

## CHAPTER 6

### SYNCHRONIZING

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**1 GENERAL**

Prior to closing the Generator Circuit-breaker to connect the generator output to a 'live' Generator Circuit-breaker Cabinet Bus it is necessary to synchronize the voltage, frequency and phases of the output to that existing in the bus.

Synchronization is achieved by fine adjustment to the Gas Turbine speed and the Generator Excitation Voltage to produce the desired effect in the generator output.

**2 AUTOMATIC SYNCHRONIZATION**

Automatic operation of the Gas Turbine Units will achieve voltage and frequency adjustment; phase synchronization; and closing of the Generator Circuit-breaker, without any intervention being required by the Operator.

The MODE SELECTOR Switch on the Generator Control Cabinet, within the Local Control Room, will have been set to the 'Automatic' mode to achieve automatic synchronization. When the 'Warm-up Completed' signal is generated, by the Control System, the automatic synchronization program will be commenced.

**NOTE:** The MODE SELECTOR Switch may also be set to the 'Test' position in which the following procedures will be carried out but the final closing of the Generator Circuit-breaker will be inhibited. The simulated closing of the Generator Circuit-breaker is represented by the TEST-IN Indicator on the control panel illuminating.

1. The START SEQUENCE screen will indicate the PERMISSIVE TO EXCITE GENERATOR become affirmative. The Field Excitation Circuit-breaker in the Motor Control Centre will be 'closed'.
2. The following descriptions relate to the functions and observations made at the Control Panels within the Local Control Room.

Observe the Generator Control Cabinet and note that:

- » The Meters on the panel will display the comparative values between the Generator Circuit-breaker Cabinet Bus and the Generator output.
- » The three SYNCHRONOSCOPE Meters will show the progress of the synchronizing. The centre meter will show, by the position and direction of rotation of the needle, the effective angular relationship between the generator and bus phases. Any relative difference between the voltage and frequency of the Generator output to the bus is shown by the angular displacement of the needles on the other meters to the '+' or '-' indications.

When synchronization is achieved the three meter needles will all lie along a horizontal line.

If a voltage error exists across the Generator Circuit-breaker operation of the synchronizing relay will be inhibited.

3. Observe the Power Turbine speed indication will stabilise at 3000 rpm and the Generator frequency will be 50 Hz.
4. Observe that the 'Circuit-breaker Closed' indication is positive in the Sequence status list as automatic synchronization is completed. In the Local Control Room observe the Generator Control Cabinet and note that:
  - » The FIELD EXCITATION CIRCUIT-BREAKER CLOSED Indicator will be illuminated.

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- » The GENERATOR CIRCUIT-BREAKER CLOSED Indicator will illuminate.
  - » The Meters will indicate the status of the Generator output.
5. The MISCELLANEOUS Screen analogue display will show the relative information for the Generator Output indicating the status and loading on the Generator.

**3 MANUAL SYNCHRONIZATION (LOCAL CONTROL ROOM)**

To allow manual control of the generator output synchronization, with the 'live' Generator Circuit-breaker Cabinet Bus, the Gas Turbine Generator Unit must be operated in the 'Local' (Turbine Control Panel) mode. The Synchronizing procedure is carried out using the controls and instruments on the Generator Control Cabinet within the Local Control Room.

**NOTE:** The manual synchronization procedure can only be carried out from the Generator Control Cabinet in the Local Control Room.

1. Close the Excitation Field Circuit-breaker by momentarily turning the EXCITATION FIELD CIRCUIT-BREAKER Switch to the right ('Close') position. Observe that the EXCITATION FIELD BREAKER CLOSED Indicator illuminates.
2. Observe the three meters that comprise the Synchronoscope on the left-hand front panel of the Generator Control Cabinet. This combination of three instruments indicates the relative voltage, angular displacement and frequency variation between the phases of the generator output with those of the main power network. To enable the synchronizing of them prior to closing circuit-breakers to feed the same bus.

The three component parts of the Synchronoscope comprises:

**COMPARISON VOLTMETER** Where the generator voltage is too low the needle will deflect down to indicate the voltage difference (to a maximum of 20 volt). Too high a generator voltage will cause the needle to deflect upward.

**COMPARATIVE PHASE POSITION METER** The instrument has an indicator needle rotating about its centre point. If the needle appears to rotate, then the generator frequency does not exactly match that of the reference frequency. A clockwise rotation indicates the generator is running fast; conversely an anti-clockwise rotation, the generator is running slow.

A stationary needle indicates the relative angle between the phases. For the phases to be in synchronization the needle has to be in the horizontal position.

**COMPARATIVE FREQUENCY METER** Where the generator frequency is too low the needle will deflect down to indicate the frequency difference. Too high a generator frequency will cause the needle to deflect upward.

3. Observe the Comparison Voltmeter and note any deflection of the indication from the horizontal zero (0) position. If required adjust the excitation voltage of the Generator by turning the EXCITATION RAISE/LOWER Switch in the appropriate direction until the meter deflection is zero (0).
4. Observe the Comparative Frequency Meter and note any deflection of the indication from the horizontal zero (0) position. If required adjust the speed of the Power Turbine by turning the SPEED ADJUSTMENT Switch in the appropriate direction until the meter deflection is zero (0).

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5. Observe the Comparative Phase Position Metre. Continue adjustment of the Gas Turbine Speed until the indicator needle indicates a slow clockwise rotation. An anti-clockwise rotation of the needle denotes that the Gas Turbine Generator unit speed is too low.
6. As the needle indication passes the horizontal position operate the GENERATOR CIRCUIT-BREAKER Switch, on the Generator Control Panel, momentarily to the right ('Close') position, to close the Generator Circuit-breaker.
7. Observe the Generator Control Cabinet Panels and note that:
  - » The GENERATOR CIRCUIT-BREAKER CLOSED Indicator will illuminate.
  - » The Meters will indicate the status of the Generator output.
8. For reference the Generator and Excitation Field Circuit-breakers in the Motor Control Centre Cabinet may be observed and the following confirmed:
  - » The respective Circuit-breaker OPEN/CLOSED Indicator will display the 'Closed' indication.
  - » The respective Circuit-breaker SPRING CHARGE Indicator will display the 'Charged' indication. The Circuit-breaker Spring Mechanism will be automatically recharged by an electric motor after each activation.
  - » The respective Circuit-breaker COUNTER will advance by one digit.
9. The operating conditions can also be observed on the Turbine Control Panel Display Screen by selecting the appropriate 'Pages'.
10. The load on the Gas Turbine/Generator Unit is adjusted by the SPEED ADJUSTMENT Switch on the Generator Control Cabinet or from the Operator Interface Terminals. As the physical speed of the Power Turbine and Generator are locked to the frequency of the main power grid a demand to the Gas Turbine for more speed will result in an increase in the power output.