GENERATOR SET
SYNCHRONING WITH AND RUNNING IN PARALLEL WITH THE SUPPLY UTILITY GRID

GENERATOR SET SYNCHRONISING WITH THE SUPPLY UTILITY GRID

When a generator is to be paralleled with the Supply Utility Grid the voltages on either side of the paralleling circuit breaker must be matched (synchronised).

To synchronise the generator set and the Grid voltages, three different parameters of the generator set voltage across the open paralleling circuit breaker must be controlled:

- The **voltage magnitudes**
- The **frequency** of the voltages
- The **phase angle** between the voltages

VOLTAGE MAGNITUDE

For safe paralleling, a maximum **voltage magnitude** difference of 0.5 percent is recommended.

FREQUENCY

For safe paralleling, a maximum **frequency** difference of 0.1Hz is recommended.

PHASE ANGLE

For safe paralleling, a maximum **phase angle** difference of 10 degrees is recommended.

GENERATOR SET IN PARALLEL WITH THE SUPPLY UTILITY GRID

When the generator set voltage has been synchronised with the Grid voltage the paralleling circuit breaker can be closed.

Once the paralleling circuit breaker has closed the generator set and Grid supplies are ‘paralleled’. At this stage the generator set output is normally zero so it is contributing no power to the paralleled system.

The generator set control system now increases the fuel supplied to the engine and the output of the generator set ‘ramps up’ to:

- a predetermined **Generator Set kW Output** level

or

- a predetermined **Grid kW Import/Export** level

NOTE

The increase in fuel supplied to the engine ‘forces’ the generator set to produce kW since the frequency of the paralleled system is controlled and fixed by the Grid voltage and the engine speed cannot increase in response to the increased fuel.

GENERATOR SET PROTECTION WHILE IN PARALLEL WITH THE SUPPLY UTILITY GRID

When the generator set is in parallel with the Supply Utility Grid it is necessary to protect it from the many day to day events that occur on any Grid network.

These Grid events include:

- Power failures
- Short circuit currents
- Earth fault currents
- Voltage and frequency transients

POWER FAILURE ON THE GRID

When a Grid power failure occurs the Grid voltage 'disappears' and the generator set will attempt to feed that part of the Grid that it is still connected to. This may include local businesses, industry, residential units etc. The generator set will deliver higher than normal current and/or kW with the result that the generator set will most likely overload and shutdown.

To prevent the generator overloading and shutting down the Grid power failure must be detected and the generator set disconnected or decoupled from the grid as quickly as possible.
However, the normal 'phase failure' relay or under-voltage relay which monitors the Grid voltage will not detect the power failure as there will be no variation in the voltage at the monitoring point since the generator set voltage will be present.
The solution is to install a protection relay that can detect the power failure by means other than monitoring the Grid/generator set voltage. This can be achieved by installing a protection relay that will monitor the generator set 'rate of change' of frequency and/or the 'phase angle shift' of the generator set voltage which occurs when the generator set is hit by the additional load.
Once the Grid power failure is detected the generator set is immediately decoupled from the Grid by the opening of the Grid circuit breaker.

The end result is that the generator set will now be the only power source connected to the load.

SHORT CIRCUIT ON THE GRID

When a Grid short circuit occurs the generator set will feed into the fault and it will deliver a higher than normal current with the result that the generator set will most likely either overload and shutdown or the generator circuit breaker will trip.
To prevent this happening the Grid short circuit must be detected and the generator set disconnected or decoupled from the grid as quickly as possible.
The solution is to install a protection relay that can detect the short circuit by monitoring the current flowing into the Grid. This can be achieved by installing a Directional Over-current relay connected to a set of instrumentation current transformers.
Once the Grid short circuit is detected the generator set is immediately decoupled from the Grid by the opening of the Grid circuit breaker.

The end result is that the generator set will now be the only power source connected to the load.

EARTH FAULT ON THE GRID

When a Grid earth fault occurs the generator set will feed into the fault and it will deliver a higher than normal current with the result that the generator set will most likely either overload and shutdown or the generator circuit breaker will trip.
To prevent this happening the Grid earth fault must be detected and the generator set disconnected or decoupled from the grid as quickly as possible.
The solution is to install a protection relay that can detect the earth fault by monitoring the neutral voltage displacement. This can be achieved by installing a Neutral Voltage Displacement relay connected to an ‘open delta’ winding on a set of instrumentation voltage transformers.
Once the Grid earth fault is detected the generator set is immediately decoupled from the Grid by the opening of the Grid circuit breaker.

The end result is that the generator set will now be the only power source connected to the load.

VOLTAGE AND FREQUENCY TRANSIENTS ON THE GRID

When a Grid voltage or frequency anomaly occurs it must be detected and the generator set disconnected or decoupled from the grid as quickly as possible. The solution is to install a protection relay that can detect the voltage and frequency deviations. This can be achieved by installing an Under and Over Voltage and an Over and Under Frequency relay connected to a set of voltage instrumentation transformers.
Once the Grid voltage or frequency anomaly is detected the generator set is immediately decoupled from the Grid by the opening of the Grid circuit breaker.

The end result is that the generator set will now be the only power source connected to the load.