Operating Instructions
for
YAMAMA GT6 - GT9

Contents

1 Introduction

Warning! **Only authorised personnel are permitted to operate the gas turbine unit.**

Only personnel authorised by Siemens Industrial Turbomachinery AB (SIT) are permitted to programme this equipment.

The authority-key is to be kept in a safe place, not available to unauthorised personnel

READ THE FOLLOWING DOCUMENTS BEFORE OPERATING!

Make sure that you are familiar with the following documents in the Operator Documentation:

- Operating Safety
  Deals with the safety precautions concerning Gas turbine (GT) and its auxiliary systems.
- HMI (Human-Machine Interface) Description
  Describes and explains the basic principles in working with the computerized control system.
- Display Descriptions
  Describes and explains the displays used while operating the Gas turbine.
- Fault Procedures - Alarm and Trip Lists
  This document lists all the possible alarms and trips followed by recommended measures.

PURPOSE OF THE DOCUMENT

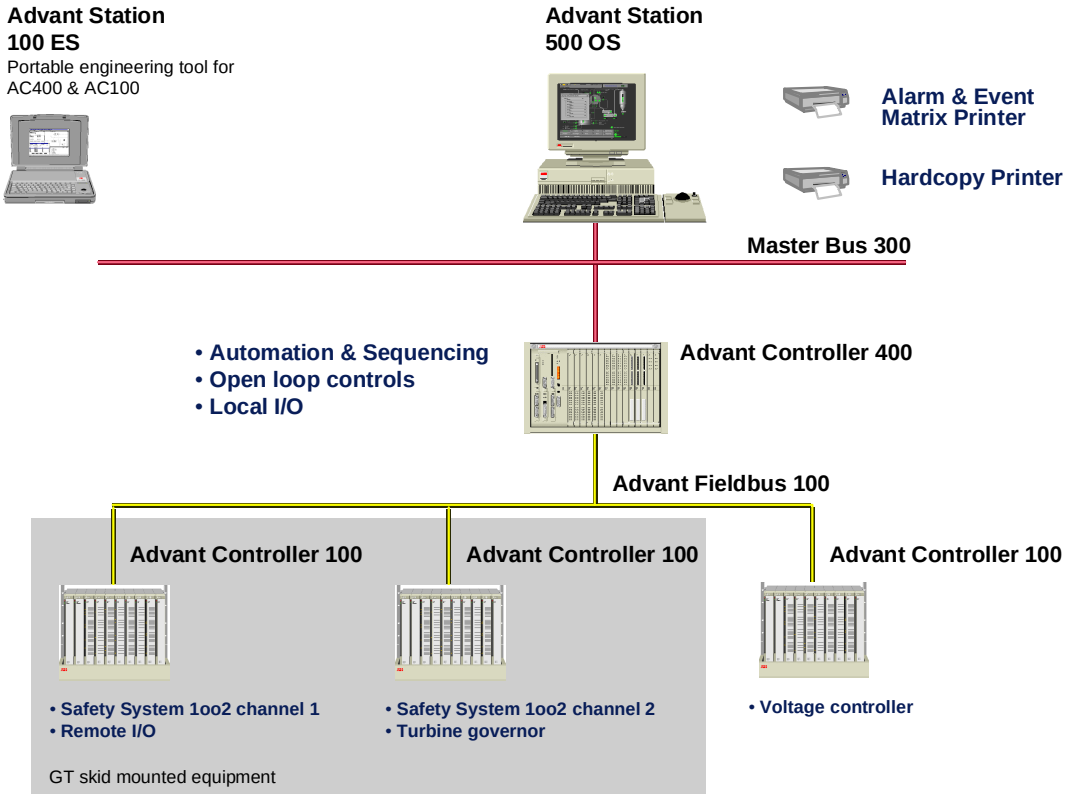
The purpose of this document is to describe how the GT is operated from the local control room.

2 Configuration of control equipment

2.1 The GT10B control system

The operator's station of the GT10B comprises ABB Advant Operator Station(OS) as shown below. The OS is located in the local control room and is connected to the Advant Controller units, AC400 and AC100 (control system computers) as shown in the figure below.

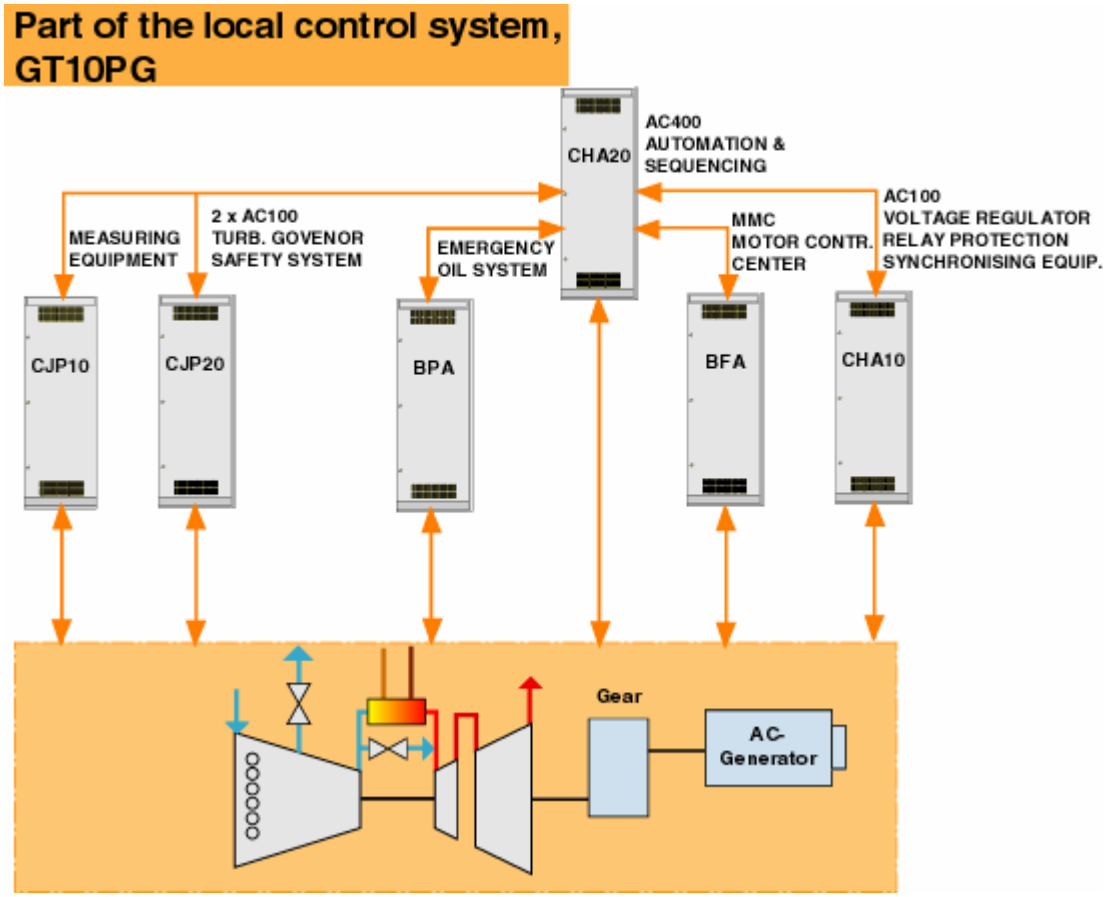
The GT10B control system



2.2 The Advant Control system

The figure on the previous page shows the entire control system, the figure below shows how the AC400 and the AC100 control the gas turbine.

Part of the local control system, GT10B



2.3 Control cubicle CJP10

This cubicle houses the power supply and the drivers of the motor actuators for the following functions:

- Inlet guide vane (IGV) angle positioning controlled by the Advant Controller 100.
- Gas fuel valve positioning controlled by the Advant Controller 100.
- Combustion chamber bypass angel positioning controlled by the Advant Controller 100.

