



ZEECO

COMBUSTION AND ENVIRONMENTAL SOLUTIONS.
PURE AND SIMPLE.



BURNERS



FLARES



INCINERATORS



PARTS & SERVICE



Low NOx Burner Retrofits with BMS for Process Heater Optimization

Rex K. Isaacs

Director of Burner Products,
Zeeco Europe Ltd.

Presented by Trevor Leagas – Director of Flare Gas
Recovery Zeeco Europe

COMBUSTION AND ENVIRONMENTAL SOLUTIONS.
PURE AND SIMPLE.



BURNERS



FLARES



INCINERATORS



PARTS & SERVICE

► Main Topics

- The use of automated excess air control with Next Generation Ultra-Low NOx Burners not only reduces emissions, but also reduces fuel costs.
- Lower emissions can be achieved with lower operating costs.



➤ Introduction

- Burner retrofits with combustion air control and fuel gas control in process furnaces are an economical solution to reducing NOx emissions while reducing operating costs with existing fired equipment.
- The optimal excess air level for achieving ultra-low NOx emissions while reducing fuel costs is around 8% excess combustion air through the burner.

► CO Formation

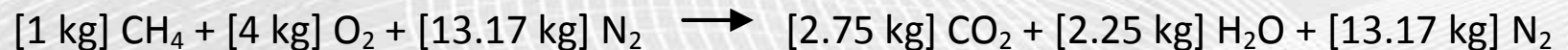
- Carbon monoxide (CO) formation normally begins at 5% excess air provided through the burner in sealed furnaces without leakage.
- The Heater operates with flue gas temperatures above 760° C, with excess Oxygen (O₂) & CO monitoring, and can be operated at 8% excess air.



► Stoichiometric Combustion

- Stoichiometric combustion is the theoretical conditions required for complete combustion of a fuel.

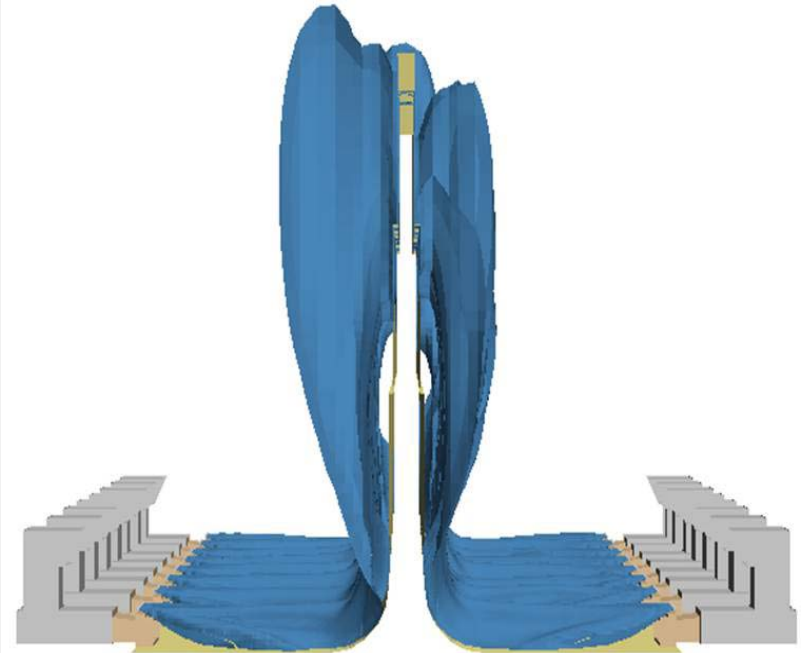
Stoichiometric Combustion of Methane in Air [weight basis]



- While stoichiometric is the theoretical point of complete combustion, in reality an excess of either fuel or air is required for complete combustion.

➤ Residence Time

- If the time required to mix air with fuel is greater than the time required for the Air and Fuel to travel through the Furnace (Residence Time), incomplete combustion occurs.



➤ Excess Air

- To ensure 100% of combustion occurs before exiting the radiant section, excess air is added.
- Excess air is necessary to obtain complete combustion. The amount of excess air should be minimized since higher excess air results in lower furnace efficiency and an increase in fuel consumption.



