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Operating Instruction for the Alstom Gas Turbine GT13E2 - Chile Kelar Project

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ITEM NO:	1GT-M-GT001 / 1GT-M-GE001 / 2GT-M-GT001 / 2GT-M-GE001
ITEM DESCRIPTION:	Gas Turbine Generator

☐ APPROVED ☐ WITH COMMENT

☐ REVIEWED ☐ RESUBMIT

THIS APPROVAL OR REVIEW DOES NOT RELIEVE THE VENDOR/SUBCONTRACTOR OF HIS RESPONSIBILITIES TO MEET ALL OF THE SPECIFIED REQUIREMENTS OF THE PURCHASE ORDER

	ORIGINATOR	CHECKED	APPD(PR)
SIGN			
DATE			

SAMSUNG ENGINEERING CO., LTD

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B	2014.12.15	Revision after SECL comments
A	03.09.2014	First issue
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bhpbilliton KELAR S.A.

CHILE KELAR CCPP PROJECT

SAMSUNG ENGINEERING

SAMSUNG ENGINEERING CO., LTD.
SEOUL KOREA
SECL. PROJECT NO.: SP2715

ALSTOM

ALSTOM (SWITZERLAND) LTD

Important Notes

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Notice to User

The content of this manual does not constitute any legally binding assurance of either the delivery scope of the plant or of its performance and operation. Site-specific deviations of the delivery scope of the plant and its performance and operation are possible. Any work described in this manual must be carried out solely under the supervision of personnel expressly authorized. Failure to comply with this requirement shall void any warranties, guarantees, representations, or other types of liability, which Alstom may have given or undertaken.

Unsafe operation
Do not operate the GT if the safety relevant control & protection functions are not fully functional and activated. Do not alter, remove or bypass any of the safeguards unless permitted to do so and safety is confirmed by the relevant site and safety authorities. If needed, please contact the relevant Alstom entity for further assistance.

Disabling the protection system:
Do not disable the safety relevant protection function to keep the GT operational.
Do not bypass interlocks to restart the GT system or to force its continuous operation.
Before trying to restart the GT system, investigate, identify and clear the root cause of the problem.
If further advice and support is needed, contact Alstom immediately.

Changes to the protective system:
Do not change any protection or safety relevant system software prior to receiving permission from Alstom.
Any changes, which are applied to the protection software on a temporary basis, must be removed at the next opportunity.
Make sure all specified sensors, logic controllers and all other control system equipment operate as designed.

Revision Notification

Page	Section	Revised
21	3.1	Text included to show settings
42	4.1.2	Text included to show settings
43	4.3.1	Text included to show settings
49	5.8	Text included to show settings
98	11	Settings included on list

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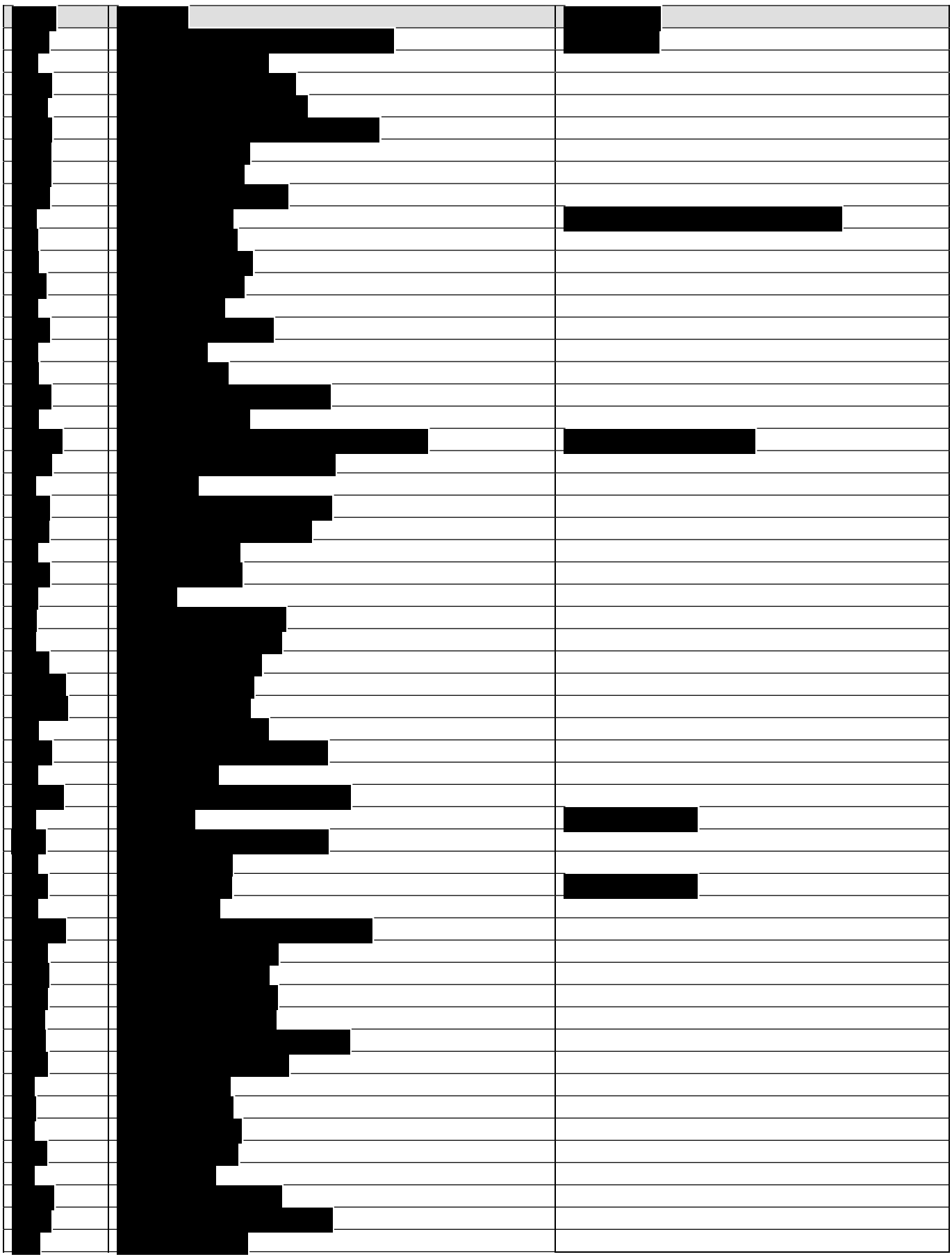