This cubicle also houses the Bently Nevada measuring rack for speed, vibration and axial displacement signals.

2.4 Control cubicle CJP20

The CJP20 cubicle houses the two AC100 programmable process control stations.

2.4.1 AC100 Safety System and Remote I/O

The computer with its functions contains circuits for power supply, measuring and processing. The functions included are:

- Safety system for turbine and generator including turbine instant shutdown, unloading shutdown and generator breaker trip out.
- Remote I/O for AC400 computer with Advant fieldbus communication.

2.4.2 AC100 Turbine Governor, remote I/O and redundant safety system

The computer with its functions contains circuits for power supply, measuring and processing. The control tasks performed are:

- Start control
- Frequency control at synchronising
- Frequency/load control
- Load limiting
- Load rejections
- Flame sustaining control
- Position control Gas fuel valves
- Speed control Liquid fuel pump
- Bleed valve 1 and 2 control
- Inlet guide vane control
- Combustion chamber bypass control
- Remote I/O for AC400 computer with Advant fieldbus communication
- Redundant safety system

The governor operates as a front end to the AC400 computer and takes care of standard measurements and the control of fast closed loops. It also constitutes a part of the redundant unit protection system.

2.5 Generator Control cubicle CHA10

The AC100 controls the output voltage of the generator. The CHA10 houses the following:

- AC100 voltage regulator.
- AC Generator protection (relay protection).
- Synchronising equipment including the 'backup panel'.

The backup panel is described in the chapter 'Manual operation of the Gas Turbine.

2.5.1 AC100 Voltage Regulator

The automatic voltage regulator (AVR) and the manual voltage regulator (MVR) low power control circuits are housed in cubicle CHA10. The setpoints, their automatic follow up and the automatic change over between AVR and MVR are derived in the AC400 computer. The standard scope of supply is as follows:

- AVR with reactive current droop setting
- MVR for stand-by and test purpose
- Temperature compensated rotor current limiter
- Under excitation limiter
- V/Hz limiter
- Power factor control, implemented as a Advant Controller function
- MVAr control, implemented as a Advant Controller function

2.5.2 AC Generator Protection (Relay protection, CHA10)

The scope of supply includes the following protections, the majority being microprocessor based and internally supervised.

- Generator differential protection, 3 phase
- Over current, a 3 phase 2 stage relay where the I> delay has either a definite oran inverse time characteristic
- Neutral point voltage, which is a stator earth fault protection
- Negative phase sequence, protects against an excessively unbalanced load
- Reverse power, protects against motoring (generator working as a motor)
- Over voltage protection
- Loss of excitation
- Under impedance protection
- Block differential protection

2.5.3 Backup panel

Automatic synchronising is normally carried out by means of the control system. Manual synchronising, if necessary, can be carried out by means of the backup panel.

The backup panel is also designed to allow the operator to continue the GT10 operation even in the event of system failure of the Advant operator station and keyboard. The Advant Controller carries out the supervision of the process even if the Advant operator station would fail to operate. In the event of an aberration from the normal the unit will trip automatically and the automatic post-operation sequence will be activated.

The backup panel is equipped with an operation mode selector switch, push-buttons for voltage, speed, emergency shutdown and unit circuit breaker control, instruments for electrical power (active and reactive) and for synchronising purpose and counters for statistic purpose (backup to the Advant indication).

The backup panel is further described in chapter Manual operation of the Gas Turbine.

2.6 Auxiliary Control cubicle CHA20

This cubicle houses the programmable process control station Advant Controller 400. The functions of the AC400 are superior automatic and sequencing including:

- Starting
- Loading
- Unloading
- Stopping
- Cooling down
- Set value generation turbine governor
- Set value generation voltage regulator
- Advant fieldbus control for AC100 computer communications

2.7 Operator station CWA

The ABB Advant operator station is the interface between the operator and the gas turbine, and is described in the document HMI Description.

3 AC-power Back Up System

3.1 Power failure

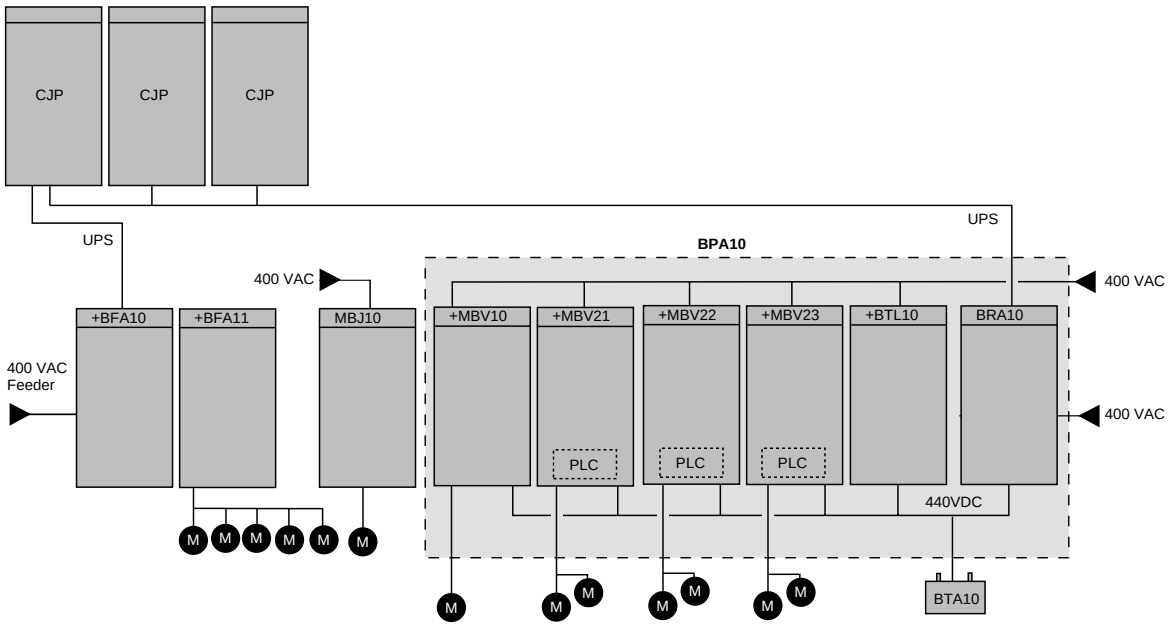
In case of power failure, it is of utmost importance that the gas turbine is kept running at barring speed, with the lubrication pumps running to avoid high temperature and thermal stress of the rotor and its bearings.

In normal operation, the charger, BTL10 is charging the batteries BTA10 and the lubrication pumps are running.

In the event of a power loss, the UPS (BRA10) will supply the control system.

The 440 V batteries will supply the lube oil switchgear with 440 VDC, in order to maintain lubrication with two lubrication pumps running to the bearings for at least 10 hours.

The battery backed up power supply system (simplified)



4 Operation Modes and Performance

4.1 Modes of operation

4.1.1 Single service (Island mode)

Single operation mode means that the power produced is feeding a dead net. In single service the output is determined by the network load demand and a constant load setting allows the frequency to vary according to the actual droop setting.

In single service the frequency is equal to the nominal frequency only when the load is equal to the set load.

To keep the frequency constant the load setting must be adjusted as soon as the load demand alters.

4.1.2 Parallel service - large networks

Parallel operation mode means that the power produced is feeding an already electrified net, which means that the voltage, frequency (RPM of the GT) and the phase angle have to be adjusted before synchronising. In parallel service and connected to a very large network, the unit itself can not at all control the frequency. A constant load setting results in increased/decreased unit load when the net-work frequency decreases/increases. Connected to a large network, the unit output is equal to the set output only when the frequency is equal to the nominal frequency.

