Critical performance characteristics

Transient load pickup characteristics of reciprocating engine generators are critical to performance of the loads themselves, to overall electrical system performance, and to stability of the bus. Islanded operation of a generator set (or multiple generator sets in parallel) is critical not only to the load being started and powered but also to other loads previously connected on that bus.

Gaseous fueled, spark ignited engines have unique load step capabilities and transient response characteristics. These characteristics are partly the nature of gaseous fueled spark ignited engines and partly dependent on fuel and air delivery control technology.

When electrical equipment loads are operated with power supplied from a utility grid, they are started, run and stopped with little to no disturbance of the utility power. Under normal circumstances the power supply remains stable and the voltage and frequency virtually unaffected.

When the same loads are operating on generator sets, the size of the power supply based on both the prime mover and the alternator affects how the loads transition onto and off the generator set. The result is dips in voltage and frequency, rises when the loads are removed and a transition time returning to nominal values. Essentially there is a time of unstable power supply during these transients and recovery times.
Generator sets from Cummins Power Generation provide superior performance of load pickup transient capability resulting in fewer voltage and frequency disturbances and faster recovery times, thus creating a more stable electric supply. The following data provides guidance on the application of Cummins Power Generation lean-burn natural gas engine generator sets.

**Load pickup and stability**

Within the range of Cummins lean-burn technology generator sets there are two primary model types, a robust design optimized for tolerance to temperature, altitude and load steps, the other optimized for efficiency. The differences are both hardware and software. The robust designs are optimized for performance with fuel/air delivery technology and multiple smaller turbo chargers for optimum response. Multi-turbo designs combined with other engine designs and operation technologies deliver unparalleled load acceptance capability.

The high efficiency models use specific technology variations in the area of combustion; for example, a single large turbo charger. These higher efficiency models are designed with a focus on continuous duty operation parallel to a utility grid and pose unique challenges when operating in island mode (not connected to a utility grid).

The load acceptance guidance for Cummins Power Generation lean-burn gas generator sets can be tabulated or graphically represented as seen in the following Figures. These performance charts are based on ISO 8528 conditions and part 5, “G1” performance criteria. The G1 performance class limits voltage and frequency dips to 25% and the recovery times to 10 seconds.

![Load acceptance guidance for CPG LBNG models: C1750N6C, C1400N6C, C1540N5C, C1160N5C, C1750N5C](image1)

The preceding data is offered as initial guidance to these capabilities for application to islanded operation. Greater load steps can be achieved both within and outside of the G1 Class performance criteria dependent on customer requirements. Some machines can exhibit superior transient load capabilities than described herein and many load types can tolerate greater disturbances without difficulty starting or disruption of operation. These cases must be reviewed on an individual basis.

Load rejection transient

Another aspect of transient performance of a generator set that is sometimes overlooked is load rejection transient. The amount of disturbance caused by decreasing load steps or total load rejection is critical. The frequency and voltage rise affects the remaining connected loads and if the disturbance is too great, those loads could be disrupted. Cummins engine technology allows excellent load pickup capability whilst limiting frequency rise on load rejection to acceptable levels.

One of the most important aspects of the Cummins technology is the ability to reject 100% of rated load in a single step and remain running. Any Cummins lean-burn natural gas generator sets, when properly maintained, will not shut down on overspeed upon 100% load rejection. This has several benefits; it avoids hot shutdown which is not desirable for any engine, critical generator ancillary equipment can remain powered by the generator, and the engine remains ready (within a few seconds) to reacquire other critical loads. It is worth noting that this is an essential criterion enabling Cummins Power Generation generator sets to be Grid Code Compliant.

Conclusion

Cummins Power Generation lean-burn gas generator sets offer superior load pickup, load rejection and recovery capabilities. The above information is offered as guidance to these capabilities for application to islanded operation. Some machines exhibit superior transient load capabilities and vary with the operational conditions. Each application is unique, posing its own requirements of load types, combinations and operational circumstances. Optimum performance can be achieved with further details analysis. Consult a Cummins representative for further guidance.
About the author

Timothy A. Loehlein is a graduate of the University of Minnesota, Institute of Technology with a Bachelor of Electrical Engineering and is a licensed Professional Engineer in Minnesota, USA. He is a specialist in electrical engineering, power generation, and generator set installations. Tim has been a Cummins Power Generation employee since 1976 in positions as Application Engineer, Design Engineer, Technical Project Leader and Manager. His current position is a Technical Advisor in Sales Application Engineering for Cummins Power Generation Power Solutions Business, providing support for energy management projects in the Americas and around the world. His duties include providing customer and internal guidance and training in applications of generator sets into projects such as combined heat and power (CHP), peak-shaving, standby power, and use of nonstandard gaseous fuels. Outside of work, he likes to wind down with woodworking, hiking, fishing, scuba diving, and boating on Lake Superior.