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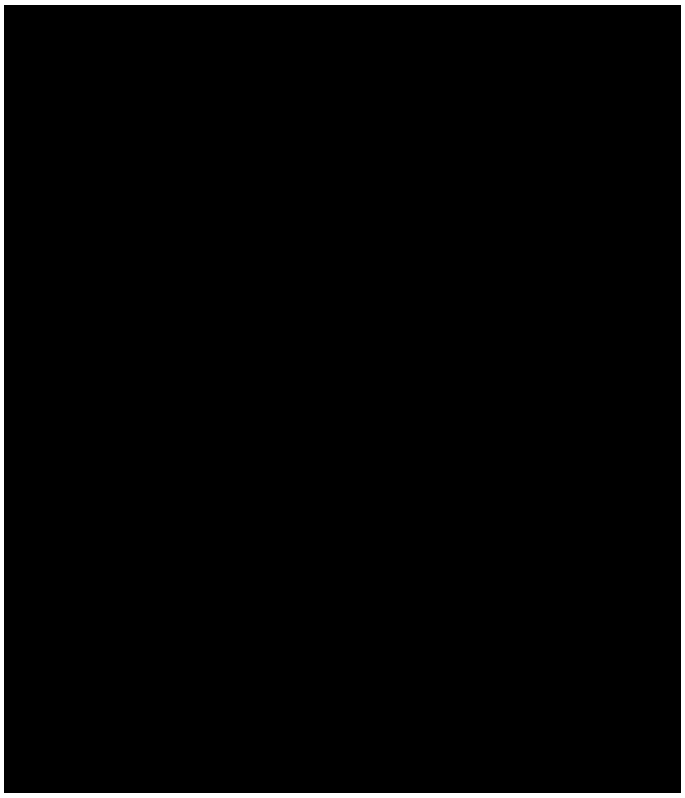