4.1.3 Parallel service - small networks

In parallel service and connected to a small network (2-3 equal units supply an own network), the mode of operation is something between solitary service and parallel service - large networks. When the network load demand increases/decreases the frequency decreases/increases. The frequency can be readjusted (within two limits) by using the load setting of one unit. Connected to a small network, the frequency is equal to the nominal frequency only when the total network load is equal to the sum of the unit's set loads.

4.1.4 AC100 Voltage regulator (MKY10)

You can choose from the following AC-generator controllers depending on the requirements from the utility:

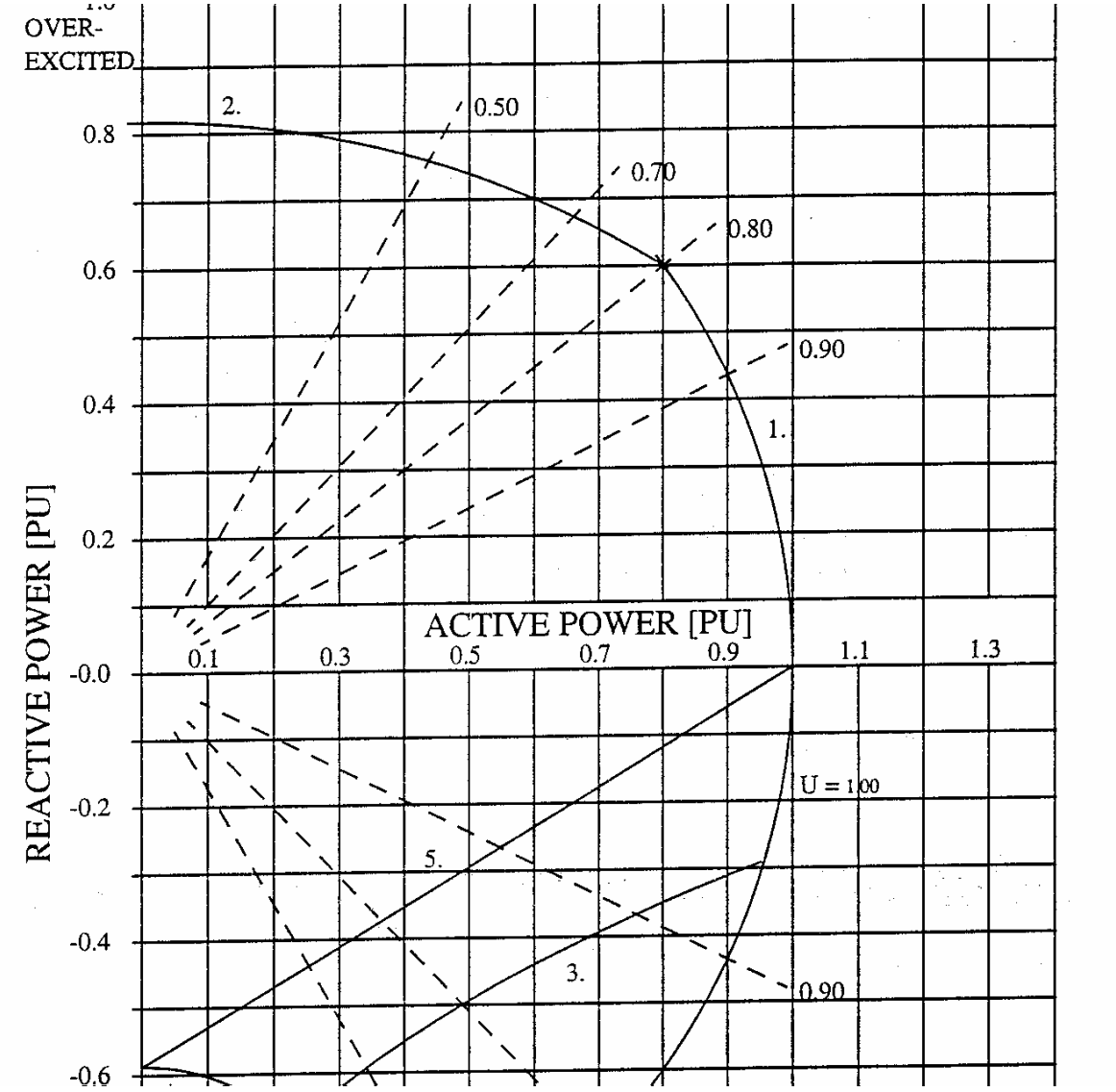
- Cos phi (power factor)
- MVAr (reactive power)
- Voltage

- FCR (Field current regulator, used for testing only)

Often the cos phi regulator is preferred since the AC-generator is optimised at a certain cos phi (often 0.8). The utility might need extra reactive power (reactive power is desired when there is a small grid with a large number of drivers) and in such cases the MVAr-controller is selected. In the figure below you can see the ratio between power factor (cos phi), reactive (MVAr)- and active (MW).

If the gas turbine is feeding a dead net, the voltage regulator is selected.

Typical capability Diagram for AC-generator (see AC-generator file for more information)



4.1.5 Droop setting

The droop reflects the ratio between the frequency and the load and is defined as follows: Every power producing unit has an individual droop characteristic and a corresponding droop graph. When units are run in parallel, i.e. connected to the same network, the individual droop characteristics form a resulting characteristic and by a corresponding droop graph the relationship between frequency and output for the entire network can be shown as for a single unit in solitary service.

When the total network output decreases, i.e. consumers are disconnected the frequency increases and vice versa. For a certain load/speed setting the parameters load and frequency follow a specific line in the droop diagram. Adjusted load/speed moves the line and adjusted droop alters the slope.

Definition of Droop

$$S = \frac{\frac{df}{F}}{\frac{dp}{P}}$$

S = Droop
F= Nominal frequency
df = Frequency deviation
P = Rated active output
dp = Output deviation

RECOMMENDED DROOP SETTING

Suitable droop value depends on the network frequency variations, the type of consumers connected, the relationship between generator output and total network output and on the permitted frequency variation.

High droop setting gives, compared to low droop setting, the following advantages:

- Less risk of governor hunting
- Smoother governing of the unit
- Milder thermal shocks at quick load/frequency variations, but less frequency accuracy.

RECOMMENDED DROOP VALUES

0% - Can only be used in single service and should only be used when small frequency variation is of utmost importance and the network load is very stable. (A great number of small consumers).

1-2% - The unit is large (more than 30%) in relation to the network, the network load is stable and high frequency accuracy is required.

4% - Normal value when the unit is large (at least 30%) in relation to the network.

5-10% - The unit is small (less than 30%) in relation to the network.

If high frequency accuracy is required in solitary service, or when two units supply an individual network, the governor feature frequency governing should be used. The frequency is then, after a load change, automatically reset to nominal value independently of the droop setting.

4.2 Performance

4.2.1 General about performance

As a result of the condition of the gas turbine and the inlet air, the gas turbine will achieve a certain performance. It is easy to understand that dirty compressor- and turbine blades cause poor performance (loss of performance of this kind is impossible to calculate). Also the condition of the inlet air will have an influence of the performance and this is easier to calculate.

Considering the physical laws, a high density of the inlet air will lead to a greater amount of molecules of oxygen to pass and to ignite in the gas turbine which will lead to increased performance. A low temperature and a high air pressure will increase the density. So the higher density of the inlet air the more “MegaWatts” will be produced.

4.2.2 Performance diagrams

With the GT10B comes calculated and tested performance curves for different types of air inlet conditions, elevation, etc. Using the diagrams to calculate the output power makes it possible to determine the condition of the gas turbine. In the document *Nominal performance*, you will find the performance diagrams needed to calculate an approximate value of the nominal turbine output.

