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Achieving Ultra-Low NOx Emissions Without EFGR In Burner Retrofit Applications

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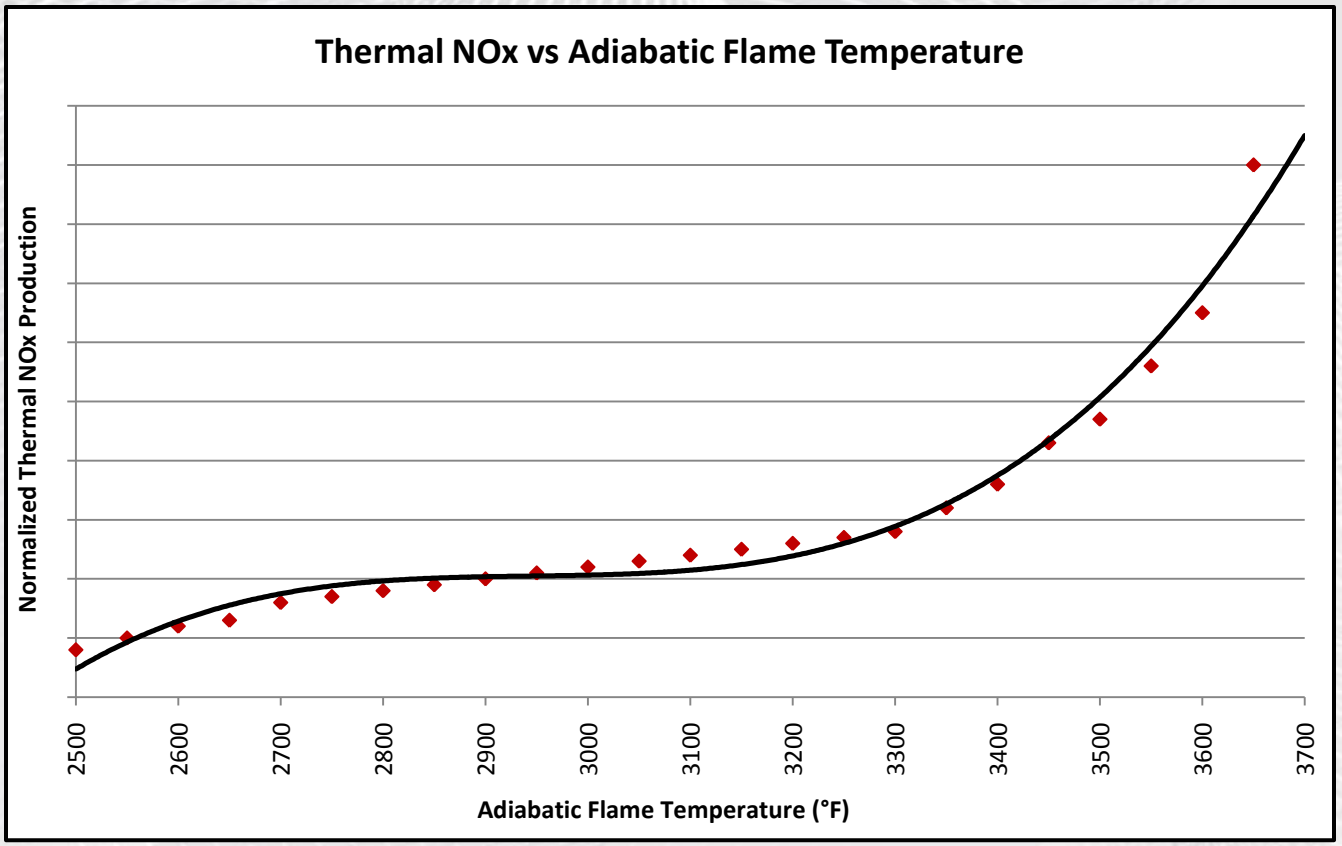
Problem

- Requirement of Ultra-Low NOx Emissions
- Existing heater with set cutout and tube circle
- Short flame length requirement
- EFGR and SCR are not practical
- High firebox temperature

