Project Title: A Technique for Accurately Determining the Fuel Gas Calorific Value for an Industrial Gas Turbine

Siemens Industrial Turbomachinery (SIT) Ltd in Lincoln, designs, manufactures, installs and provides life-time support for world-class gas turbines for Industrial Power Generation and the Oil and Gas Industry. These turbines provide power in the range 4 to 16MW and ae regularly be used to drive generators, compressors and pumps. The turbines generally run using gas or liquid fuel, although on occasion they have been run using gas from bio-mass plants as fuel.

Due to cost constraints fuel flow meters and calorimeters are not generally installed so neither the fuel flow nor the calorific value of the gas fuel are measured. The control system is given an assumed calorific value, usually based on information from the customer, and when in operation calculates a fuel demand in kW based on the output power demand, and the fuel valve is opened/closed appropriately to control the flow rate until the necessary output power is achieved.

We are interested in being able to calculate, in real-time, the calorific value of the gas fuel since it will help us to more precisely identify poor quality gas, which in turn may help us to more accurately predict whether or not the gas fuel burners are likely to be fouling quicker than normal and therefore in need of changing more frequently. If the burners become fouled then this can lead to flame failure, which results in the turbine shutting down unexpectedly, and has the knock-on effect of the customer being unable to restart the turbine until he has changed the burner(s). Similarly a more accurate determination of the fuel calorific value would enable us, as the Original Equipment Manufacturer – OEM, to ascertain when customers are using poor quality fuels that are outside of design specifications for the turbine. Due to the use of lean premixed combustion in our engine's dry low emissions (DLE) combustion systems, a low calorific value fuel would result in high combustion dynamics, flame perturbation and blow out. As the OEM, we want to be able to accurately identify when an engine's combustion dynamics is resulting from the use of low quality fuel blends.

The constraints we face are primarily with the instrumentation where again due to cost constraints do not necessarily install sufficient instrumentation, for example, we do not always know the inlet air pressure and assume this to be 1bar, or the compressor discharge pressure. However given these constraints, and possibly data from turbines that are better instrumented, we would be interested in learning if it is possible to create a model, possibly statistical or mathematical, that can accurately capture the calorific value of the gas fuel. We intend to provide real-life engine data measured by sensors that are installed on some of our engines. These parameters may include, but not limited to, the following: ambient air temperature and pressure; compressor discharge temperature and pressure; turbine running speed; interduct temperature and pressure; exhaust gas temperature and pressure; fuel flow demand (kW); fuel valve positions and gains; output power from the generator – this is for engines that are used as electrical generator sets, those engines that are used as mechanical drives do not produce output power.