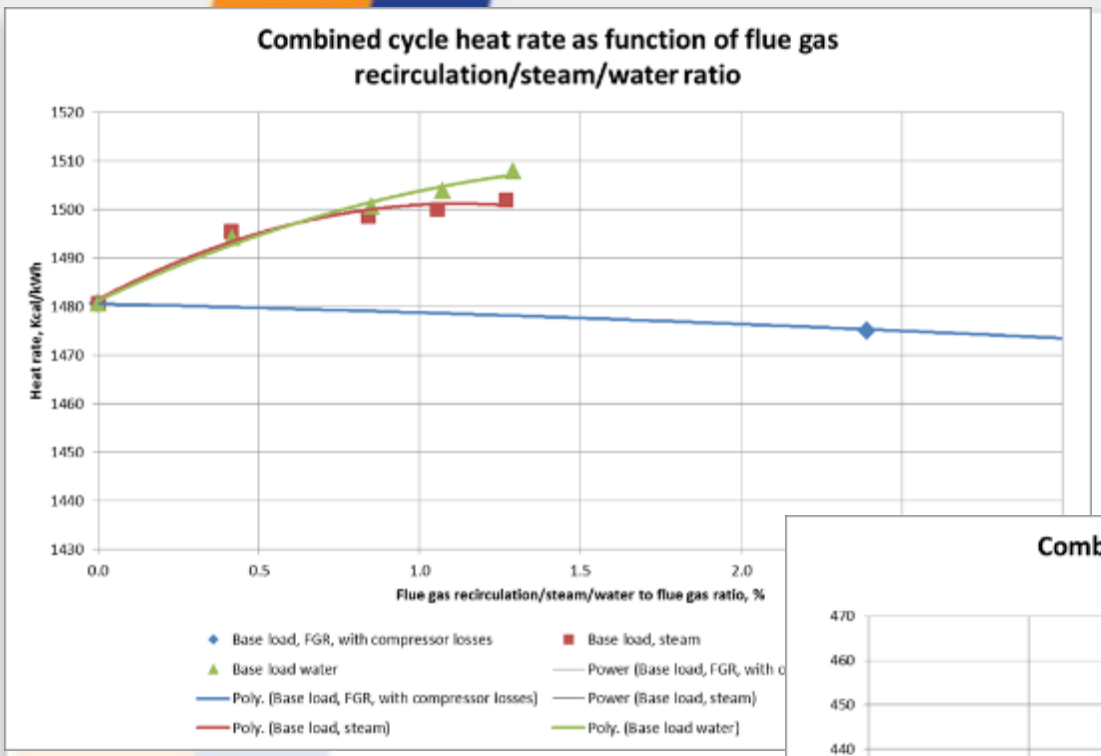


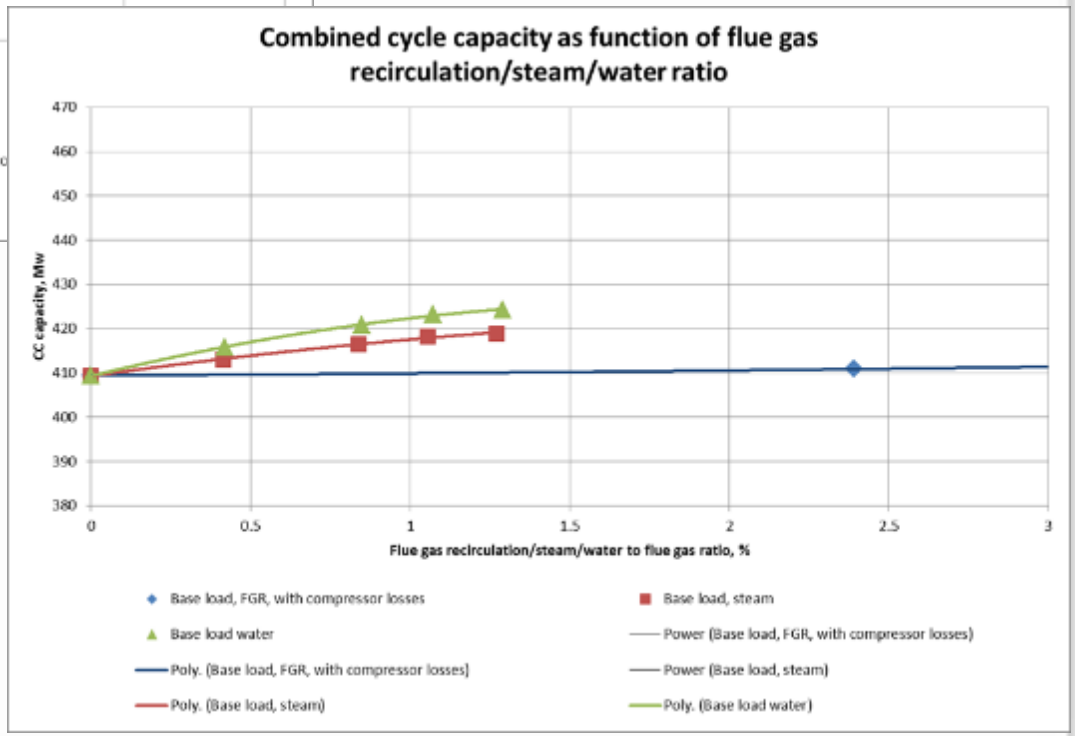
Large “F” CC simulations results





Large “F” CC simulations results





Conclusion

Based on the performed simulation it may be concluded that:

FGR mixing with fuel may be a useful tool for extended GT load range operation while keeping minimum emissions. However, in order to make more accurate conclusion about the proposed technology a laboratory and full scale test are recommended.

Thank you