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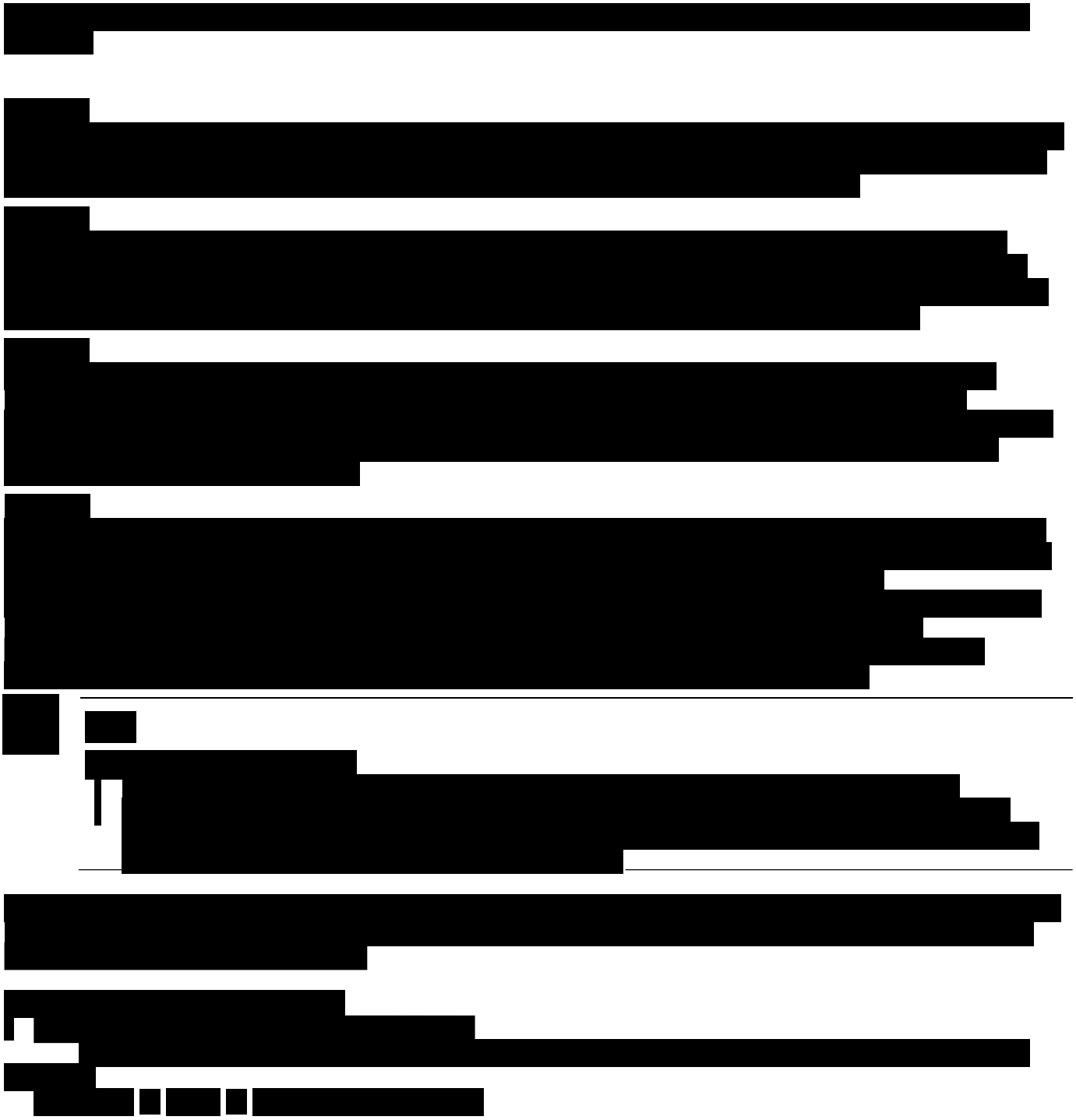

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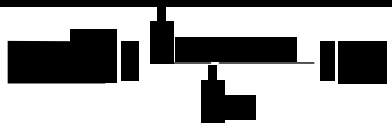

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3.6 Shut Down

Once Shut Down is selected, the control system automatically selects *minimum_load* and the gas turbine is deloaded with the *normal_deloading_gradient. R*everse power protection is used to open the generator breaker.

The unit remains at *nominal_speed* for the *idle_cooling_time*, this is required to reduce the thermal stress in the hot sections. Excitation remains on (Voltage Controller active) to allow a quick re-synchronization and loading during the idle cooling period.

If the operator does not interrupt the shut-down sequence after the *idle_cooling_time,* excitation is switched-off. The fuel control and the trip valves are shut and the blow-off valves open immediately. The jacking oil pumps are started and ensure a smooth run-down of the rotor.

[redacted]

After reaching *otor_barring_release_speed* the unit is put on rotor barring for a uniform cool down of the rotor.
[redacted]

[redacted]

WARNING

Hazard of automatic start after shut-down
Equipment, which is shut-down, may restart at any time by the control system.
- Ensure to follow locking and tagging procedure before working on any equipment.

3.6.1 Deloading and Shut-down

To take the GT out of service from load operation, proceed as following:
- Go to the HMI mimic display *GT13 OVERVIEW*
- Initiate *GT MAIN SEQ → OFF* in the section *GT MAIN SEQ*
- The GT will deload and disconnect from the grid automatically. Once idle is reached, the GT remains there for *idle_cooling_time*
- Final shut-down is initiated after *idle_cooling_time*
- Verify that rotor barring comes into operation when the rotor standstill criteria are reached. Due to heat exchange in the hot exhaust duct, an airflow through the turbine can be created (wind milling, see below), so that the rotor shaft will not reach standstill and rotor barring.

Wind milling
Convection heat exchange in the hot exhaust duct generates airflow through the compressor and the turbine. This airflow causes a continuous turning of the rotor shaft that is called wind milling.

Caution
It is not allowed to switch off the jacking oil to stop the rotor from turning.