5 Before Start Up

5.1 General

If the gas turbine unit is in proper condition the GT10B can be started immediately without any prior checks. However, after work has been done on the gas turbine the systems must be checked according to the document Base Position List before the gas turbine is ready for start up.

5.2 Compulsory checks at the gas turbine unit

Warning! **Always wear eye protection, ear plugs and hard hat inside and near the enclosure.**

Before entering the enclosure inform personnel in control room and deactivate the CO2-equipment.

Make sure that there are no people/foreign objects in the air intake or compressor inlet.

Before leaving the enclosure always make sure there are no people left inside.

Activate the CO2-equipment when leaving the enclosure.

Before every new start-up of the GT10B a walk around check of the gas turbine unit is advisable. Look out for the following:

- Abnormal conditions or signs of machine faults, such as leaks etc.
- Make sure that the settings, modes and positions are according to the document Base Position List. If there has been any work on the gas turbine or it has been completely stopped, the document Base Position List must be read and checked carefully.

5.3 Emergency stop button

Pull out the emergency stop button (if pushed).

5.4 Operation mode

Select position of the backup panel switch on cubicle CHA10, either “BACK-UP”, “LOCAL” or “REMOTE”. Depending on if the machine is to be operated from Video

Display Unit, which is the normal mode of operation or from backup panel (for more information on the backup panel please refer to the chapter Manual Operation of the Gas Turbine).

5.5 Synchronising mode

You can choose between automatic or manual synchronising. If you select automatic synchronising (normal selection) the GT10B will automatically synchronise. If manual synchronising is selected there will be no synchronising until manual synchronising is performed. If position “0” is selected synchronising will not take place.

PROCEDURE TO SELECT AUTO SYNCHRONISING (NORMAL SELECTION):

1. Select synchronising switch position “AUTO” on cubicle CHA10
2. Select Display “Unit Start/Stop”
3. Click on the icon “GCB synch/off”
4. Press Dynamic key 1 (“MODE” key)
5. Select “Auto”

PROCEDURE TO SELECT MANUAL SYNCHRONISING:

1. Select synchronising switch position “MAN”

This switch is located on the cubicle CHA10

5.6 Droop setting

Check that the droop setting is appropriate for the prevailing operation conditions. If the unit is to be synchronised to a network (parallel service) the droop value as set by SIT should be used. In single service (the unit working as the only source of power in an individual network) the droop setting can be varied according to the procedures below.

PROCEDURE TO CHANGE DROOP SETPOINT

1. Select display “Turbine Governing”
2. Click on “Droop setpoint SP”
3. Press “keyboard”
4. Press “Man”
5. Write a new setpoint and press the return key

5.7 Turbine governor

The first selection is to choose turbine controller; frequency or load control. Normal selection is load control, frequency control is only selected when running the gas turbine on island mode.

A. PROCEDURE TO SELECT LOAD CONTROL (NORMAL SELECTION)

1. Select display “Unit Start/Stop”
1. Click on the icon “Load” controller (click on >PID)
2. Press “keyboard”
3. Press “Auto”

B. PROCEDURE TO SELECT FREQUENCY CONTROL

1. Select display “Unit Start/Stop”
2. Click on the icon “Frequency” controller
3. Press “keyboard”
4. Press “Auto”

5.8 Generator controller

The second selection is to choose generator controller; voltage, Cos Phi, MVAr or FCR (Field current regulator) control. The normal mode is MVAr or cos phi control. Voltage control is selected when operating on a dead net and FCR (Field currency regulator) is for testing purposes only.

PROCEDURE TO SELECT GENERATOR CONTROLLER

1. Select display “Unit Start/Stop”
2. Select controller (Voltage, Cos phi, MVar, FCR) Click on the icon “>PID”
3. Press “keyboard”
4. Press “Auto”

5.9 How to change setpoints

You may change the controller setpoints before operating the turbine. Auto means that this selection is possible from local operation. E1, External, means that this selection is possible from Central control room. The controllers are

Generator controller

- Voltage, V(Auto/E1)

- Reactive load, MVAr (Auto/E1)
- Cos phi (Auto/E1)
- FCR (Auto)

Turbine controller

- Active load, MW (Auto/E1)
- Frequency, Hz (Auto)

PROCEDURE TO CHANGE SETPOINT

1. Select display “Unit Start/Stop”
2. Select desired controller (Click on the icon “>PID”)
3. Check that operation mode is “Auto”
4. Click on “SP”
5. Write desired setpoint and press return key

PROCEDURE TO ENABLE CHANGE OF SETPOINT FROM CENTRAL CONTROL ROOM

1. Select display “Unit Start/Stop”
2. Select desired controller (Click on the icon “>PID”)
3. Check that operation mode is “E1” (External)

5.10 Load setpoint

If the plant includes a boiler, you have to increase the load slowly, therefore start with a load set point of approximately 2 MW, according to instruction above. If there are no restrictions in the loading speed, you can select any load setpoint. To achieve the maximum load you can choose a set point of 30 MW, which will lead to a load limitation, such as T7.

5.11 Alarm list check

Go to the Alarm list display and look for start-blocking alarms and/or shutdown signals and take measures if needed.

1. Press “Alarm list” key on the keyboard
2. Acknowledge the alarms and/or trips by using one of the two listed options:
   - Put the cursor on the star at the latest alarm and press the acknowledge key.

- Select the dynamic key D5 “Ackn.page”, answer “Y” to the questions and press the send key.

3. Take measures according to binder 2B (Fault Procedures - Alarm and Trip List).

5.12 Fuel selection

Select desired fuel (liquid or gas) prior operation

1. Go to display “Unit Start/Stop”
2. If gas fuel; click on “FG Gas”

If liquid fuel; clicl on “FG Liquid”

3. Press the dynamic key “Mode”
4. Press the dynamic key “Auto”

5.13 Start ready

If START READY is indicated (the box is filled) you may go to next section.

6 Operating the gas turbine from control station

6.1 General

HANDLING OF ALARM AND TRIP SIGNALS

When an alarm or a trip signal occurs the instructions given in the document ”Fault Procedures - Alarm and Trip List” must be followed.

6.2 Start-up of the gas turbine

6.2.1 Procedure to give start order

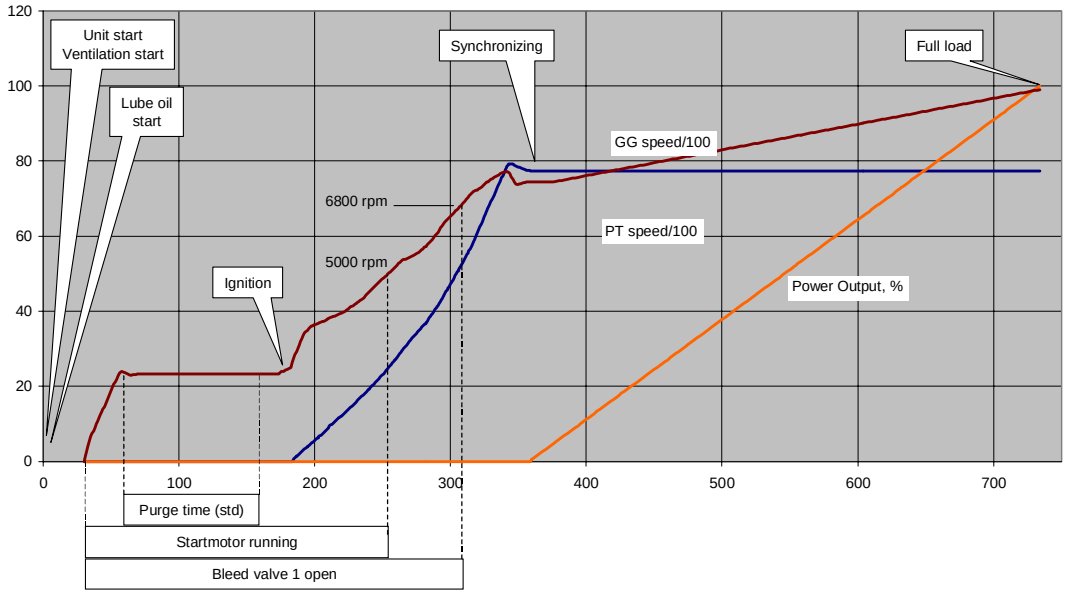
1. Select Display “Unit Start/Stop”
2. Click on “Start/Stop”
3. Press “Mode” and check that “Man” is selected
4. Press “ON”