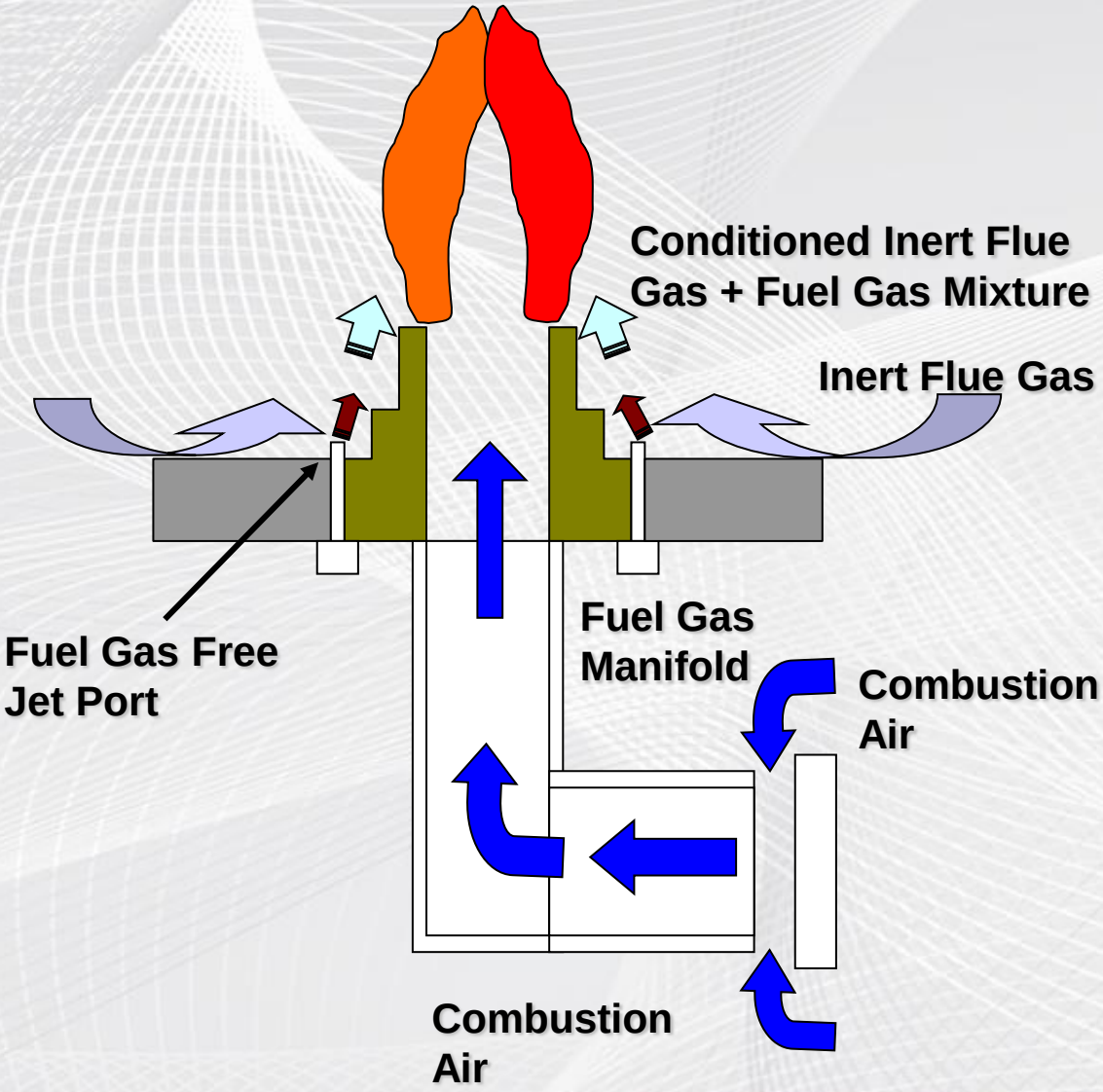
How To Reduce NOx?