3.6.2 Idle Mode Activation after Deloading

After that the GT is disconnected from the grid, idle mode may be selected if GT shut-down is not intended.
- Go to the HMI mimic display *GT13 OVERVIEW*
- Initiate *IDLE → ON* in the section *GT MODE* during the idle cooling time in step 53
- Restart the GT start-up sequencer by initiating *GT MAIN SEQ → DEACTIVATE → ON*

The GT can be synchronized and loaded up to the target load set point again by following the steps described in section 3.1.9 and 3.2.

Note
Verify during shut-down, that all relevant systems are taken out of service by the GT sequencer.
[redacted]

3.7 Cooling Down

After a unit shut down or unit trip there are basically two modes for the cool down of the unit:
- Rotor barring
- Forced cooling

The normal cool down mode is rotor barring which is automatically initiated after a unit shutdown. If a faster cool down of the unit is desired, forced cooling can be selected, however certain restrictions apply for its activation. The selection of the cool down mode mainly depends on how fast access is needed to the GT for inspection and maintenance purposes.

3.7.1 Rotor Barring

The hydraulic rotor barring system turns the rotor to ensure uniform cooling of the rotor and prevent temporary rotor bending. When *rotor_barring_release_speed* is reached during run down the rotor barring system comes into operation automatically and turns the rotor at the rotor barring speed, which takes typically 6-8 minutes per revolution. The jacking oil / lube oil pumps are in operation during rotor barring to lubricate the bearings.

3.7.1.1 Automatic and manual operation of the FG Rotor Barring

WARNING

Hazard of automatic start
The rotor barring control is automatic and may turn the rotor without command from the operator station.

- Stay away from the rotor shaft.
- Ensure to follow locking and tagging procedure before working on any equipment.

3.7.1.1.1 Automatic ON for Rotor Barring

The automatic ON command for the FG ROTOR BARRING is issued if the following criteria are met:

- Rotor face temperature [redacted]
- Speed < *rotor_barring_release_speed*
- Speed measurement [redacted] not disturbed.
- SSD SEQ: OFF
- LUBE OIL SEQ: ON

During rotor barring operation, the time needed for one revolution turn is either indicated on the OS or has to be monitored manually and should be observed to detect abnormalities such as rotor blocking.

Note

Cool down in rotor barring is the normal mode and rotor barring must always be in operation during the entire cool down phase until the release for FG rotor barring OFF is fulfilled. It is recommended to keep the unit in rotor barring operation during standstill periods for at least 72 hours, even if *the cold_GT_release_temperature* was already reached before.
It is recommended to have the rotor barring in operation for at least 6 hours before any GT start. A shorter barring time could result in high vibrations during start-up.

Caution

Jacking oil must be in operation at all the times on a hot engine.
If the jacking oil system is not in operation it is not allowed to operate the rotor barring device manually or automatically
Besides lifting the shaft from the bearings to allow rotor barring it is also cooling the turbine bearing. If for any reason the jacking oil system fails and is off for several minutes on a hot engine, the turbine bearing may get damaged

In case of a blocked rotor, it is not allowed to apply additional forces to free the rotor (e.g. by forced cooling or mechanical devices). Do not increase the rotor barring pressure by adjusting the pressure [redacted]

3.7.1.1.2 Automatic OFF for Rotor Barring

The automatic OFF command for the FG ROTOR BARRING is issued if one of the following criteria is active:

- SSD SEQ: ON
- Rotor barring failure active, see chapter 3.7.1.2
- Neither two jacking oil pumps are ON.

3.7.1.1.3 Manual OFF for Rotor Barring

To stop the rotor barring the following criteria must be met:

Rotor face temperature and exhaust gas temperature [redacted]

There is no automatic order OFF after the GT is cooled down and above criteria are met. The rotor barring must be taken out of service manually at the OS as follows:

- Go to the HMI mimic display *GT13 LUBE OIL*
- Initiate *FG ROTOR BARRING → OFF*

  → the Rotor Barring and jacking oil system will be turned off

If desired, the lube oil system may then be taken out of service:

- Go to the HMI mimic display *GT13 LUBE OIL*
- Initiate *LUBE OIL SEQ → DEACTIVATE → OFF*

The rotor barring may be switched off (for inspection, hand washing of the VIGVs, outage) [redacted]

3.7.1.1.4 Manual ON for Rotor Barring

To start the FG rotor barring on the operator station, proceed as follows.

- Go to the HMI mimic display *GT13 LUBE OIL*
- Initiate *LUBE OIL SEQ → DEACTIVATE → ON*
- Initiate *FG ROTOR BARRING → ON*

3.7.1.2 Rotor Barring Alarms

3.7.1.2.1 Rotor Barring Failure due to rotor seizure

If an automatic order ON for the FG ROTOR BARRING was given but no rotor barring is established (shaft speed remains at zero rpm for longer than one minute), a rotor barring failure alarm is given. In the case of a blocked rotor, the rotor barring system goes into an intermediate operation mode: lube oil and jacking oil remain in operation while the rotor barring is turned off. The rotor barring will be started automatically every 15min in an attempt to turn the rotor again. If the rotor does not turn within one minute, the rotor barring will turn off again for 15 minutes.