Warning! **In case of failed start when using liquid fuel, the combustion chamber casing and the exhaust gas sections must be drained before a new start attempt is made**

6.3 Start up sequence

The control system will now automatically initiate the start-up sequence, which is principally shown in the figure below. The control system starts to control the speed (frequency) and the AC-generator voltage. When synchronous speed of the power turbine has been reached, the synchronising equipment will bring the AC-generator into phase with the grid and close the breaker. After synchronising the selected controllers will be used to control the gas turbine (often load control as turbine controller and cos phi as generator controller). You can follow the start-up sequence on “Unit Start/Stop”, where the start indications are shown for ventilation, lubrication, ignition etc.

GT10B PG Start-up sequence (simplified)

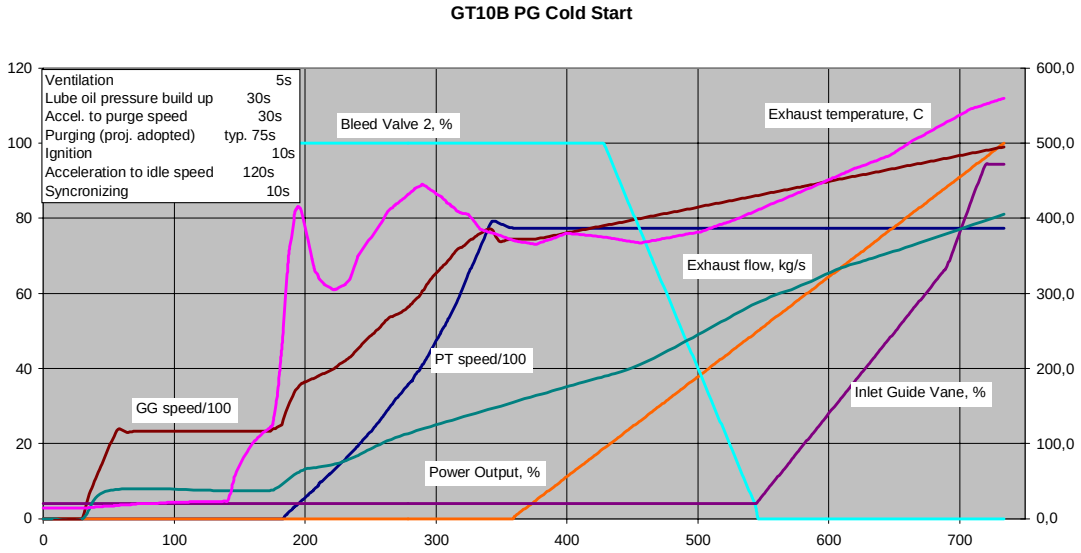


6.3.1 Supervision during start-up sequence

You should always check the start up sequence carefully on the desired display. It is recommended to start supervising the sequence on display “Unit Start/Stop” then change over to display “Fuel system” to observe the ignition of the combustion chamber. T7, vibrations and the alarms are of the greatest importance and should be observed carefully.

6.3.2 Cold start characteristics

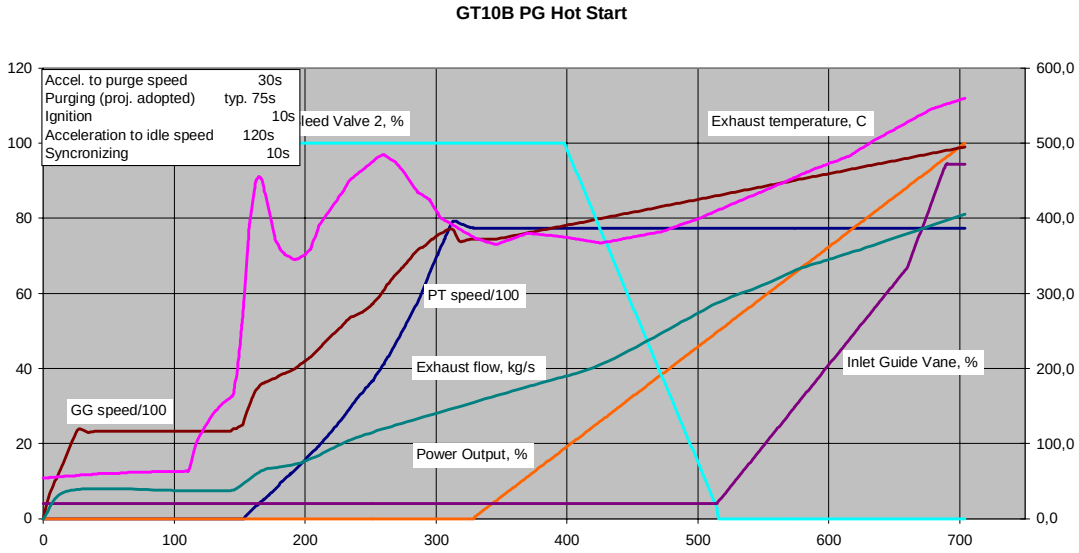
A cold start is defined as a restart of a machine after more than 5 hours after previous shutdown. Valid for GT10B standard only.



Caution! **Running of the generator in idle conditions without excitation shall be avoided as far as possible. At colder ambient temperatures, i.e. –15 ºC or lower, it is forbidden to run the generator unexcited for more than 15 minutes. If so, a manual stop has to initiated by the operator.**

6.3.3 Warm start characteristics

A warm start is defined as a restart of a machine within 5 hours. Valid for GT10B standard only.



6.4 Synchronising

6.4.1 Automatic synchronising

If automatic synchronising is selected, the following will take place: Unit will automatically synchronise to the network and pick up an initial load of about 0.5 MW. Load is then automatically increased at the preset value following the chosen fast or normal loading ramp (if applicable), providing the droop-setting is above 0% and network frequency is nominal. When synchronising is started the SYNCHRONISING symbol is filled. The GCB symbol will change to show closed position.

6.4.2 Manual synchronising

See chapter “Manual operation of the gas turbine”.

6.5 After start up

6.5.1 Start up sequence completed

When the start up sequence is completed, UNIT IN SERVICE is indicated.

ROUTINE READING PART 1

Immediately after completed start-up sequence print “Log Page 1” & “Log Page 2” displays and insert it in a log book.

WALKAROUND CHECK AND ROUTINE READING PART 2

Before entering the enclosure inform personal in control room and deactivate the CO2-equipment.

Check for the following indications after performed start-up

- leakages (oil, gas, airblowing)
- abnormal noises
- abnormal vibrations
- abnormal levels
- abnormal values
- untightened bolts
- perform daily operation maintenance, according to the “Operation Maintenance Schedule”, “D (Daily)-column”.

If a component show one of these indications or any other signs of malfunction, contact responsible personnel and refer to the troubleshooting part of the sub supplier's documentation. If in doubt, contact SIT.

Also make a print of “Log Page 1” & “Log Page 2” displays and insert it in a log book.

Warning! **After performed inspection activate the CO2-equipment.**

6.6 Supervision during operation

ROUTINE READINGS

Routine readings shall be performed daily according to the document Routine Readings in this binder.