Thermal NOx is the primary contributor to overall NOx



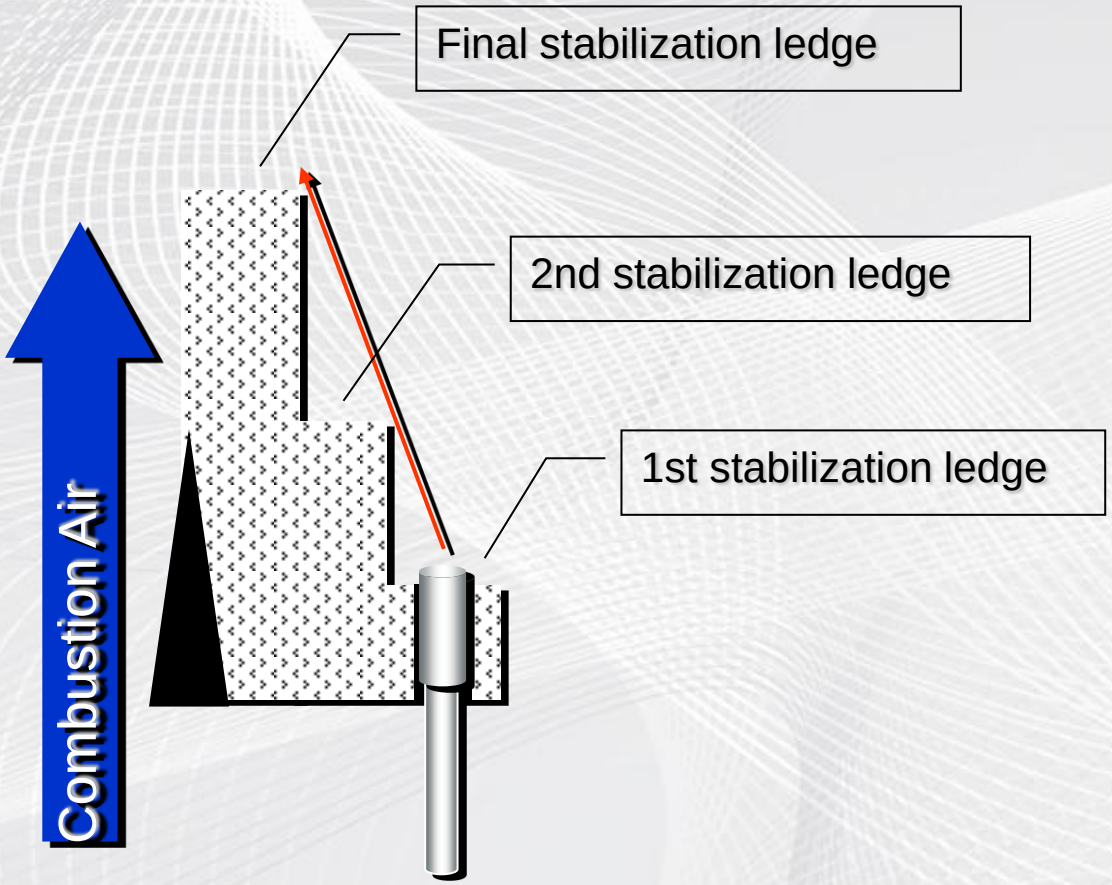
Internal Flue Gas Recirculation to Lower NOx

Simple Design for a complex problem. The fuel gas is mixed with inert products of combustion before combustion occurs, thus “Reconditioning the fuel gas”

