

CHAPTER 7

NORMAL RUNNING

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1 GENERAL

The following descriptions relate to the functions and observations made at the Control Panels within the Local Control Room and the Operator Interface Terminals.

NOTE: As the Operator facilities available at the Main Computer are outside the scope of the **Dresser-Rand Power** supply refer to that supplier's documentation.

When the gas turbine unit is running normally, under load, the following indications on the various Control Panels should be observed. Any other indication will require confirmation to ensure that acceptable conditions exist.

2 NORMAL OPERATION

The various screen displays available to the Operator at either Operator Interface Terminal are identical in content. Alarm and some other setpoint value adjustments may only be made from the Turbine Control Panel Operator Interface, which, in addition require the entry of a security code to prevent unauthorised adjustments. The instrumentation and indicators available to the Operator in both the Local Control Room and at the Gas Turbine/Generator Unit provide a comprehensive indication of all running conditions.

The following descriptions relate to the functions and observations made at the Control Panels within the Local Control Room.

1. The Power Turbine Rotor speed indicated by the digital POWER TURBINE (PT) SPEED Meter, on the Turbine Control Panel, will indicate 3000 rpm for normal rated speed (for a Generator Frequency of 50 Hz).
2. The digital GAS GENERATOR (GG) SPEED Meter, on the Turbine Control Panel, will indicate the actual speed of the Gas Generator Rotor. This speed will vary according to the loading on the Gas Turbine, but, above an acceptable limit an alarm will be generated.
3. The Power Turbine Inlet Temperature is indicated, on the Turbine Control Panel, by the POWER TURBINE INLET TEMPERATURE Meter. The actual operating temperature will vary in direct relationship to the load on the turbine.

WARNING: Running the gas turbine with the Power Turbine Inlet Temperature above the first alarm level will have a detrimental effect on the service life of the turbine components.

4. The HOUR COUNTER, on the Turbine Control Panel, will be operating and indicate the total running time, to date, for the Gas Turbine.
5. The meters on the Generator Control Cabinet panels recording electrical values will all indicate the output performance of the generator, within the parameters specified for the installation.

The following indicator lamps will be illuminated:

- » EXCITATION FIELD CIRCUIT-BREAKER CLOSED
- » GENERATOR CIRCUIT-BREAKER CLOSED
- » AUTOMATIC or MANUAL VOLTAGE REGULATOR (as selected by the Excitation Auto/Manual Switch)

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6. The Signalling Panel Flag Indicators will all indicate normal operating conditions.
7. The meters and indications on the Rectifier Cabinets; Motor Control Centre and Fire and Gas Detection Cabinets will indicate normal operating conditions.
8. The Generator has been synchronized to an 'active' bus, and the Generator Circuit-breaker closed, the Power Turbine Rotor Speed will be 'locked'. Adjustment of the Speed Adjustment Control will vary the Fuel supply (and Turbine Gas Generator Rotor Speed) and ultimately the power applied to the Power Turbine.

Where the Gas Turbine Generator Unit is being operated in 'Local' mode the SPEED ADJUSTMENT Switch on the Generator Control Cabinet or the Operator Interface on the Turbine Control Panel are used to adjust the load on the Gas Turbine. For 'Remote' or 'Local' Operator Interface operation the loading on the Generator will be controlled from the Operator Interface by the selection of the N2 (POWER TURBINE) SPEED RAISE or LOWER on the Control Functions Screen. Additionally the POWER FACTOR RAISE or LOWER selection on the Control Functions Screen allows for load adjustment.

3 STEAM INJECTION (STIG) SYSTEM

The purpose of the steam injection system (also referred to as STIG system) is to inject steam into the combustor of the engine to minimize the emissions resultant from the combustion process.

The controls provided for the Steam Injection System consist of two major parts. The first is the logic associated with the sequencing and monitoring of the system valves, temperatures, etc., that is required to get the steam to the engine nozzles.

The second aspect of the steam control system is the metering of the desired amount of steam to the engine. This metering control is accomplished within the Fuel Control Controller.

Before the Steam Injection system is able to operate, certain gas turbine operating parameter permissives are required to be satisfied. The Gas Generator speed (NI) must be above 4900 rpm and the Gas Generator Compressor Discharge Pressure must be above 10 bar minimum pressure and the electric Generator Circuit-breaker must be closed. With a gas turbine permissive for steam injection established, the operator can initiate the Steam Injection system by enabling the nozzle steam system.

Reset will need to be activated if any Steam Injection alarm exists on the panel. The Steam Injection system valves will sequence through the various steps to drain and preheat the Steam Injection piping and injection system.

The different states of the sequence are as noted below:

State 1 - Steam Injection Shut-down Position

State 2 - GT Start/Run Position

State 3 - Pre-Heat Cycle 1

State 4 - Pre-Heat Cycle 2

State 5 - Steam Injection

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Anytime the gas turbine is running, the Steam Injection system valves transfer from State 1 to State 2 to close the two Manifold Drain Valves. Enabling the Steam Injection system will transfer valves to State 3 until steam purge preheat temperature has reached 270°C. When temperature is attained, the Steam Injection system will transfer to State 4.

The system will stay in State 4 until the following temperatures are achieved:

TE-4565 Control Steam Preheat Temperature > 270°C

TE-4570 Steam Manifold Preheat Temperature > 245°C

TE-4567 Nozzle Steam Manifold Temperature > 240°C

When all the above temperatures are met, the Steam Injection system will transfer to State 5 and steam is being injected into the engine.

The amount of steam injected (Kg/Hr, measured in kilograms per hour) is controlled by the Fuel Control Computer. When the NO_x controller is disabled, the operator controls the steam flow setpoint by manipulation of the steam injection setpoint RAISE or LOWER function points on the operator interface.

