Application Notes: Low emissions gas turbines

For various reasons many operators choose to buy low emissions gas turbine(s). These are also called DLE (Dry Low Emissions) or DLN (Dry Low NOx) gas turbine turbines. Following are the reasons given:

- Low NOx emission requirement specified by the local authorities,
- Lower overall emissions expectations by the local regulators.

DLE / DLN gas turbine suppliers typically quote low NOx limit of 25 ppm or lower. Nitrous oxide are formed due to high temperature spots in the combustor. Low NOx emissions are achieved by ensuring that the gaseous fuel and air are properly mixed for uniform temperature in the combustion chamber thus prevent or reduce formation of various nitrous oxide.

Even though the technology has substantially improved over time, DLE / DLN turbines when purchased to meet emissions requirement, if not properly designed may lead to poor equipment reliability for a variety of reasons which may or may not be in the control of the gas turbine suppliers.

When purchasing DLE/DLN gas turbines the plant design engineers should consider the following and try to mitigate these issues to ensure reliable operations:

DLE/DLN turbine and support system design considerations:

1. Low emissions DLE/DLN turbines have reported errors in temperature monitoring in the burner cans which control the flow of the cooling air in the turbine. This has also led to the burners being damaged.
2. At part load operations DLE/DLN turbines have reported load oscillations requiring tuning of the turbine.
3. Rumbling has been reported in the combustors and exhausts of DLE/DLN turbines.
4. For stable operation of DLE/DLN turbine compressor section, air bleeding may be required at higher part loads thereby reducing the efficiency at part loads.
5. DLE/DLN turbines have reported load control issues when operating on liquid fuels.

Plant / facility design considerations:

1. DLE/DLN turbines can accept only a narrow range of fuel (gas) heating value. Hence, the fuel gas supply system has to be designed to minimise fluctuations in temperature, pressure, and fuel gas composition. The fuel gas wobbe index is required to be maintained between 40 and 60 and must not vary more than +/- 10% within the time duration specified by the turbine supplier.
2. Duel fuel DLE/DLN turbines have shown lack of controllability, flame out and frequently reported damage to hardware (fuel nozzles) due to switching between diesel and gaseous fuel.

3. Facilities may require additional turbine spinning reserves for starting of large equipment example, large motor driven compressor.
4. DLE/DLN turbines may not be suitable for very low ambient temperature.
5. DLE/DLN turbine fuel gas supply temperature is limited to 70°C.
6. DLE/DLN turbines require higher fuel gas filtration and conditioning.

Operational concerns:

1. The allowable load variation range of DLE turbines, without damaging its hardware or flame out, is lower compared to the conventional gas turbine.
2. DLE/DLN turbines may not be able to reliably respond to a rapid change of load. This is more pronounced when operating at low loads. Evaluate load change limitations against plant requirements for both grid supply or island mode operations.
3. Due to the lack of speed response by the control system, DLE/DLN turbines are known to trip on flame out. Flame out has also been reported on rapid deceleration or in cold weather conditions.
4. Plant and grid load balance flexibility is adversely affected as DLE/DLN turbine(s) are required to run above a certain load.
5. DLE/DLN turbines are claiberated to operate within a small range of gas heating value to ensure flame stability. Gas heating value should not vary more than +/- 10%.
6. Additional tuning may have to be carried out as the weather changes from summer to winter and vice versa.

Reliability / Availability / Maintenance issues:

1. DLE/DLN dual fuel flow turbines have reported auto-ignition and flash back within the pre-mix chamber after the switching of fuels.
2. Trained, competent staff are required to be stationed at the site with tuning and mapping skills to operate DLE turbine(s). When they are not available, it may result in extended loss of production.
3. DLE/DLN turbines have generally reported higher number of start attempts per successful start when compared to the conventional turbine.
4. DLE/DLN turbines have reported lower production availability when compared to the conventional turbines.
5. Due to extended operation in lean-lean mode, DLE/DLN turbines have reported reduced maintenance interval since lean-lean mode operation with higher firing temperature accelerates hardware wear.

6. DLE/DLN turbines on average report a higher rate of replacement of the bleed valves.
7. Variable geometry fuel injectors of certain low emissions turbines have shown lower reliability.
8. Coatings in DLE/DLN turbines are sensitive to the corrosion in the fuel gas system and consequent particulate matter reaching the combustor.
9. DLE / DLN turbines have reported higher rate of mechanical failure of the bleed duct.
10. DLE/DLN turbines have reported cracks in the combustion liner due to rumble arising from white noise.
11. DLE/DLN turbines subjected to oscillation vibration have experienced higher mechanical failure.
12. DLE/DLN turbines with variable geometry fuel injectors have shown poor reliability when the air flow to the injector is controlled by variable plugs.
13. DLE/DLN turbines have reported higher rate of mechanical failures of combustors, exhaust collectors and bleed valves.
14. Duel fuel DLE/DLN turbines have generally shown lower reliability / availability.
15. DLE/DLN turbines generally have reported higher maintenance cost at 16K/24K/30K hours maintenance.

Recommendations: A properly selected DLE/DLN gas turbine and well designed plant utilities are more environmentally friendly and economical. Selecting the right turbine(s) at the design stage requires experience, and expertise. It cannot be simply left to the suppliers claims. The plant design engineer needs to spend time evaluating the options and carefully weighing the pros and cons of the various offers. Poor efficiency can load a purchaser / operator with higher emissions and higher fuel cost running into millions of dollars per annum for the life of the plant. Choose wisely. Talk to us if you need help. Our contact details are given below.