ESSENTIAL CONSIDERATION FOR PARALLEL OPERATION OF DG SETS

The following prerequisites are essential parameters for efficient and trouble free synchronisation of the alternators:

1) Potential of both alternators must be equal. Both must have same output voltage.
2) Phase sequences of both the alternators must be same. The RYB phases of one alternator must be connected the RYB phases of the other alternator.
3) Frequency of both the alternators must be equal. If one alternator is operating at a frequency of 49 Hz and the other one is delivering voltage at 51 Hz, then load on the second alternator would be more. We have to increase the speed of the prime mover of the first alternator in order to effect a match in frequencies.
4) Phase angle of voltages of the two alternators must not be more than 10 degrees.
5) During manual operation of synchronisation, the load could witness kick (which is a peak of current). This kick could burn the alternators on the load. The only solution is the use of automatic synchronisation equipment. However, expert engineers could close the CB of the second alternator when the difference of phase angle between the two voltages is 2 degrees.
6) The alternators must share loads with respect to their ratings.
7) The alternators must have similar voltage drooping characteristics.
8) The engines of the alternators must have similar governor characteristics;

The Golden Rules:

1) While synchronising the alternators of different capacities or makes, read the operational instructions of manuals carefully.
2) If the number of alternators is more than two, then also the instructions appended above must be followed strictly.

EQUIPMENT REQUIRED FOR PARALLEL OPERATION OF ALTERNATORS

1) Two alternators with similar voltage ratings and frequency ratings.
2) A common bus bar, which could take the combined current load of the two alternators.
3) ACBs for two alternators (of suitable current and breaking capacities).
4) ACB for common busbar.
5) An ammeter of suitable current measuring capacity.
6) A kilo-wattmeter of suitable power measuring capacity.
7) A digital multimeter.
8) A reverse power relay.
9) Three lamps for designating R, Y and B phases.
10) A Synchronoscope.
11) PF Meters for both the alternators.
12) Separate AVRs for both the alternators.

A NOTE ON REVERSE POWER RELAY

A reverse power relay is used for protecting the alternator from going into motoring action. During the shut down of an engine (due to low oil pressure, over-temperature etc.) could lead to motoring action of the failed alternator. The cost of the reverse power relay is the major components of the instrumentation costs to be incurred during parallel operation of alternators.

(A) SYNCHRONISATION OF TWO ALTERNATORS ON A COMMON BUSBAR:

We have to proceed in the following steps in order to effect synchronisation:

1) Run alternator no. 1 at no load and maintain its normal speed.
2) Check its following parameters:
   (b1) Phase sequence (it must be noted carefully);
   (b2) Potential difference of phases (they must be equal) and
   (b3) Frequency (it must be 50 Hz or 51.5 Hz). For 60 Hz operation, this frequency must be 62 Hz.

3) Now put the machine on load and see the total droop. Normally, droop is 5-6 per cent. Now load the alternator gradually to full load at 0.8 PF. After adjusting the droop from the AVR, bring the output voltage of the alternator to a nominal value, say 415 V. Let us assume that at full load, the voltage produced by the alternator is 415 V.
4) Now switch off alternator No. 1.
5) Now switch on alternator No. 2 and repeat the same procedure. Note that you have to bring the same value of voltage for the alternator number as well. After adjustment of droop from AVR of the second alternator, the same must also deliver 415 V at 100 per cent load at a PF of 0.8. The voltage variation of the two alternators must be set within 1 percent of the one another.
6) Now connect the circuits of three bulbs of R, Y and B phases. Also connect the circuit of synchronoscope.
7) Now run both the machines on no load. Check voltage, frequency, phase sequences and relay operations once again. Switch on the synchronoscope and the bulbs must also be ready for glowing. The parameters measured here for both the alternators must be the same and exactly matching.