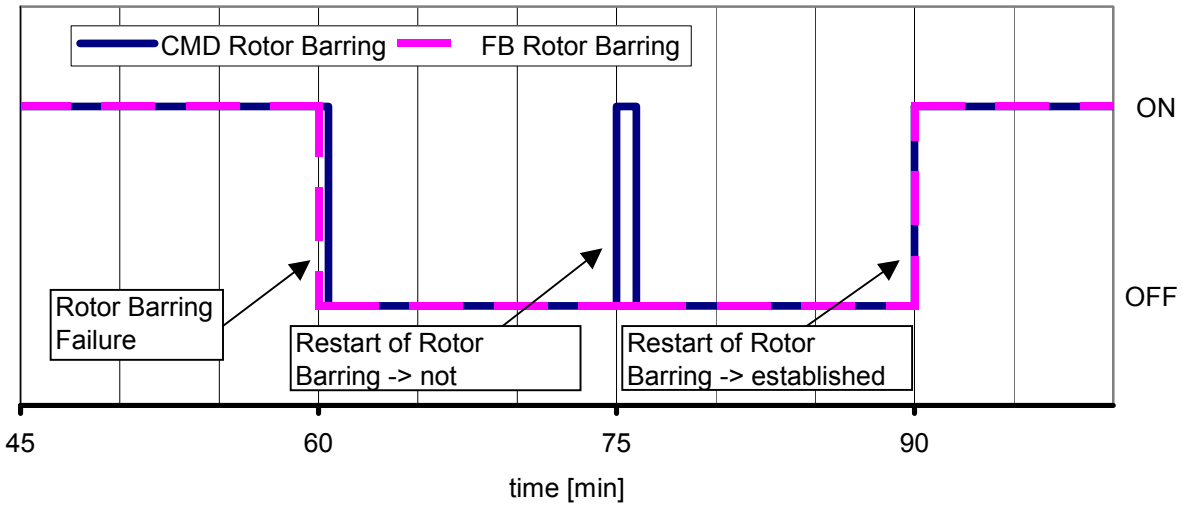

Figure 12 - Rotor Barring Failure behavior

Caution

It is not allowed to apply additional forces (e.g. by SFC, mechanical devices) in case of a blocked rotor. [redacted]

3.7.1.2.2 Hydraulic Jack Failure

While rotor barring is in operation and the hydraulic jack of the rotor barring is not moved from its DOWN position, an alarm Hydraulic Jack Rotor Barring will be indicated.

Immediately investigate the source of the alarm, [redacted]

- Check if the rotor barring pump is on
- Check for correctly adjusted rotor barring pressure [redacted]
- Check the limit switch of the hydraulic jack and the correct function of the solenoid pilot valve for Rotor Barring [redacted]

3.7.1.3 Manual Operation of the Hydraulic Rotor Barring Device

3.7.1.3.1 Manual Rotor Barring Operation from the OS

In case of a disturbance of 2 out of 3 speed measurements, the rotor barring will not start automatically.
In this case, the rotor barring has to be operated from the OS.
Manual operation from the OS may also be used for related inspection and maintenance work.
Before starting the manual operation, it should be visually checked that the rotor is in a standstill position. As soon as the operator receives the communication, rotor barring can be activated from the OS.

3.7.1.3.2 Manual Rotor Barring Operation with the Hand Pump MBX22AP003 (Emergency Operation)

If the DC-powered pump MBX22AP002 of the rotor barring device fails, the rotor must be turned with the hand pump MBX22AP003.

Proceed as follows for this:

When the rotor is at a standstill ensure that the FG LUBE OIL is switched on and that both jacking oil pumps MBV50AP001/002 are switched on.

Press the control piston on the solenoid valve MBX51AA001 and hold it by hand or the fixed clamp.

Operate the hand pump until the piston has reached its limit of movement.

This is indicated by:

- o An increased pumping force.
- o The rotor stops turning.

Relieve the oil pressure by removing your hand or the clamp of solenoid valve MBX51AA001.

Wait 10 seconds until the piston reaches its bottom end position.

Repeat steps 2) to 5) until the rotor has been turned 180°.

Wait 10 minutes and then turn the rotor through a further 180°.

Continue the above manual emergency rotor barring procedure until automatic rotor barring operation is possible again. Manual turning of the shaft should prevent the blades rubbing due to bending and high vibrations during the next start-up.

During normal operation the piston of solenoid valve MBX51AA001 has to be released.

Note
It is not allowed to operate the rotor barring device if the jacking oil system is not in operation.
If the jacking oil system fails, manual rotor barring operation must also be stopped.
In this case the GT must be completely cooled down.
After cooling down followed by 6 hours of rotor barring operation the gas turbine can be restarted.