➤ Excess Air & CO Formation

- Since carbon monoxide (CO) formation normally begins at 5%, excess air is provided through the burner in perfectly sealed furnaces without leakage.
- The burner operates with flue gas temperatures above 760°C , with excess oxygen (O_2) and CO monitoring, and can be operated at 8% excess air.
- Should slight CO formation occur, the excess air level should be raised accordingly



➤ Excess Air & CO Formation Ctd.

- If significant CO formation occurs, then the fuel gas pressure should slowly be reduced to ensure that an explosive reaction does not occur.
- For safety, the combustion air control system is set to operate at 8% excess air. If CO formation occurs, then the control system will increase the excess oxygen level until CO formation is stabilized at an acceptable level
- To operate with high efficiency and low emissions, tramp air must be eliminated. Furnaces operating with tramp air have lower efficiency and higher NOx.

➤ Internal Flue Gas Recirculation (IFGR)

- Zeeco's Free-Jet burners mix the Fuel Gas with the inert products of combustion (flue gas) before combustion can occur, known as IFGR.
- The new fuel mixture is 80~90% inert for most cases and burns at a lower peak flame temperature, resulting in reduced thermal NO_x.



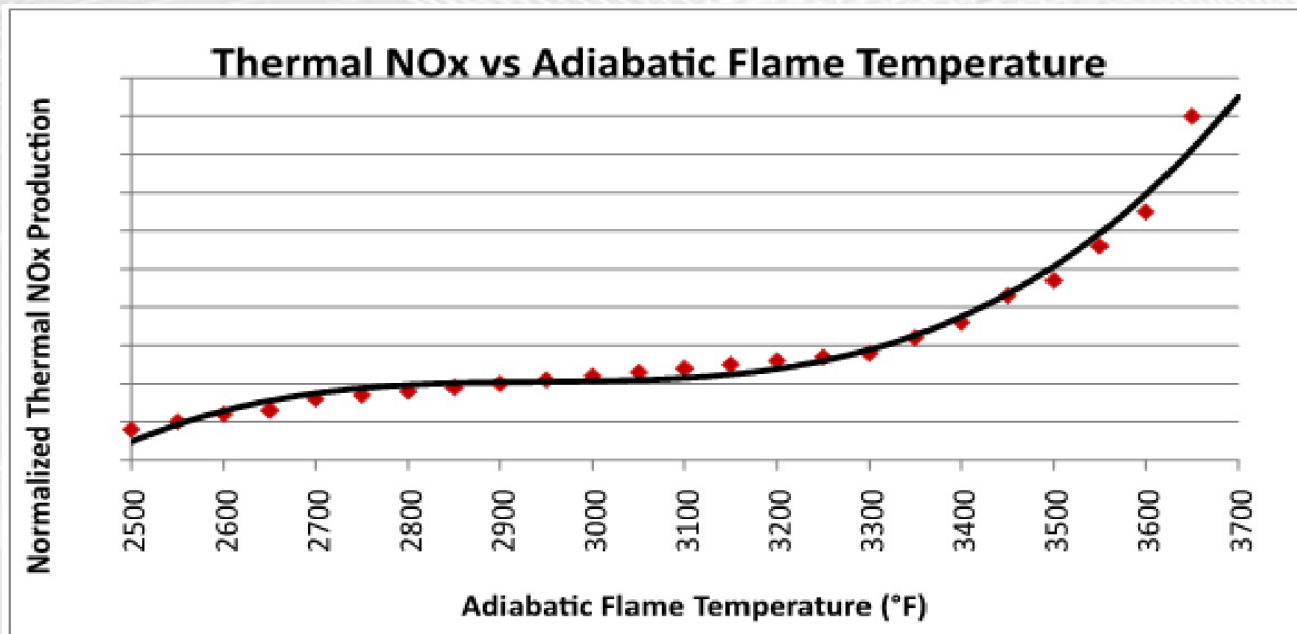
➤ Internal Flue Gas Recirculation (IFGR)

- With IFGR, Zeeco's GLSF Free-Jet Burners can achieve NO_x emissions levels of less than 50 mg/Nm³ at 8% excess air.
- The resulting flame is very transparent and difficult for human eyes to "see" at normal operating temperatures.



➤ Thermal NO_x Reduction

- The illustration below plots Peak Flame Temperature vs. Thermal NO_x created. NO_x emissions increase as the adiabatic flame temperature increases. Slowing the combustion reaction reduces the flame temperature, which results in lower thermal NO_x emissions.