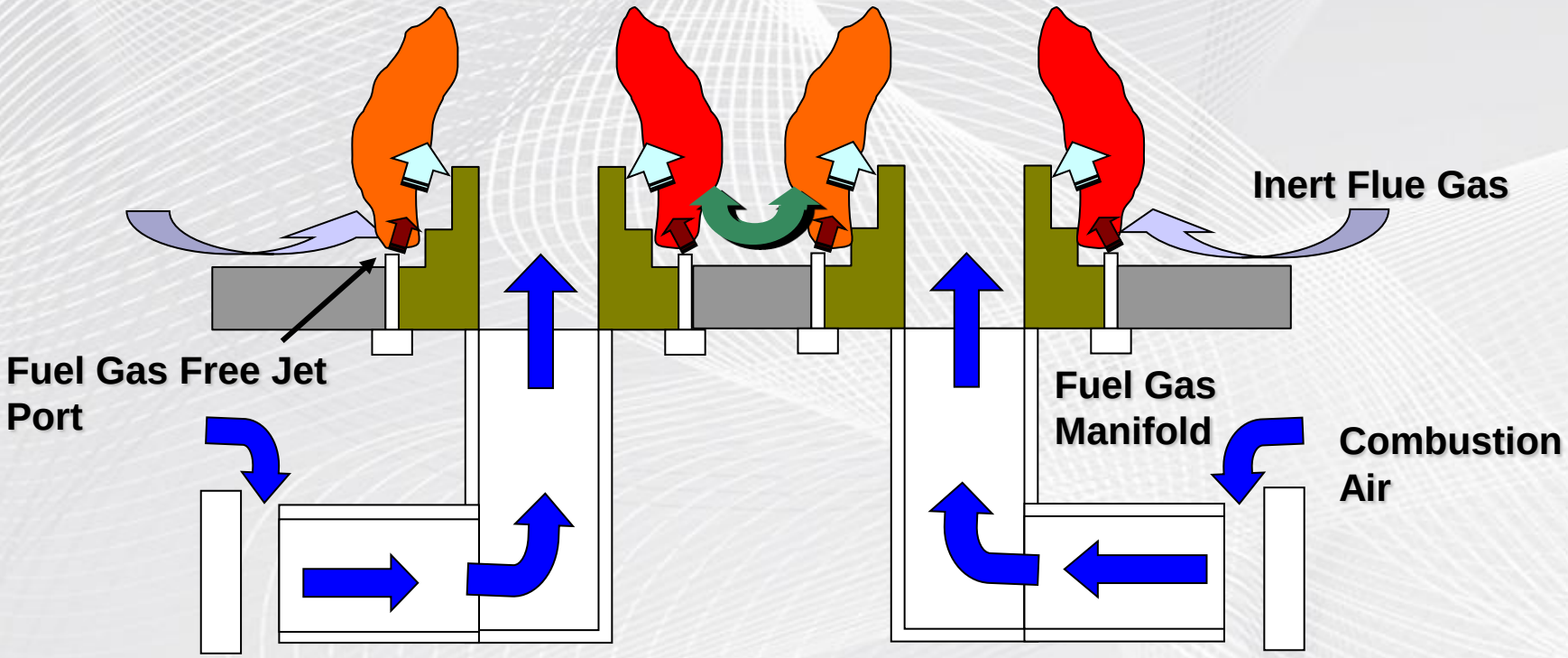


Free-Jet Stabilization

As the oxygen content in the furnace is reduced, the flame front moves from the tile's 1st stabilization ledge to the other ledges. At high excess oxygen levels, the flame stabilizes on the 1st ledge much a conventional burner flame stabilizes on a refractory tile ledge.