The Golden Rule: For different makes alternators to be operated in parallel, the neutral of the alternators as well as the neutral of the panel should not be connected to the ground directly. In order to limit the circulating current, add choke in series with neutral.

8) Now shut down both the machines.
9) Now start alternator no. 1 on no load. The common breaker must be open. The ACB1 must remain closed. The bulbs would glow. Start alternator no. 2 as well. The ACB2 must remain open. Till the time of frequency of both the alternators is not same, the bulbs would continue to flicker. Adjust the frequency till it is same for both the sets. You can adjust the frequency of one alternator by changing the speed of the prime mover. This could be done by regulating the governor of the prime mover. Further, if PF of both the sets is different, you can also adjust the droop and synchronise the PF.
10) When the synchronoscope shows a reading of 90 degrees and all the three bulbs are in no-glow condition, close the ACB2 of the second alternator. The alternators would generate power. At the same phase angle and then onwards, their voltages would be in phase with one another.
11) When you are fully satisfied that the bulbs are not at all flickering, PF readings are same for both alternators and the voltage outputs for both the alternators are 415 V, close the Common CB for connecting the load to the common busbar.
12) The load should be low initially, say 10-15 percent of the total load, in order to avoid damage to it in case any parameter of the alternators is not matched. Gradually increase the load to 25 percent of full load and observe current and kW readings of both the alternators. If everything at the load end is fine and the alternators continue to be synchronised, put full load on the common bus bar.
13) For unequal currents, adjust the droop potentiometer and balance the sharing as close as is feasible.
14) For unequal kW readings, adjust the speed of one engine.
15) If one of the alternators is shut down due to any reason, all the load would be transferred to the other alternator. It must be capable of taking the extra load of the first alternator (which was shut down by you).
16) When the alternators are working in parallel operation, do not change the PF, droop or voltage of either of them and let them work without adjustments in parameters. If load is reduced, alternators would still continue to be synchrinised as their phase angles, frequencies and power factors have already been matched. A variation of 10 percent of currents in both the alternators is permissible.
17) If you want the alternators to be shut down, open the common ACB first. Now switch off alternator no. 1 and then switch off alternator no. 2.

ESSENTIAL CONSIDERATION FOR PARALLEL OPERATION OF DG SETS

WHEN THE MACHINE IS ALREADY WORKING AND ANOTHER HAS TO BE HOOKED ON TO THE PARALLEL OPERATION

1) Start the second machine and bring it to the rated speed. Keep the circuit breaker open.
2) Adjust the speed of the second machine so that its frequency just matches with that of the bus bar frequency.
3) Adjust the voltage of the second machine with the help of the AVR to match the same with the voltage of the bus bar and synchronise the two sets.
4) Now increase the speed of the second machine till load sharing is proportional to its rating.
5) Adjust the voltage of the second machine till it shares its proportional KCAR.

REMOVAL OF THE SECOND MACHINE FROM THE BUS BAR

1) Adjust the governor of the second machine so that the kW output from this machine becomes zero.
2) Adjust the voltage setting of the second machine such that KVAR of current from this machine is almost zero.
3) Open the circuit breaker of the second machine.

IMPORTANT: 10% UNEQUAL CURRENT IS PERMISSIBLE FOR PRECISE SHARING OF LOAD. DO NOT ADJUST AVR AND THE SPEED OF THE ENGINE AFTER THE SETTING.

SL. NO.	PROBLEMS	CAUSE	REMEDY
1)	Oscillation in KW, Voltage and ammeters.	Engine Governing.	Correct the engine governor.
2)	Unbalanced current, but balanced and stable KW.	Incorrect voltage settings, droop CT reversal.	Adjust droop .
3)	Unbalanced KW and current as load increases or decreases.	Dissimilar governor speed regulation.	Interchange Q1 & Q2. Correct the engine governor.
4)	Unbalanced current as load increases but balanced KW.	Droop CT not indentical or CT may be reversed.	Change CT or interchange Q1 & Q2.