► Fuel Reconditioning for Lower Thermal NO_x



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

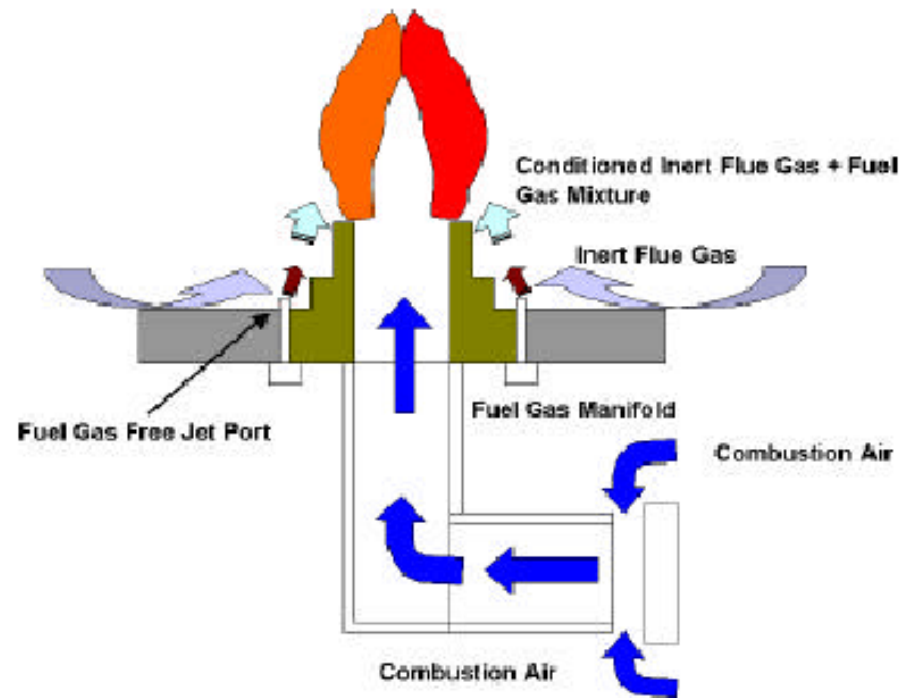
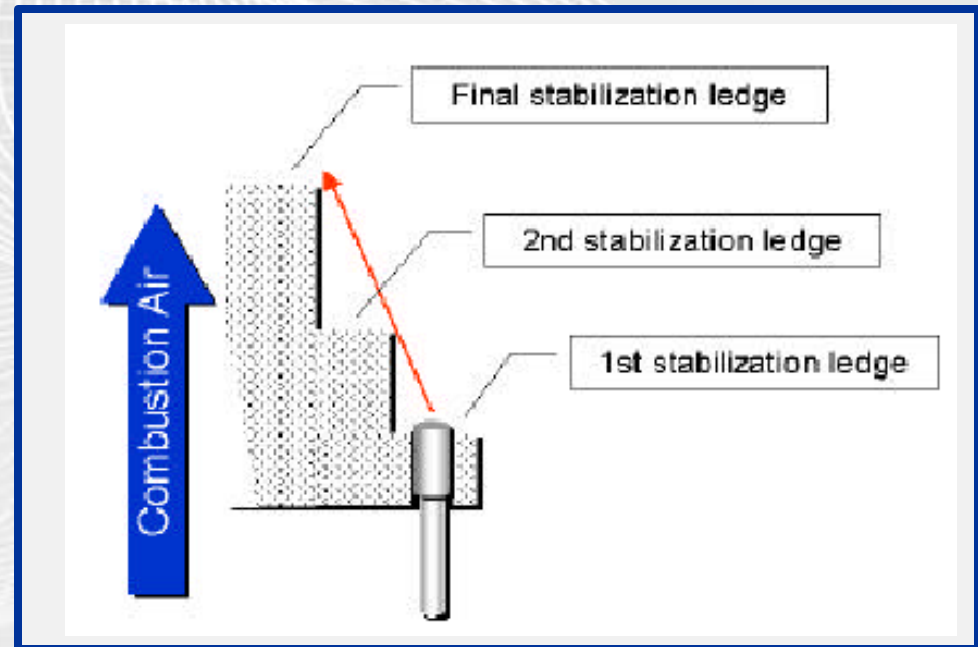


Figure 1: Free Jet Schematic

► 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 as conventional burner flame stabilizes on a refractory tile ledge.



