C.2. Project Abstract

The main objective of this project is to substantially reduce NO_x emissions from direct-fired process heaters in the petrochemical industry. These heaters are a significant source of NO_x emissions, emitting about 19,000 tons of NO_x per year in Texas. This project accomplishes the objective of reducing NO_x emission with support of TCET fulfilling objective (e) "Advanced Technologies that Reduce Emissions from Other Significant Sources" of Senate Bill 5.

The secondary objective is to accomplish the main objective without reducing overall process efficiency or increasing other emissions, which often occurs with NO_x reduction technologies. This is accomplished by the use of Oscillating Combustion. Oscillating Combustion is relatively simple process. It is accomplished by oscillating the rate of fuel flow to a burner. The effect of these oscillations is to produce fuel-rich and fuel-lean zones in the flame. Since combustion under both fuel-rich and fuel-lean conditions produce low levels of NO_x, the total NO_x formed is significantly lower than that which would occur if the combustion took place without fuel oscillation but at the same overall average fuel flow rate. When the fuel-rich and fuel-lean zones eventually mix in the heater or furnace, after heat has been transferred from the flame to the load and the flame temperature is lower, the resulting burnout of combustible gases occurs with little additional NO_x formation. The fuel-rich combustion zones have increased flame luminosity, and that combined with the increased turbulence resulting from the flow oscillations provide increased heat transfer to the heater or furnace load. The increased heat transfer enhances a heater's or furnace's efficiency and its production capacity.

The oscillation of the fuel flow rate is achieved by means of the installation of an oscillating valve on the gas line supplying each burner of a heater. Laboratory testing on many types of industries burners and limited field testing in steel mills, glass plants, and forging shops have shown that the Oscillating Combustion technology can reduce NO_x emissions by 30% to 70%, while usually increasing heat transfer by 2% to 13%, or furnace efficiency by 3% to 5%.

This project consists of two phases. The first phase of the project will consist of testing a typical, full-size, process heater burner with Oscillating Combustion in a test furnace at GTI's combustion laboratory located in Des Plaines, Illinois. Once satisfactory results are obtained in the laboratory (the goal is 50% NO_x reduction), the second phase, consist of retrofitting a direct-fired process heater at a BP Products North America, Inc. facility in Texas, will commence. A field trial will be conducted to establish the benefits for NO_x reduction and efficiency and productivity gain under industrial conditions.

In addition to the funding support from TCET, BP is providing in-kind support for installation of the Oscillating Combustion retrofit system, and GTI's Sustaining Membership Program (SMP) and the GTI (formerly GRI) FERC program are providing monetary cost sharing.

The Oscillating Combustion technology is expected to reduce NO_x emissions by 50% when applied to direct-fired process heaters with conventional burners. When applied to heaters in the chemicals industry (with 566 of this industry's 700 heaters in Texas) and the petroleum industry (with 257 of this industry's 1482 heaters in Texas), with a conservative 10% to 20% market penetration, it can be estimated that Oscillating Combustion will reduce NO_x emissions by 620-1,240 tons per year in Texas (770-1,540 tons per year in the U.S.) in the chemicals industry and by 350-700 tons per year in Texas (2,000-4,000 tons per year in the U.S.) in the petroleum industry. These amounts do not include any additional NO_x reductions or any CO_2 emissions reductions resulting from lower fuel use due to improved efficiency.

Successful testing of Oscillating Combustion will directly facilitate the deployment of this technology in the petroleum and chemicals industries, and demonstration of the commercial worthiness of the equipment installed to implement Oscillating Combustion will help with deployment of this technology in other industries.