If the NO_x controller is enabled, the steam flow setpoint is determined by a current signal generated from a remote location via the modbus.

The Fuel Control Computer will output a signal to the steam control valve to maintain the steam flow at the selected setpoint. The actual, or measured, steam flow signal is provided by the Steam Flow Computer on the Turbine Control Panel.

The maximum amount of steam flow allowed is a function of Compressor Discharge Pressure (CDP). The limiting schedule is programmed into the Fuel Control Computer. If the operator attempts to increase the amount of steam injected by raising the steam setpoint above the limit for the current CDP, the Fuel Control Computer will clamp the steam flow signal at the maximum limit.

For additional information on the Fuel Control Computer refer Part 2 of this Operating Manual and to the manufacturer's information inserted into Part 7 of the Technical Manual, control section and the vendor's data section of this manual.

The Steam Injection system can be shut off at any time while the unit is running by selecting the nozzle steam system disable on the operator interface. The Steam Injection valves will then transfer to State 2. When the gas turbine is stopped, the Steam Injection valves will transfer to State 1 position.

Certain parameters of the Steam Injection system are monitored for Alarm, Steam Injection Shut-down, and Gas Turbine Shut-down.

4 PRE-HEATING OF INTAKE AIR (ANTI-ICING)

If the sensor for the Gas Turbine combustion air intake indicates that a low temperature is detected then an alarm will be generated. The Operator must then select the TURBINE INLET HEATER ENABLE at the respective Operator Interface Terminal Control Functions Screen and depress the ENTER Key on the Keyboard to enable the Pre-heating System. When operating the Pre-heating system directs steam through a heat exchanger at the front face of the Combustion Air Intake Filter.

Prior selection of the TURBINE INLET HEATER ENABLE at the respective Operator Interface Terminal Control Functions Screen will provide for automatic operation of the Pre-heating System to control the turbine air inlet temperature to a minimum value of approximately 6°C.

To switch off the Pre-heating facility select TURBINE INLET HEATER DISABLE on the Control Functions Screen and depress the ENTER Key on the Keyboard.

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5 VIDEO DISPLAY UNIT SCREEN DISPLAYS

The Video Display Unit and the associated Configuration Keyboard enable the Operator to maintain a constantly updated overview of the operating condition of the Gas Turbine and Generator Unit. During the Start Sequence the 'Start Sequence Screen' may have been displayed to provide a reference as each of the milestones were achieved.

Any Alarms generated during the operation of the Gas Turbine Generator Unit will be automatically displayed in the bottom window of the screen, irrespective of the 'Screen' selected.

1. Once the Gas Turbine Generator Unit has been put under load all the 'milestones' on the respective Status Screen will have been attained.
2. Depress the alpha-numeric Key on the Configuration Keyboard to select the 'Page' or 'Sub-menu' from the MAIN MENU Screen. Repeat this same process from a Sub-menu Screen to display the required Analogue or Discreet display (or composite 'Custom Screen').

The screen display is limited to the number of lines that can be viewed in the main 'window' at one time. To view other items on the screen page the list can be scrolled up or down by depressing the UP or DOWN ARROW Keys on the Configuration Keyboard.

To change screen page it is necessary to return to the previous level(s) of menu screen(s) by depressing the ESCAPE (Esc) Key on the Keyboard the required number of times and then selecting the new page from the Menu Screen.

3. For example the analogue values for Temperatures throughout the systems may be viewed by depressing the '1' Key on the Turbine Control Panel Configuration Keyboard.
4. The following information may be gathered from the Temperature Screens:
 - » The value displayed on the Turbine Control Panel PTIT (GAS TEMPERATURE) Meter is an average of the values obtained from a ring of thermocouples. The 'Temperature Screen' lists the individual temperatures detected by the thermocouples, ('POWER TURBINE INLET TEMP - T5.4 [TE-4006A/K]'), that are arranged equidistant around the Power Turbine Inlet. In addition the 'average' is also displayed on the screen. The temperatures shown, for the thermocouples, should be comparable.

NOTE: It is important that the turbine is not operated for long periods with an excessively high Inter-Turbine Gas Temperature as it will reduce the operational life of the turbine components.

- » Temperatures at the various bearings within the Generator enable close monitoring of the operating conditions for the Generator Lubricating Oil System.
- » The temperatures within the Gas Turbine and Generator Enclosures can provide early warning of ventilation problems before Alarms or Shut-downs are generated. For example a temperature differential in excess of 35°C between the Turbine Enclosure and the exterior ambient temperature requires investigation at the Ventilation Fan Baffles.
- » The temperatures within the three stator windings of the Electrical Generator are also monitored from the Temperature Screen.

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5. Selecting the 'Vibrations Page' will display the following values:
 - » The vibration displacement (μm) for the Gas Turbine Gas Generator and Power Turbines measured at the Casing.
 - » The vibration displacement (μm) for the Generator Bearings measured in the 'X' and 'Y' planes.
6. Selecting the 'Pressures Page' will display the following values:
 - » The pressure of the Lubricating Oil and Fuel Supplies and Scavenge for the Gas Turbine and Generator Units. Also the differential pressures across filters.
 - » The pressure of the gasses at the various stages through the gas turbine; from inlet air to exhaust.
 - » The pressure of the Hydraulic Control Oil and the Filter Differential Pressure.
7. Selecting the 'Miscellaneous Page' will include the following values:
 - » The Gas Generator Operating Conditions.
 - » The actual Power Turbine Rotor Speed is displayed in revolutions per minute.
 - » The Gaseous Fuel consumption in kilograms per hour.
 - » The Steam Injection System operating conditions.
8. Other screens may be selected for the Operator to ascertain the complete operating conditions of the Unit.