► 1st Stabilization Ledge

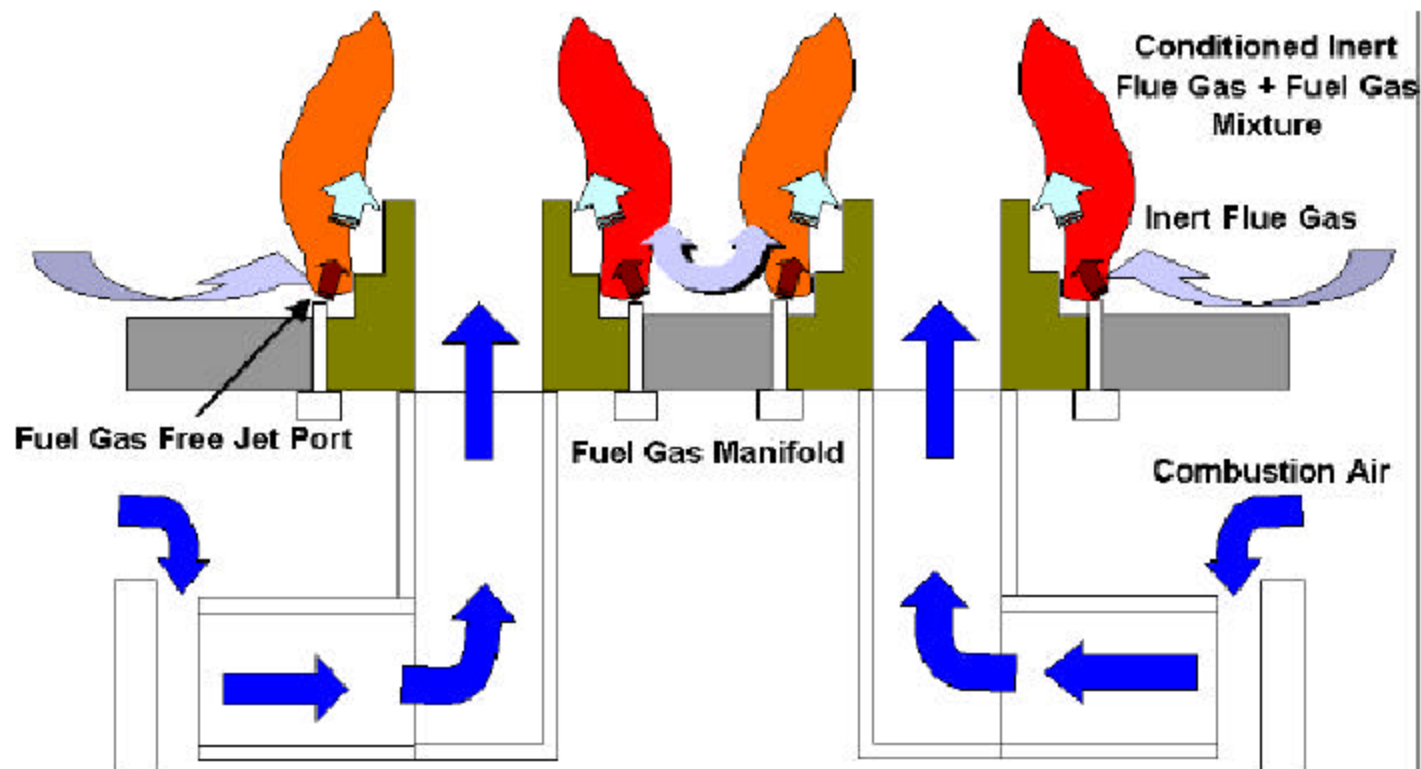
