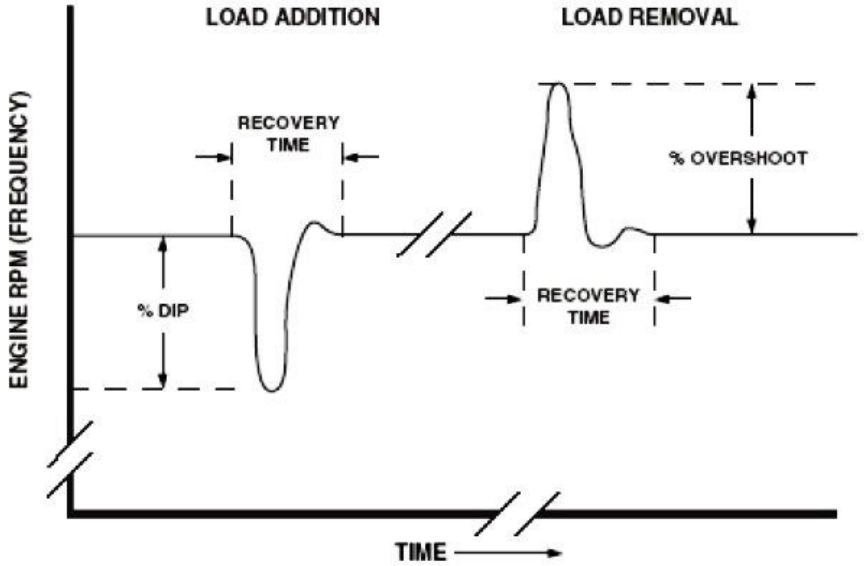
Diesel generator power quality (part 2)

When a large load is added to a circuit, there is no need to worry about the utility power to accept the load or any transient effects on power quality. However, when power is drawn from a generator set transient effects become a valid concern.

Whenever a large load is added to a generator set, engine speed temporarily slows down – or dips – before returning to its steady state condition. When this large load is removed, engine speed increases – or overshoots (rise) – temporarily. Since generator frequency is determined by engine rpm, the power quality is affected. Measurements of these temporary speed changes are called transient response. Both voltage and frequency transient response dictates the generator set performance.



Transient response is measured by percentage voltage or frequency change and duration. The amount of time it takes for the engine to return to steady-state operation is called recovery time. This can vary from as short as 1 second to 20 seconds. In general, the larger the load added, the greater the percentage of dip and the longer it will take the engine to recover. Dips are more critical than overshoots because severe block loading can stall the engine and cause the generator voltage to collapse.

PNS ISO 8528 part 5 and PNS IEC 60034 part 22 specifies four performance classes of generator sets with the required transient response, Table 1.

Note:
PNS ISO 8528 – Philippine National Standards, International Standards Organization 8528 – Reciprocating Internal Combustion Engine Driven Generating Set.
PNS IEC 60034 – Philippine National Standards, International Electrotechnical Commission 60034 – Rotating electrical machines.

Table 1. PNS ISO 8528 part 5 Generator Set Performance Class

Performance Class	G1	G2	G3	G4
Voltage:				
Steady-state voltage	2.50%	1.50%	1.00%	AMC
Max. voltage dip	-25%	-20%	-15%	AMC
Max. voltage rise	35%	25%	20%	AMC
Voltage recovery time	10 sec	6 sec	4 sec	AMC
Frequency:				
Steady-state frequency	2.50%	1.50%	0.50%	AMC
Max. frequency dip	-15%	-10%	-7%	AMC
Max. frequency rise	18%	12%	10%	AMC
Frequency recovery time	10 sec	5 sec	3 sec	AMC

Description of each performance class:

a. **Class G1** – this applies to generating set applications where the connected loads are such that only basic parameters of voltage and frequency need to be specified. Example: general-purpose applications (lighting and other simple electrical loads).

b. **Class G2** – this applies to generating set applications where its voltage characteristics are very similar to those for the commercial public utility electrical power system with which it operates. When load changes occur, there may be temporary but acceptable deviations of voltage and frequency. Example: lighting systems, pumps, fans and hoists.

c. **Class G3** – this applies to applications where the connected equipment makes severe demands on the stability and level of the frequency, voltage and waveform characteristics of the electrical power supplied by the generating set. Example: Telecommunications and thyristor-controlled loads. It should be remembered that both rectifier and thyristor-controlled loads may need special consideration with respect to their effect on generator-voltage waveform.

d. **Class G4** – this applies to applications where the demands made on the stability and level of the frequency, voltage and waveform characteristics of the electrical power supplied by the generating set are exceptionally severe. Example: Data-processing equipment or computer systems. The specification of this type of generator set is normally with prior agreement by the manufacturer and customer (AMC).