MAINTENANCE SCHEDULE

Maintenance shall be performed daily, weekly, monthly, every 6 months and yearly according to the document Operation Maintenance Schedule.

6.7 Change of setpoints

In case you need to change setpoints during operation do as presented below.

PROCEDURE TO CHANGE SETPOINT

1. Select display “Unit Start/Stop”
2. Select desired controller (click on the icon “>PID”)
3. Change operation mode to “Auto”
4. Click on “SP”
5. Write desired setpoint and press return key

Note! **To achieve operation at maximum load enter a load setpoint of 30 MW which will lead to a load limitation, such as T7, etc.**

PROCEDURE TO CHANGE SETPOINT VIA THE BACKUP PANEL

You can also (if Advant station is out of service) change the settings on the backup panel.

1. Press INCREASE/DECREASE to the desired value.

The unit will automatically increase to the selected value according to the chosen “FAST” or “NORMAL LOADING” ramp.

6.8 Fuel change over

In case of interruption of selected fuel, the control system will automatically change over to the backup fuel. There is also a possibility for the operator to order a fuel change over, according to the following instructions.

1. Go to display “Unit Start/Stop”
2. If gas fuel; click on “FG Gas”

If liquid fuel; click on “FG Liquid”

3. Press the dynamic key “Mode”
4. Press the dynamic key “Auto”

6.9 Pump/Fan change over

If a malfunction occurs with the selected pump or fan, an automatic change over will take place to the stand-by pump/fan. There is also a possibility for the operator to change over during operation, according to the following

1. Go to the desired system display
2. Bring the cursor to the stand-by pump/fan, indicated with an “S”

3. Click the mouse
4. Press dynamic key D1 “Mode”
5. Press dynamic key D4 “Auto”
6. Press the key “Dialog Exit” on the keyboard

Please note that the control system automatically stops the other pump/fan.

6.10 Lube oil pump change over

If a malfunction occurs with the selected pump group, an automatic change over will take place to the stand-by pump. There is also a possibility for the operator to change pumps during operation, according to the following

1. Go to the lube oil/start system display.
2. Bring the cursor to the stand-by pump, indicated with “S”
3. Click the mouse
4. Press dynamic key D1 “Mode”
5. Press dynamic key D4 “Auto”
6. Press the key “Dialog Exit” on the keyboard
7. Bring the cursor to the pump to be stopped
8. Click the mouse
9. Press dynamic key D1 “Mode”
10. Press dynamic key D7 “Stand-by”
11. Press the key “Dialog Exit” on the keyboard

6.11 Resynchronizing

If the GCB is opened during service and it is desired to close the GCB and continue on load service, you have to resynchronise according to the following

1. Select synchronising switch (cubicle CHA10) in AUTO position
2. Select display “Unit Start/Stop”, “GCB synch/off”
3. Press “Mode” and select “Man”
4. Press (synch) “ON”

6.12 Shut down

6.12.1 Normal stop

Normally the unit is stopped independently of the mode of operation and load from the ABB Advant-keyboard. However, it is advisable to decrease the reactive load before the unit circuit breaker drops out.

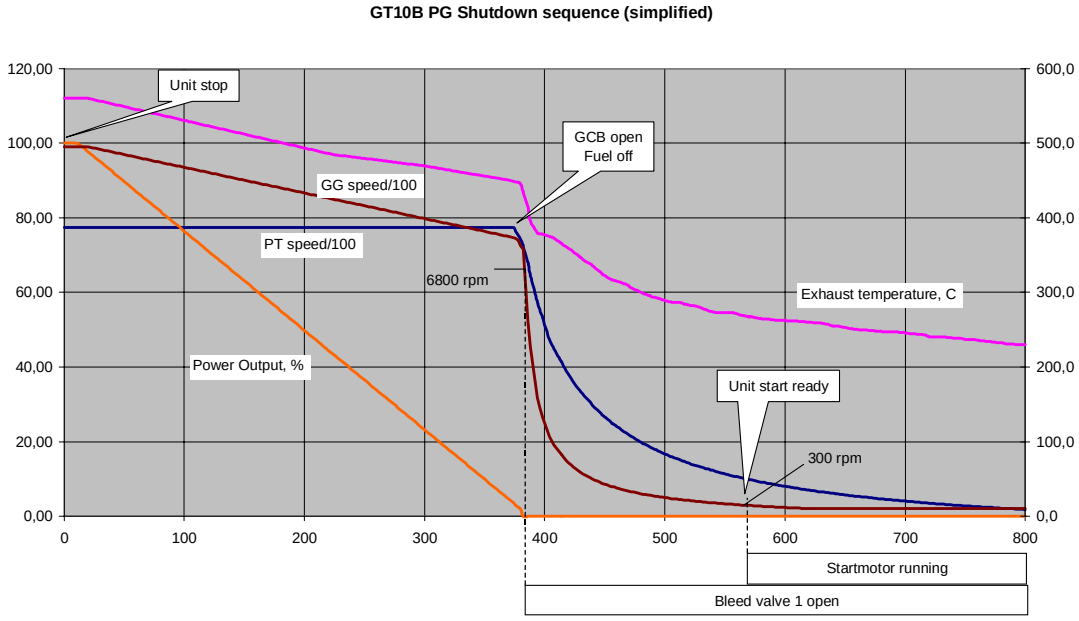
PROCEDURE TO SHUT DOWN THE GAS TURBINE

1. Select display “Unit Start/Stop”.
2. Select the icon “Start/Stop” and click the mouse
3. Check that the operation mode is in “Man”
4. Press the dynamic key for “OFF”

6.13 Shut down sequence

When shut down is ordered the unit will now automatically unload to approximately 0.5 MW, then the AC-Generator breaker opens and the unit shuts down. At the end of the running out period the start motor starts and turns the gas turbine for about 10 hours while the lubricating oil system is still in service. This period is known as the cooling down period and the unit can be started any time during this period. During this period it is vital that the bearings all the time are supplied with lubricating (and cooling) oil to protect the bearings from excessive temperatures.

Shut down sequence



The gas generator rotor is turned by the start motor during the cooling down period. In turn, the power turbine rotor is turned by the gas generator during cooling down period. This turning is necessary to avoid excessive temperature gradients resulting in temporarily bended rotors. Standing still rotor during cooling down causes temperature gradients and temporarily slightly bended rotor. If the unit is started at such conditions, vibrations might appear. In such case run the unit at low load until the vibration level has decreased to normal value. When the gas turbine has almost stopped and the indication START READY is lit, the unit can be started again by ordering START from the HMI.

Shut down possibilities

Normal, 90-0% load approx. 5.5 min.

Unload 90s, 90-0% load approx. 1.5 min.

Unload 30s, 90-0% load approx. 0.5 min.

6.13.1 Normal stop

When STOP is ordered the active output is automatically reduced (with a speed which depends on whether ”FAST LOADING” or ”NORMAL LOADING” is chosen) to just above zero, whereupon the unit circuit breaker and the field circuit breaker drops out. During this 3-4 minutes running down period restart is interlocked. When the rotor has almost stopped (300 rpm) and the indication START READY is lit, the unit can be started again by ordering START from the HMI.

6.13.2 Emergency stop

In the event of running disturbances approaching critical values, the unit shall be stopped at once by pressing one of the ”EMERGENCY STOP” buttons.

Pressed emergency stop button means that the unit is immediately tripped without previous unloading which will cause additive wear to the gas turbine.

6.13.3 Trip

The unit is tripped in two different ways: with or without preceding unloading, depending on the cause of the trip. The cooling down period after a trip is equal to that after a normal stop, if the barring motor and the lubricating oil system are still in service.