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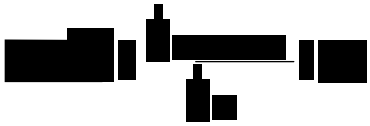

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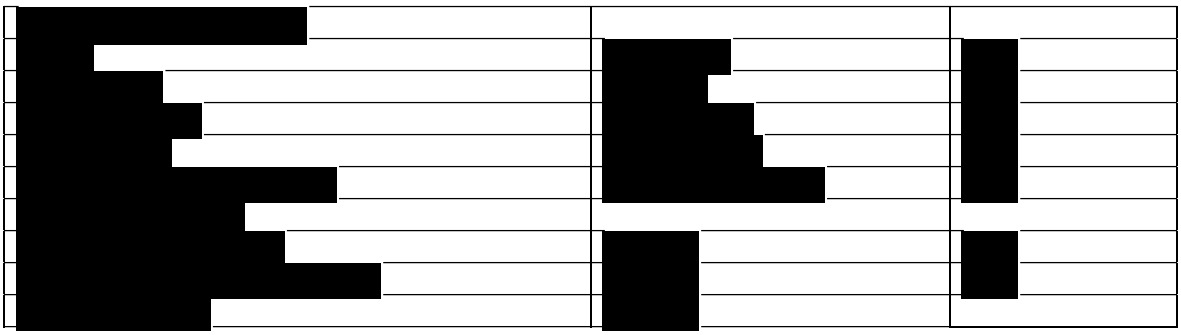

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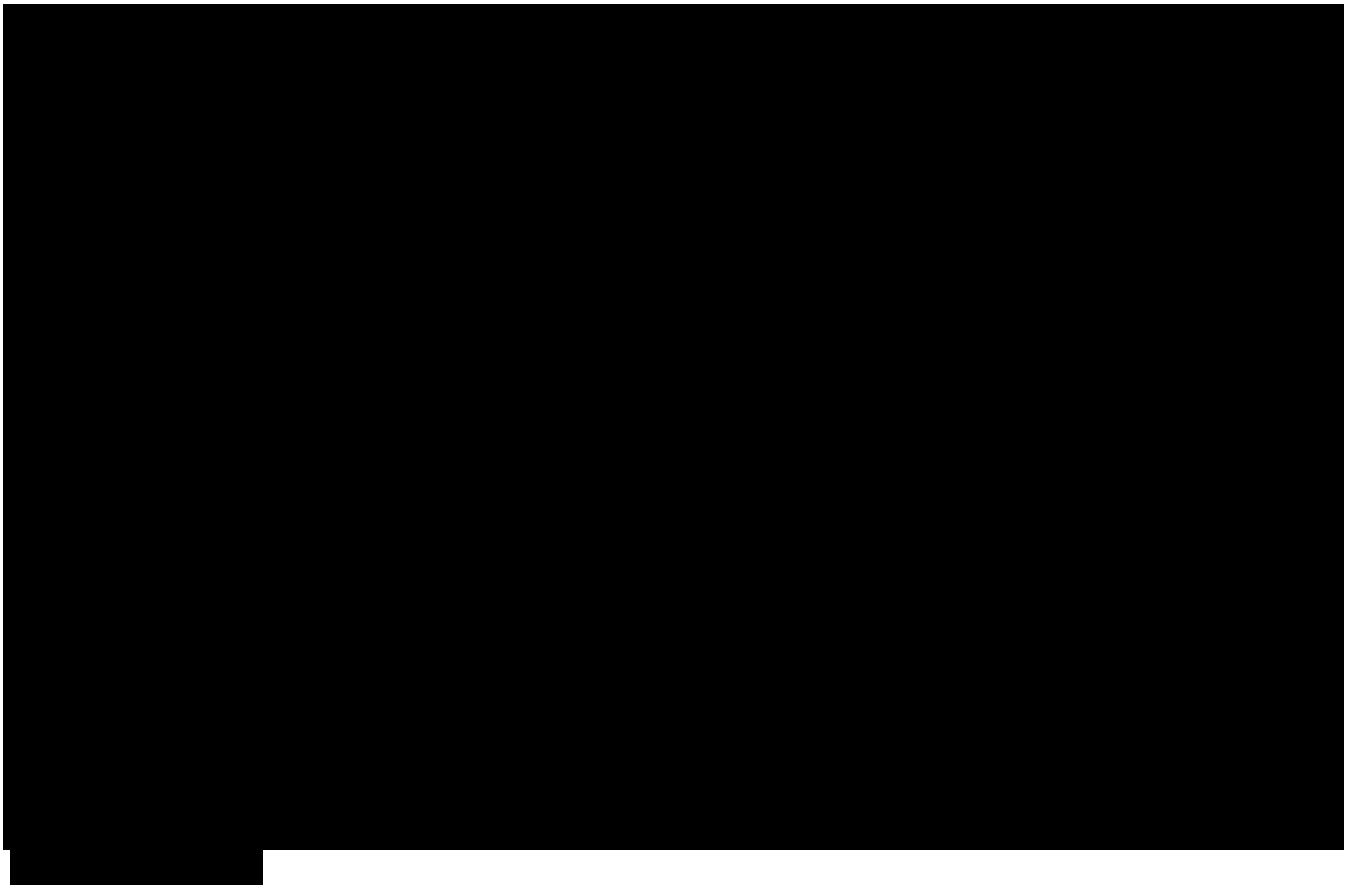

