# SOLID FUEL TO NATURAL GAS CONVERSIONS FOR CIRCULATING FLUID BED BOILERS

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Recent discoveries of vast natural gas reserves across the world have led to increased natural gas production, resulting in lower prices. Utility and large industrial facilities are performing solid fuel conversions on their boilers to natural gas as a cost-effective and efficient fuel solution. Natural gas is not only economically beneficial but also environmentally efficient with cheaper prices and reduced $SO_2$, NOx, and $CO_2$ emissions. In the United States, the Environmental Protection Agency (EPA) has recently released mandatory requirements that directly affect the cost effective operation of solid fuel boilers, resulting in natural gas becoming a more economically appealing choice of fuel for facility operators.

Zeeco recently completed a solid fuel to natural gas conversion of a Circulating Fluidised Bed (CFB) Boiler designed for 1.3 billion Btu/hr of heat input for the maximum continuous steam rating.
The project required that the following conditions were met:

- Maintain boiler steam design capacity (~1200 kpph)
- Meet permitted NOx requirements – 0.07 lbs/MMbtu
    - 25-100% heat input for NOx emissions
- Minimal or no impact on the boiler waterside design
- Boiler able to follow steam needs per electrical generation requirements
- Ability to ramp per the original design conditions
- Turndown of 10-1

The owner required less than 26-week delivery for all components, as the need to fire natural gas was critical to the financial status of the project. Two sister units were built/commissioned on solid fuels approximately two years previously. The units were originally designed with natural gas start-up burners and commissioned for main fuel support via the petcoke. The petcoke was to be fired and combusted via a circulating fluid bed system; however, their petcoke fuel contract was no longer cost effective. The boilers were in operation for less than two years when the decision was made to switch to natural gas and utilise Zeeco's DT Ultra-Low NOx Free-Jet Burner technology.

The Zeeco Free-Jet burner series was designed with the specific purpose of maximising the amount of IFGR to reduce thermal NOx emissions without sacrificing burner performance with respect to flame length, turndown, and stability. The maximisation of IFGR means many of the problems associated with using high levels of EFGR to achieve low emissions can be reduced or eliminated. Specifically, Zeeco's Free-Jet design dramatically reduces or eliminates the need for EFGR by reducing blower power usage, increasing turndown, reducing maintenance and improving flame quality.

To do this, Zeeco devised a method to stabilise the burner flame in a low-pressure area created on a series of specially designed hot refractory ledges. As combustion occurs, the refractory ledge retains heat and flame stability is enhanced. Before combustion is initiated, a furnace is typically filled with normal air, which contains 21% oxygen. Once the burner is ignited, the oxygen content inside the furnace decreases until the burner achieves maximum duty. At this point, the oxygen content in the furnace is normally 2 to 3%. To keep the burner stable throughout the transition from start-up with 21% oxygen to maximum duty with 2 to 3% oxygen, Zeeco developed a series of stabilisation ledges as shown in **Figure 1**. These ledges are a design feature of the Zeeco® Free-Jet Burner chosen for the boiler retrofit. Since the boiler was only in operation for a short period of time, the plant needed assistance with the selection of the new gas firing system and options that would allow them to operate the boiler at the same steam flow capacity and pressure as originally designed for petcoke firing. Zeeco designed three options for converting the boiler to natural gas firing, and the operator chose one requiring the replacement of the four start-up burners with new burners, plus adding a

second level of four burners above to achieve the necessary heat input for full load steam conditions (1500 MMbtu/hr). The new Zeeco Free-Jet DT burners **(Figure 2)** fit within the existing opening, minimising retrofit costs.

This option provided the operator with maximum flexibility to return to petcoke firing if the price for natural gas rose to a level higher than that of petcoke fuel.

Final Conditions:

- Burner performance and full steam boiler operation was achieved in less than two weeks.
- Final emissions performance met the contract and permit requirements of 0.07lbs/MMBtu
- Plant owner was able to generate plant power within less than a month after the initial boiler start-up.

**Figure 1:** Free-Jet Flame Stabilisation Method Illustration_

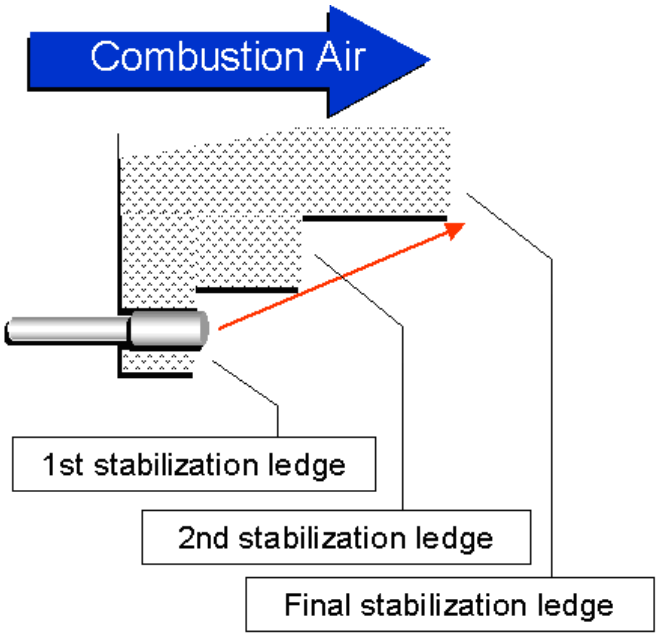


**Figure 2**: Zeeco's DT Free-Jet Burner