Caution! **If ventilation in gas turbine enclosure fails arrange temporary ventilation as described in Operating Safety, chapter Operational Cautions.**

Warning! **If the gasturbine plant is shut down at the same time as the external auxiliary power has a blackout, it shall be noted that the air conditioners of the local electrical and control modules are stopped. Normally this does not lead to any problem, although the post lubrication of the bearings will automatically be operated via the DC auxiliary- and control system for the whole emergency cooling down period (ca. 10 hours).**

At warmer ambient temperature conditions, i.e. approx. + 40 ºC or higher the operator shall pay extra attention to the electrical & control cubicles exceeds 55 ºC, special measures has to be carried out. One simple measure is to open the module doors, in order to increase the natural ventilation inside.

6.14 Cancelling of shut down order

After a stop has been initiated and before the load has decreased to 1 MW it is possible to inhibit the shut down. After cancelling, the unit will increase the load to the previous selected load set point.

PROCEDURE TO INHIBIT SHUT DOWN ORDER:

1. Check that stopping is indicated on the start-up display.
2. Select Display “Unit Start/Stop”.
3. Press Mode
4. Check that Manual is selected
5. Press ON.

Go to chapter “START-UP OF THE GAS TURBINE UNIT”.

6.15 Start motor check

After running down time, check that the start motor (barring) comes into operation.

6.16 Barring

Check that the lube oil pumps are in operation during cooling down barring.

6.17 Restart immediately after shut down

A restart is possible to initiate as soon as the rotor speed is below 300 rpm and the reason behind the shut down is investigated.

1. Safety system reset

The safety system is reset as soon as all SHUTDOWNs and ALARMs are acknowledged and cleared.

2. Unit ready

Check that “UNIT READY TO START” is indicated.

3. Start order

Go to section "Start-up of the unit" and continue as a normal start.

7 Manual Operation of the Gas Turbine

7.1 Operations possible via the Backup panel (CHA10)

In some very special situations, for instance if the Operator's station has broken down, it is still possible to operate the gas turbine manually, via the backup panel at the control cubicle CHA10 in the control room.

The following operations are possible from the backup panel irrespectively of the Advant station

- Start the GT10
- Select backup/local/remote control
- Select manual or automatic synchronising

The following operations are possible from the backup panel after a start of the GT10B from the keyboard.

- Increase and decrease the GT10 power turbine speed and load
- Increase and decrease the GT10 generator voltage
- Manual synchronising e.g. connection of the unit to the grid (parallel operation)
- Connection of the unit to dead-net grid
- Increase and decrease the active and reactive load when the unit is connected to the grid
- Disconnection of the unit from the grid
- Stop the GT10. Both normal (unloading) and emergency stop.

Warning! **It is possible to operate the GT10 during faults in the Advant equipment but the decision is up to the operator or appropriate personnel to make. The unit control logic and protection is still in operation. However, there will not be any alarm annunciation or any information as to the reason for any unit shutdown.**

7.2 Description of the backup panel

In order to present the output from the GT10 unit, the backup panel is equipped with indicating instruments presenting active power output (MW) and reactive power output (MVar).

In addition to these instruments the panel also includes instruments for synchronising purpose, a double voltmeter (grid and AC generator voltage), a double frequency meter (grid and AC generator frequency) and a synchronoscope presenting the phase angle rotation.

For statistical purposes there is a counter presenting the total number of starts. There is also an hour meter presenting the total service time for the unit.

STATUS INDICATION

The status of the GCB (open or closed) is presented by indicating lamps in the push-button for GCB control:

Light in GCB ON = Closed

Light in GCB OFF = Open

7.2.1 Operation mode selector switch

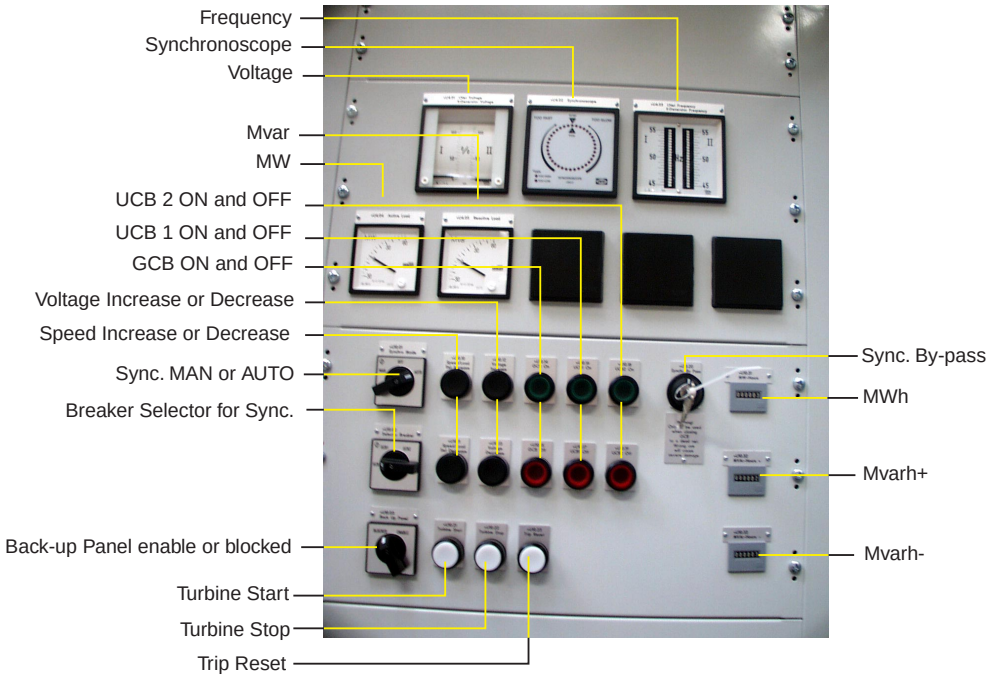
The mode of the turbine control is indicated by the position of the OPERATION MODE selector switch. The different position indicates as follow (from left to right):

BACKUP = Backup panel is active.

LOCAL = Backup panel is blocked, local VDU is active and remote control is blocked.

REMOTE = Backup panel is blocked, local VDU is active and remote control is active.

Back-up panel



SYNCHRONISING MODE SWITCH

The mode of the synchronising system is indicated by the position of the synchronise MODE selector switch. The different positions indicate as follow (from left to right):

AUTO = Automatic synchronising. This is the normal position.

0 = synchronising is off. This will prevent closing of the GCB.

MAN = Manual synchronising is selected. The actions for setting voltage, speed and to operate the GCB must be made by the operator.

FREQUENCY (SPEED) SETTING INCREASE/DECREASE

Press the push-button ”FREQUENCY SETTING INCREASE” or ”FREQUENCY SETTING DECREASE” to change the setpoint of

1. The frequency when the AC generator is not synchronised.

The frequency will increase/decrease rapidly when the respective push-button is pressed. When the button is released, the frequency decreases/increases slowly back to nominal value.

2. The load when the AC generator is synchronised and connected to the grid.

The push-button operate in parallel with the Advant (actions from the keyboard). When the push-button are used it changes the active load set point in the Advant Controller.