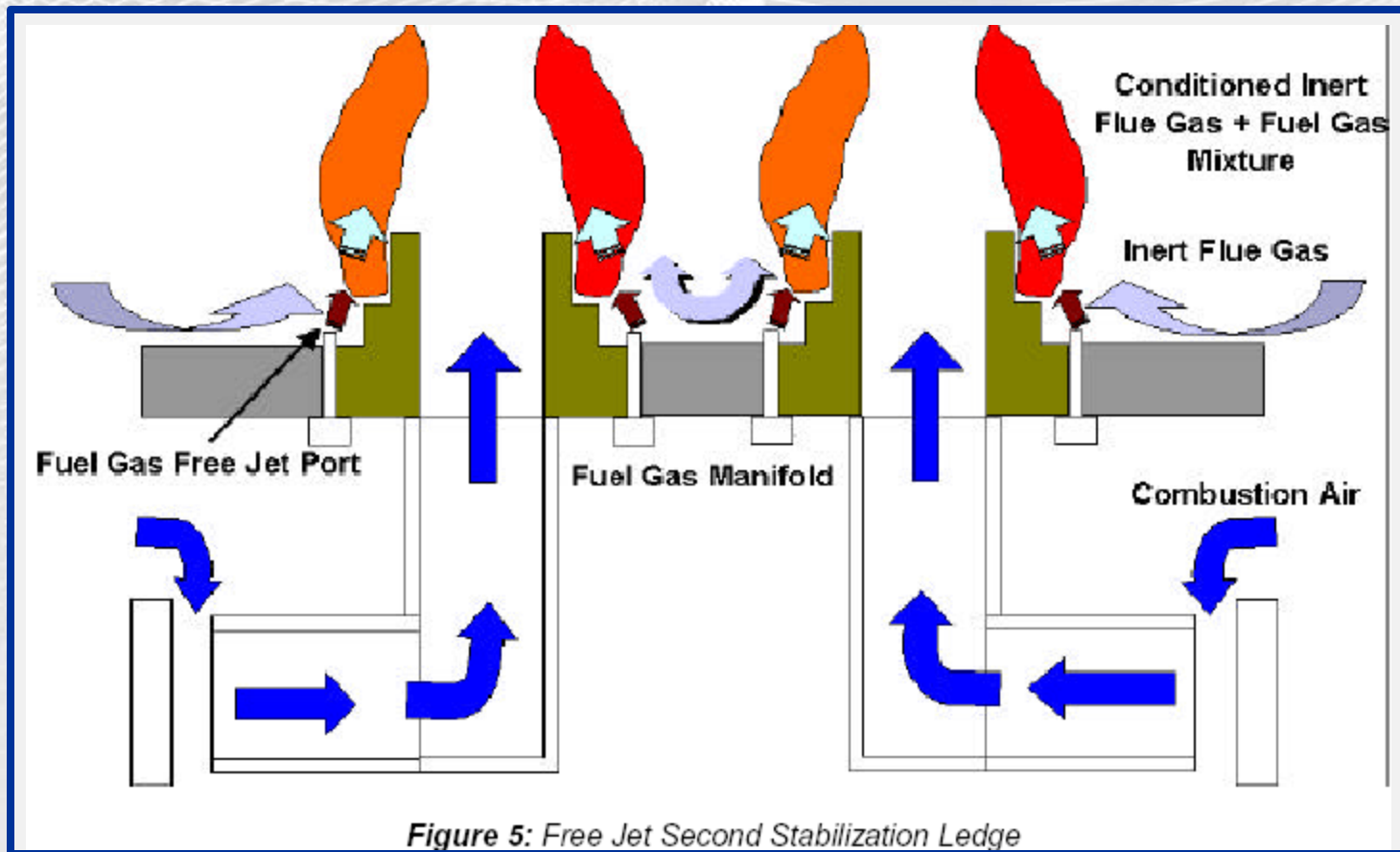
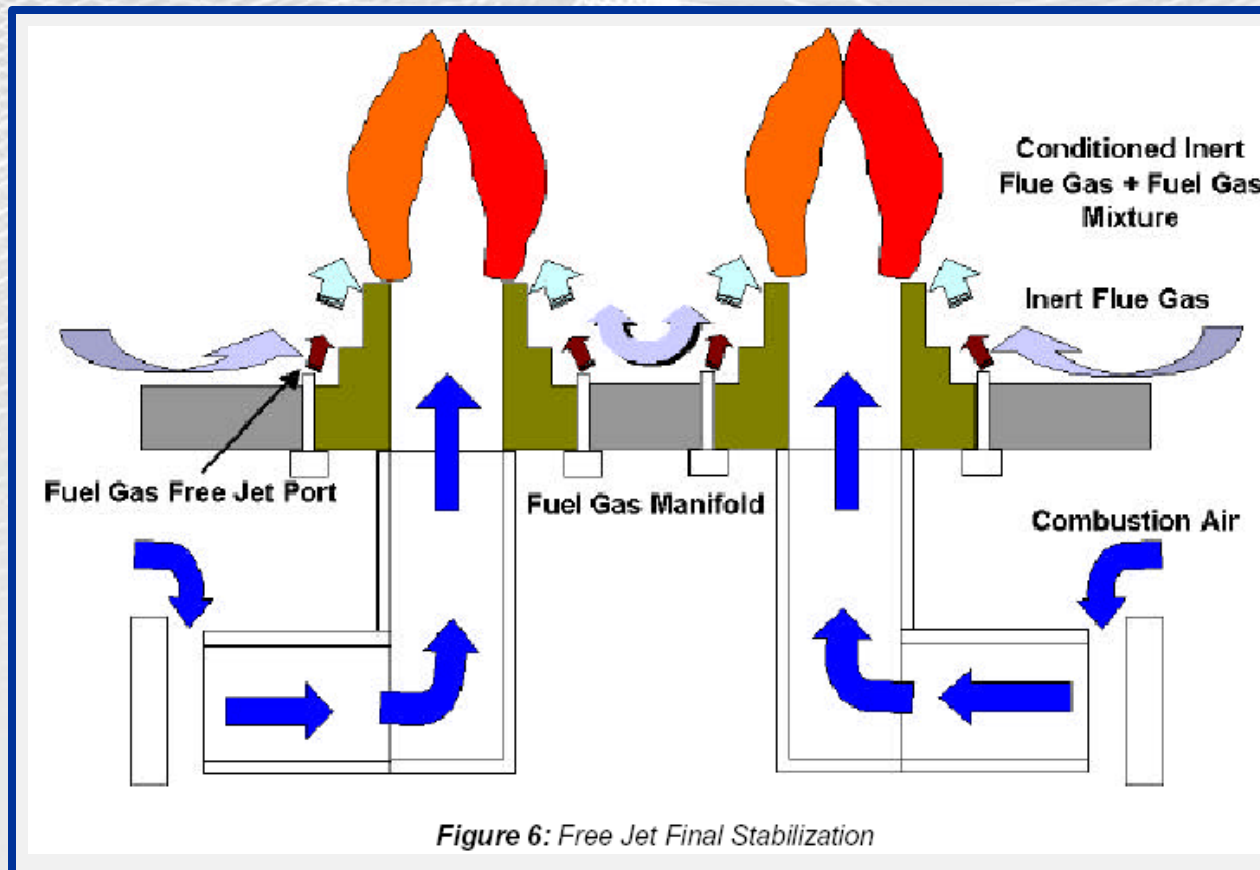