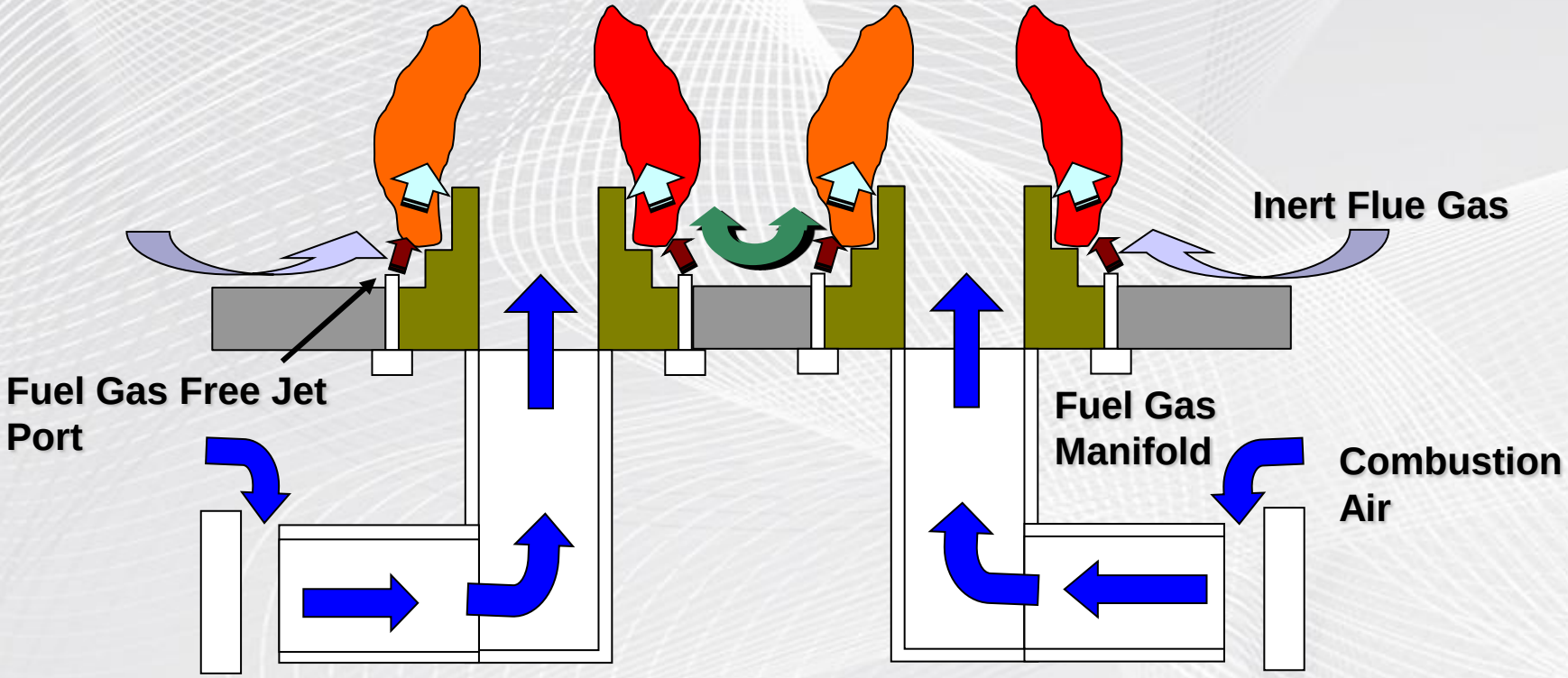


1st Stabilization Ledge



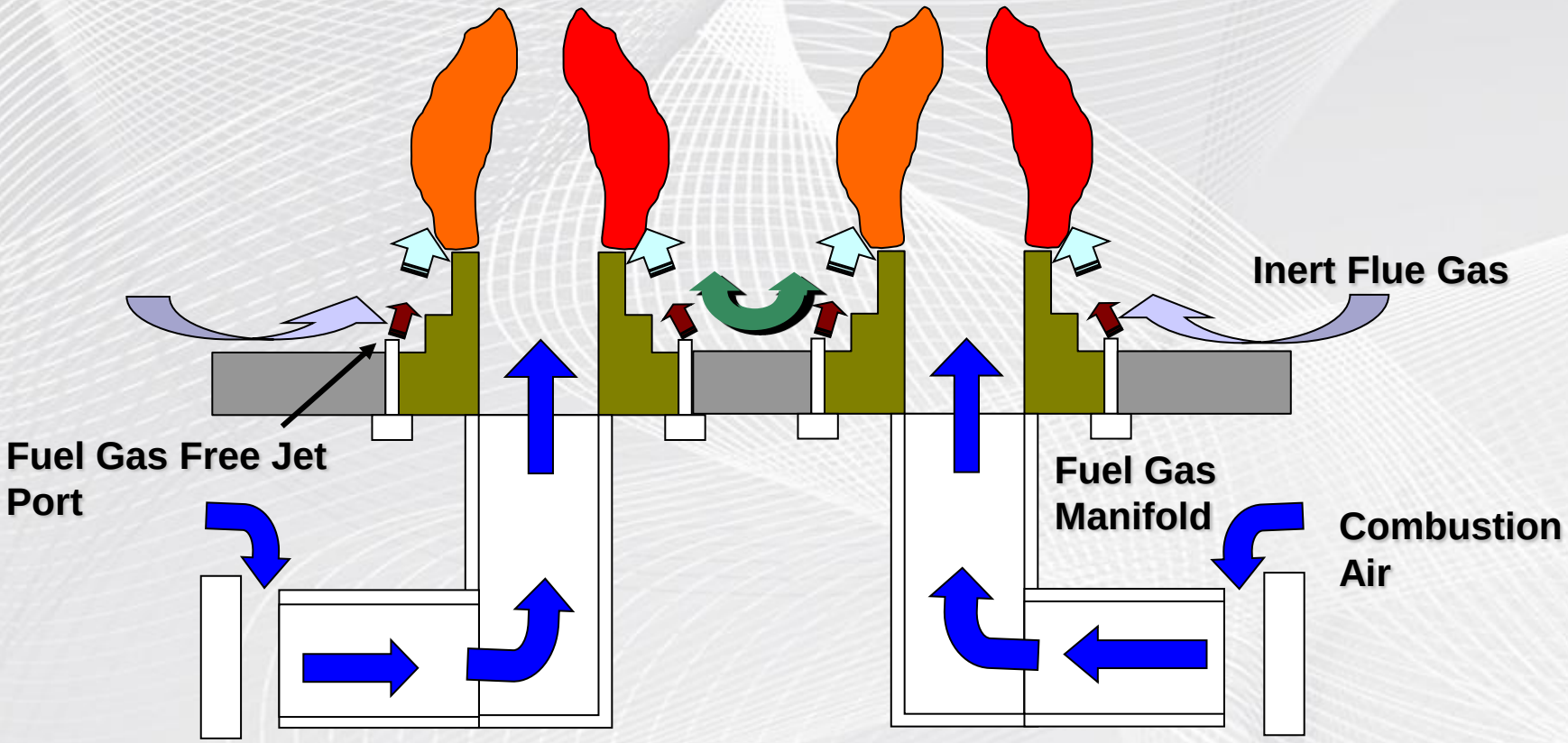
At high excess air levels, the burner flame stabilizes on the 1st stabilization ledge.