VOLTAGE SETTING INCREASE/DECREASE

Press the push-button ”VOLTAGE SETTING INCREASE” or ”VOLTAGE SETTING DECREASE” to change the setpoint of

1. The voltage when the AC generator is not synchronised.

2. The reactive load when the AC generator is synchronised and connected to the grid.

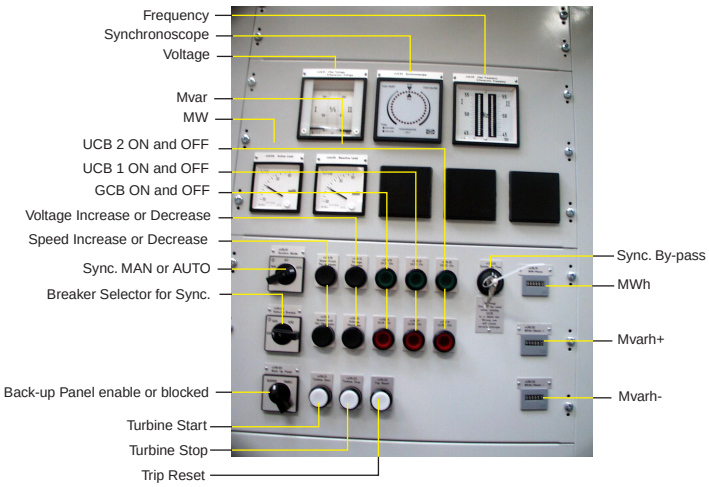
The push-button operate in parallel with the Advant (actions from the keyboard). When the push-button are used it changes the voltage or the reactive load set point in the Advant Controller.

7.3 Manual start

Press the "Trip reset" push-button to get the turbine start ready.

Press the "Turb start" push-button to start the turbine.

Turbine start



7.4 Manual synchronising

Turn the synchronising mode selector switch to ”MAN” to select manual synchronising.

Caution! **Manual synchronising shall be performed by authorised personnel only. Mistakes during manual synchronising can lead to severe damages.**

If manual synchronising is selected, the generator circuit breaker (GCB) can now be closed as follows

1. Adjust the unit voltage (also see figure below)

Adjust it equal to the network voltage by means of ”VOLTAGE INCREASE/DECREASE” on the backup panel or from the HMI-unit. Unit and network voltages can be compared on panel instrument on the backup panel, CHA10, (available in local mode only).

2. Adjust the unit frequency (see figure below)

First, check the unit frequency by reading the double frequency meter on the stand-by panel. Then adjust it equal to, or slightly above, the network frequency by means of ” SPEED INCREASE/DECREASE (FREQUENCY)” push-button on the backup panel.

Frequency adjustment, nominal frequency: Press ” SPEED INCREASE (FREQUENCY)” until the generator frequency is well above the network frequency and then release the push-button.

Automatically the generator frequency slowly decreases towards nominal frequency.

3. Close the GCB

This is done by pressing the button GCB ON when the generator frequency still is slightly above the network frequency and the indicator of the synchronoscope is in correct position (Min. 4-5 s per turn of the synchronoscope. Correct phase angle is shown on synchronoscope on the backup panel).

Unit will pick up an initial load of about 0.5 MW. Load is then automatically increased to the preset value following the NORMAL LOADING ramp provided the DROOP-setting is above 0% and network frequency is nominal.

In order to minimize the stresses on the unit, preset if possible a low load and manually increase the load slowly to desired value. Slowly in this connection means 0-1/1 load in 15-20 minutes.

PROCEDURE TO SYNCHRONISE TO SINGLE SERVICE (DEAD NET)

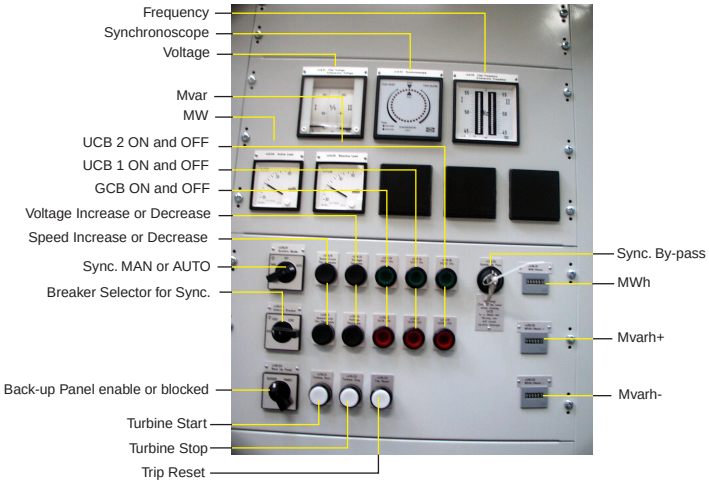
1. Check that unit voltage and frequency values are correct.
2. Adjust on the backup panel or the ABB Advant-unit if necessary.

Warning! **Make sure that there is no voltage on the grid!**

3. Close the unit circuit breaker by pressing button ”GCB ON” and ”DEAD NET RELEASE” on the backup panel simultaneously as shown in figure above.

OPERATING THE GCB

Press the push-button ”GCB OFF” to open the circuit breaker.



7.5 Emergency Stop

Press the red push-button ”EMERGENCY STOP” to make an immediate shut down of the GT10 unit.

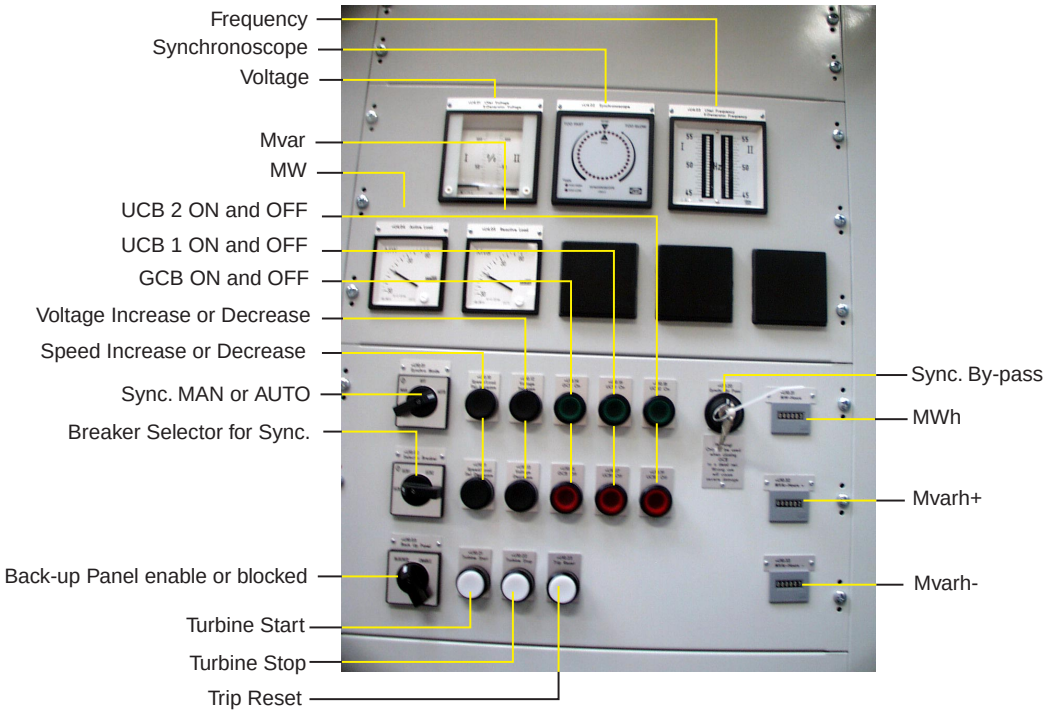
The shut down will simultaneously close the fuel shutoff valves and, open the GCB and the field circuit breaker (FCB)

To reset the push-button, turn and pull.

7.6 Normal Stop

Press the push-button "Turb stop" to make a normal stop. The unit will unload according to the selected load ramp to below 0,5 MW after which the shutoff valves will close and the GCB and FCB will open simultaneously.

Turbine stop



8 During Standstill

8.1 Known long period of standstill

During longer standstill it is recommended to run assemble the blind plates in the gas turbine is described in the GT Storage and Preservation document W980026E.

REVISION

Rev. ind.	Page (P) Chapt. (C)	Description	Date Dept. / Init.