Figure 1. Transient voltage response measurement of Powercity 25 KVA generator set.

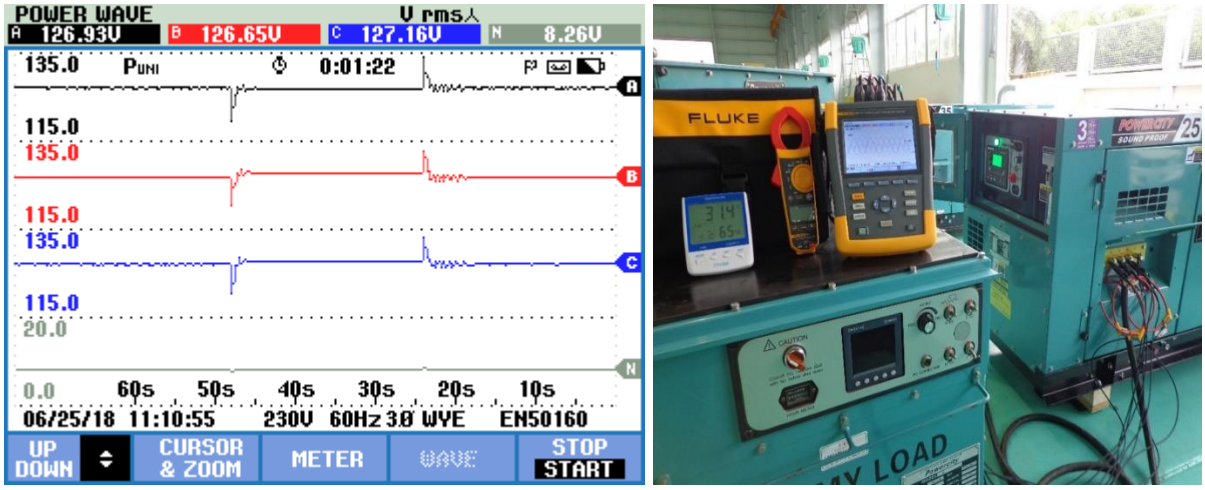
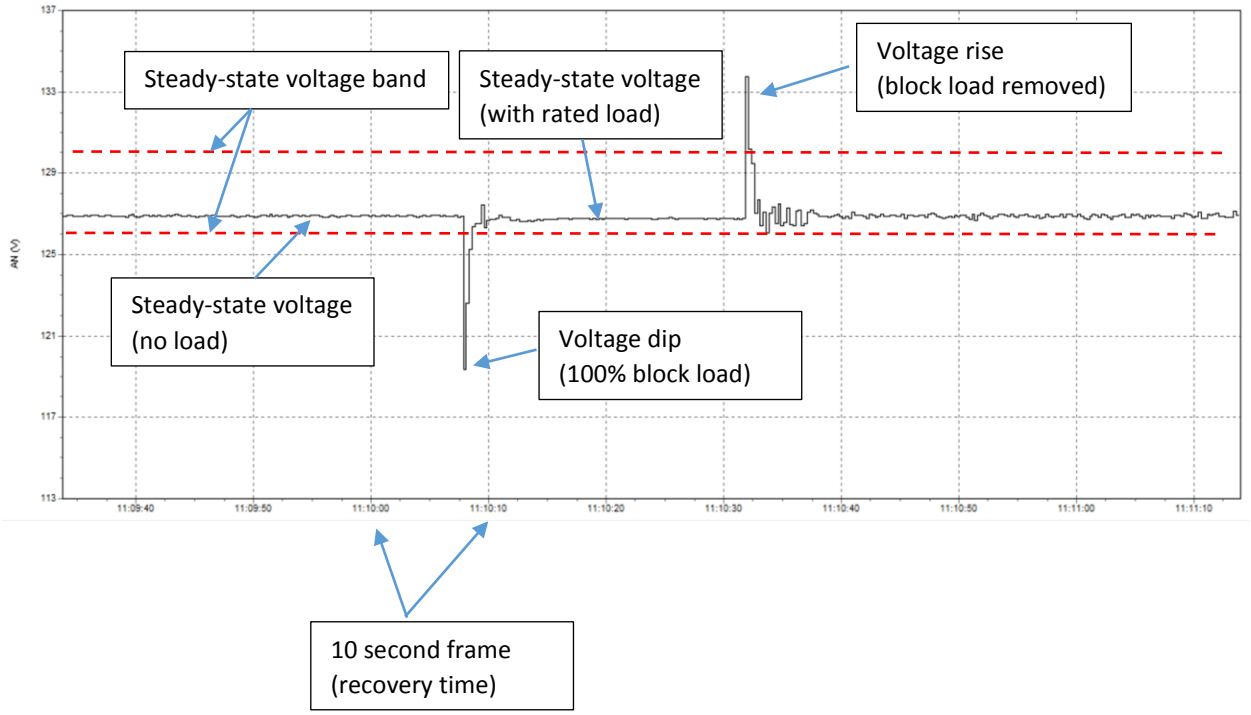
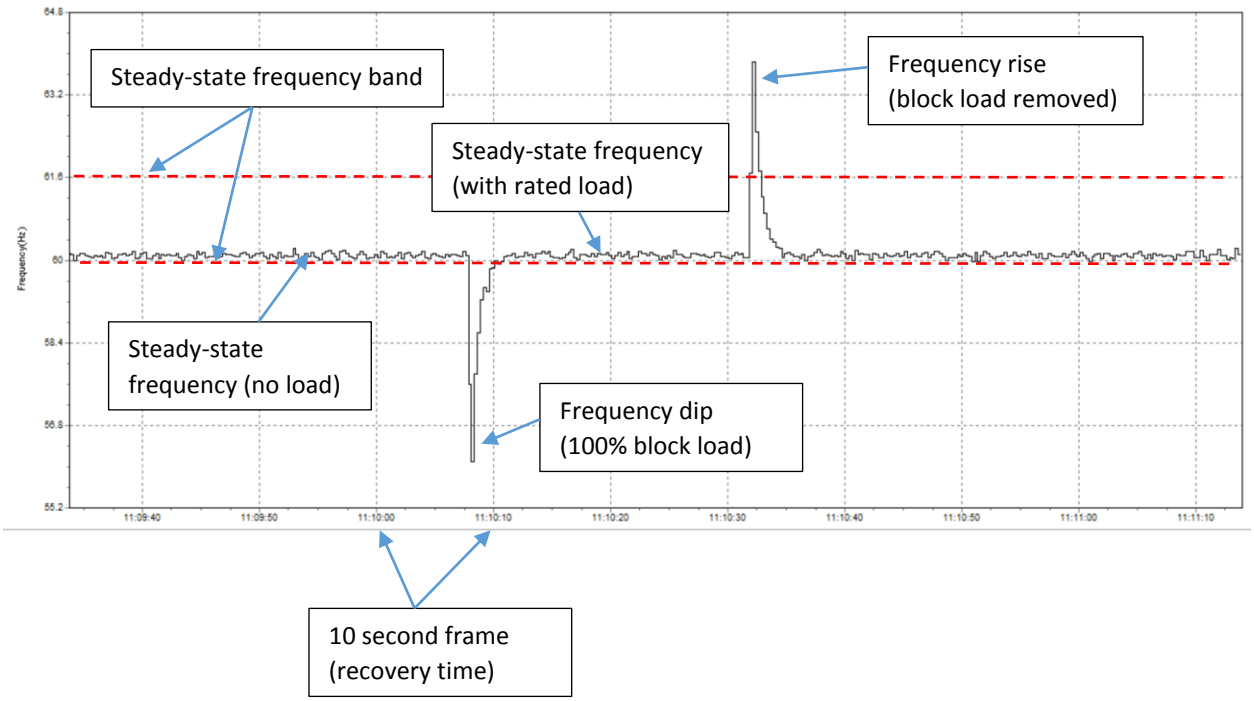


Figure 2. Transient voltage response of Powercity 25 KVA applying 100% block load.



The generator set provides a good voltage regulation as can be observed in its steady-state voltage band. The transient voltage recovery is less than 10 seconds, qualifying the generator set for Class G2.

Figure 3. Transient frequency response of Powercity 25 KVA applying 100% block load.



The generator set provides a good frequency regulation as can be observed in its steady-state frequency band. The transient voltage recovery is less than 10 seconds, qualifying the generator set for Class G2.

Basically, these measurements correspond to the following:

1. Performance or response of engine governor or speed controller.
2. Quality of voltage regulation.
3. Sufficiency of engine mechanical power (kW_m) at rated load.