



Cheng Low NO_x (CLN)

Dear IPT Colleague,

This letter will bring to your attention some recent developments in Cheng Low NO_x (CLN), the ultra-low emissions gas turbine technology developed by IPT. While the CLN technology has been applied to other gas turbines, this letter focuses on CLN's application to the Allison 501KB(x) line of engines.

The CLN technology is a nozzle steam system that is similar in overall principal to the Allison 501 OEM stock nozzle steam injection system that has been in existence since the mid 1990's. The Allison stock OEM nozzle steam system mixes saturated steam with cold fuel prior to entering the combustion liner which then quenches the peak flame temperature thus resulting in lower NO_x. The problems with the OEM design include low mixing efficiency, due to the short nozzle body mixing length, and steam condensation in the nozzle due to the injection of cold fuel into the steam. Both of these nozzle steam design deficiencies contribute to the inability of the stock system to achieve ultra low NO_x, stable CO, and leveled BOT temperature patterns.

Nozzle steam injection is not new for the Allison 501 and millions of hours of nozzle steam injection experience have been accumulated in the Allison 501 marketplace. The nozzle steam injection system was introduced by Allison in the 1990's to provide an engineered solutions alternative to the Allison 501 users employing water injection systems on their gas turbines. As compared to engines employing water injection, the stock nozzle steam system proved to decrease turbine fuel consumption and increase liner lifetimes.

CLN takes advantage of this experience and adds to it the capability to achieve even lower NO_x emissions, controlled CO, and improved BOT flame pattern. The patented CLN technology improves on the stock OEM nozzle steam design and eliminates the problems of the stock system identified above by mixing the steam and fuel further upstream of the engine from its OEM mixing point which then results in a much higher level of mixing efficiency, called homogeneity, and by increasing the temperature of the steam and fuel mixture prior to injection into the engine. Additionally, a specialized IPT fuel nozzle is also installed in place of the stock nozzle in systems requiring less than 15 ppm NO_x. The combined effect of these CLN improvements to the stock system results in being able to achieve ultra-low NO_x, controlled CO at very high steam injection rates, and greatly improved combustion liner lifetimes when comparing CLN to water injection.

The highlights of the technology include:

- Guaranteed NO_x down to 5 ppm (corrected to 15% O₂) for the KB5(x) engine burning pipeline natural gas.

- Meeting all US AQMD retrofit requirements including the new San Joaquin Rule 4703 for Gas Turbines under 10 MW.
- Improved BOT flame pattern resulting in increased combustion liner lifetimes.
- Guaranteed nozzle steam injection quality and purity according to the Allison Installation and Design Manual (IDM) nozzle steam injection specifications.
- Over 35,000 hours of CLN operation on the 501-KB(x) class of gas turbines.
- Reduction of CO2 green house gas resulting from greatly improved turbine heat rates while operating with nozzle steam injection as opposed to operating with water injection.

Steam injection quality (moisture content) and purity (TDS content) are guaranteed by IPT to meet the Allison Installation Design Manual (IDM) injection steam specifications when IPT performs the steam injection piping engineering and installation. The CLN can be employed on gas turbine systems with and without heat recovery and for all types of boiler HRSG designs including natural and forced circulation boilers and OTSG (Once Through Steam Generator) type boilers. Steam quality and purity are both a function of feedwater supply quality, boiler outlet steam quality, and the required injection steam moisture removal efficiency, all of which are taken into consideration during the design phase of the project and which result in a CLN steam injection system that will remove the moisture and TDS in the injection steam down to the level required by the manufacturer of the engine.

There are no technology risks to the end user for employing CLN because there is no exposure to any additional hazards or dangers as a result of installing CLN. The CLN is a new technology, however, it does not introduce any additional risks to the end user because mixing steam with fuel for NOx control has been around for a very long time and because there are millions of hours of experience with the Allison 501 nozzle injection steam systems in the world. The CLN builds on that experience to improve performance along the most significant measurable engine operating parameters including: NOx emissions, CO emissions, BOT temperature pattern, turbine heat rate, and combustion liner lifetimes. Simply stated, the CLN system can achieve ultra-low NOx emissions with no added risk, guaranteed.

Please see IPT's web site www.intpower.com for more information about IPT and the CLN technology and please don't hesitate to call for more information or for a tour of our Menlo Park, California CLN cogeneration plant.



Randy Turley
President & CEO