2nd Stabilization Ledge



As the excess oxygen level is reduced to the 15% to 7% range, the flame moves up from the 1st stabilization ledge to the 2nd stabilization ledge.

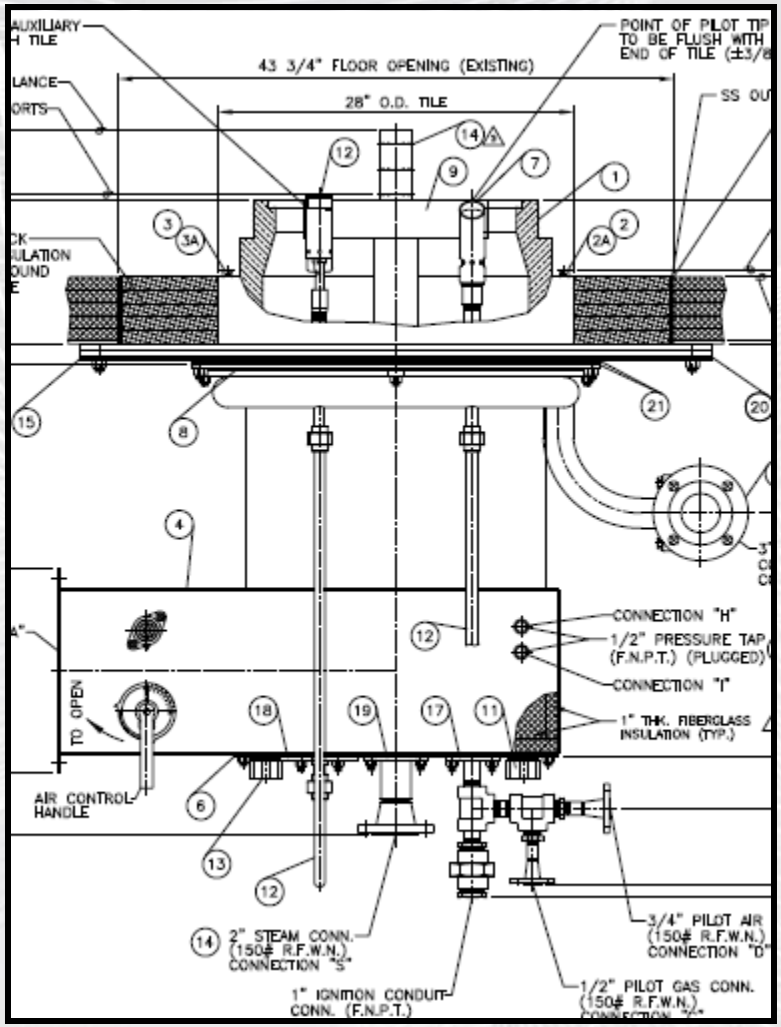
3rd Stabilization Ledge



As the excess oxygen level is reduced to approximately 7% and lower, the flame moves up from the 2nd stabilization ledge to the Final stabilization ledge. By the time the flame front has reached the top of the tile, the resulting reconditioned fuel composition is 80% to 90% inert.

Case Study: Dow in Pittsburg, CA USA

- < 9 PPMV NOx requirement
- 6.55 MM Kcal/hr Heat Release
- 6.6 m firebox height
- 926 C firebox temperature.
- 2.9 m tube circle
- 994,964 Kcal/m2 heat flux density
- 0.6 kg steam/kg fuel steam injection



Field Results

- Emissions measured by 3rd party agency to be reported to Enviromental Protection Agency
- 5.94 PPMV NOx dry average
- 2.51 PPMV CO dry average