Figure 4: Free Jet First Stabilization Ledge

➤ 2nd Stabilization Ledge



► Final Stabilization Ledge



➤ Application Summary

- The purpose of the retrofit application was to replace the burners to achieve ultra-low NOx emissions.
- A Coker Furnace was retrofitted with sixty four (64) Zeeco GLSF Free-Jet burners each operating with a maximum heat release of 2.93 MW. The total maximum heat release of the Coker Furnace was 187.5 MW.
- The burners were designed to operate in the forced draft mode with 316 C combustion air preheat at 8% excess air. In addition, the furnace was designed to operate with a furnace flue gas temperature of 820 C of the gases exiting the radiant section.

► Application Results



After the sixty-four (64) burners were installed in the Coker Furnace, a third party measured the resulting emissions recorded at the below listed conditions:

- Operating Conditions:
- Number of Burners: Sixty-four (64)
- Burner Heat Release: 2.9 MW
- Furnace Heat Release: 185.6 MW
- Excess Air: 8%
- NO_x Emissions: 49 mg/Nm³
- CO Emissions: 5 mg/Nm³
- Calculated fuel savings: 0.68% fuel savings compared to operation at 20% excess air



► Results



- The use of an automated excess air control with Next Generation Ultra-Low NOx Burners can not only reduce emissions, but also reduce fuel costs.
- Burner retrofits with combustion air and fuel gas control in process furnaces are an economical solution to achieving lower NOx emissions levels and operating costs with existing fired equipment.
- The optimal excess air level for achieving low NOx emissions and less operating cost is ~8% excess air through the burner.
- The GLSF Free Jet Burner design can be used with a combustion air control system to achieve less than 50 mg/Nm³ NOx emissions with 316 C combustion air preheat and 0.68% fuel savings compared to operation at 20% excess air.