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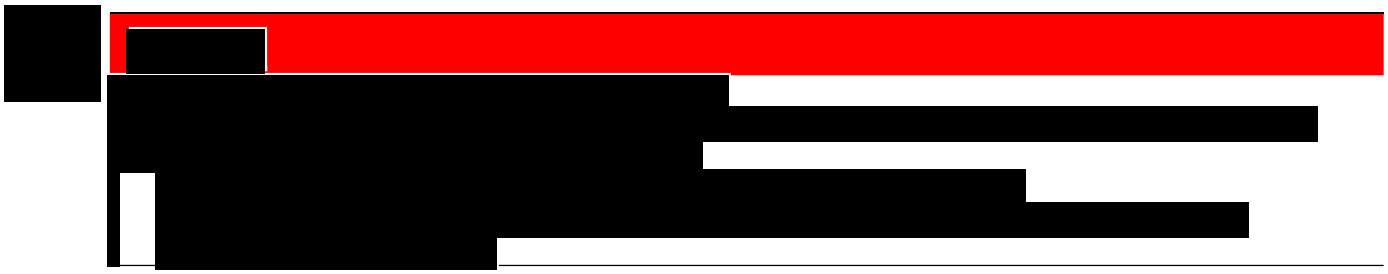

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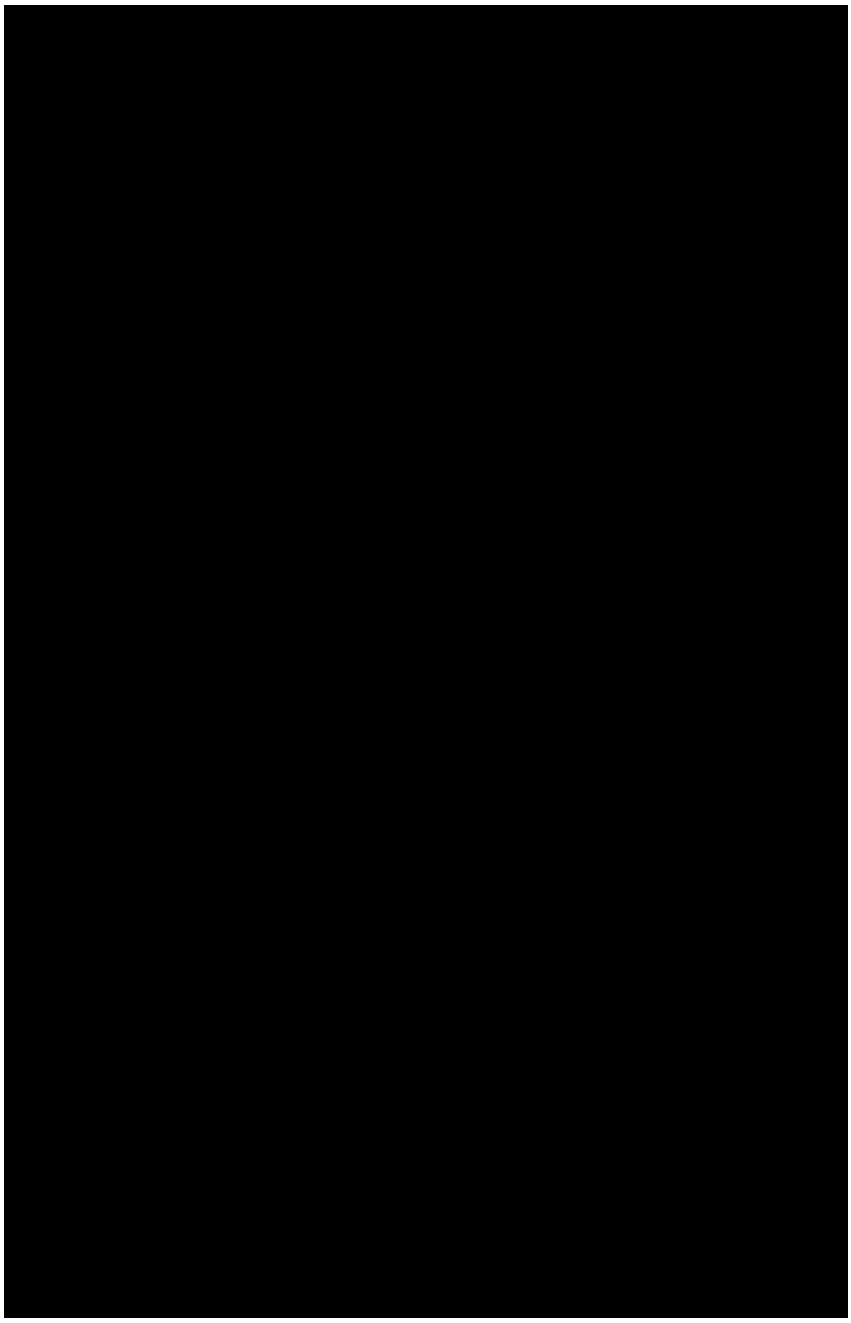

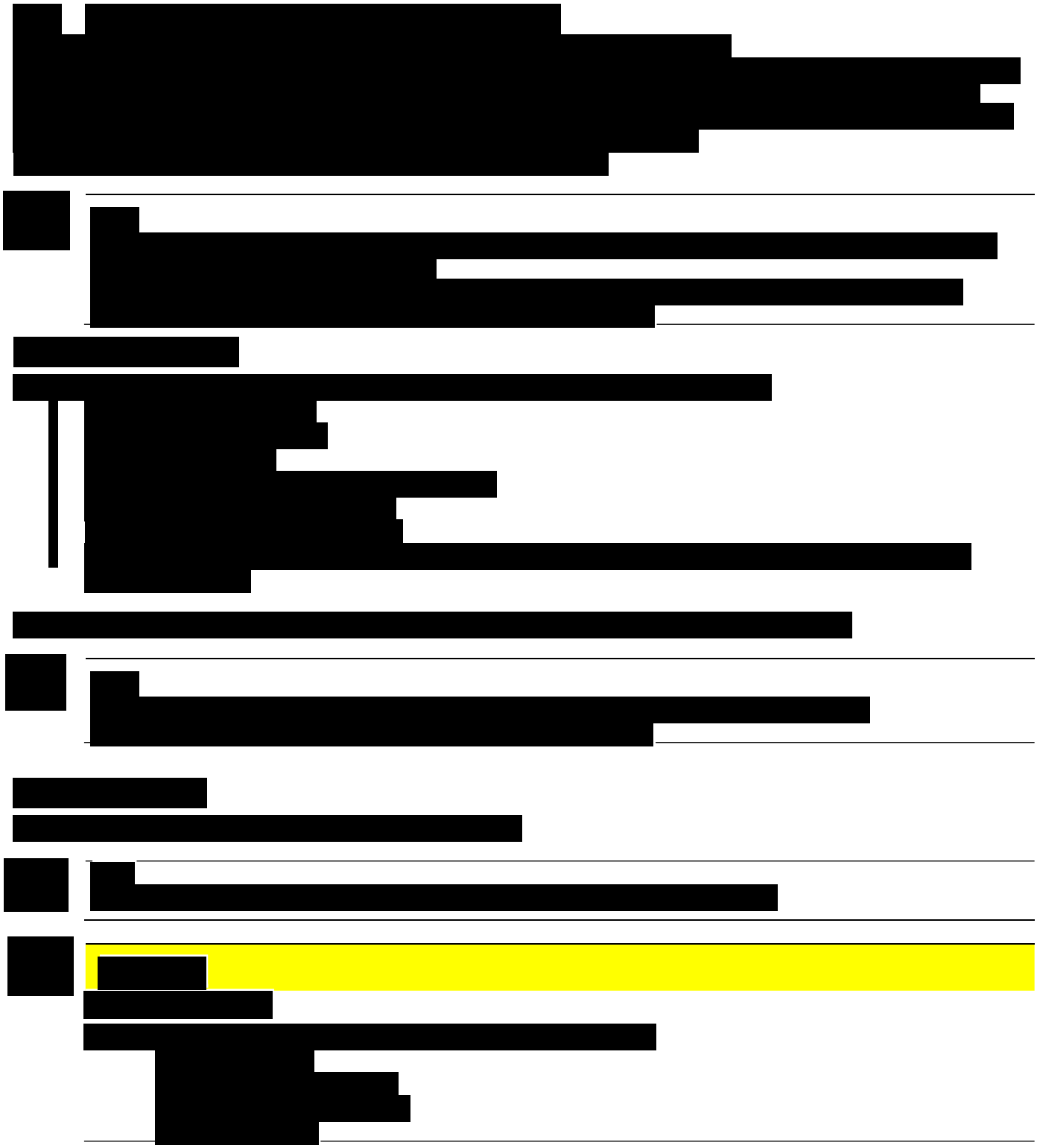

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