MEMORANDUM

FINAL PAPER 1

EXTERNAL INTEGRATED SUMMATIVE ASSESSMENT (EISA)

OCCUPATIONAL CERTIFICATE: GAS TURBINE PROCESS CONTROLLER

SAQA ID: 118111 NQF LEVEL: 6 CREDITS: 360

CANDIDATE DETAILS				
Candidate Name and Surname:				
ID Number:				
Assessment Centre Name:				
Assessment Centre Registration Number:				
Assessor Name and Surname:				
Assessor Registration Number:				
Moderator Name and Surname:				
Moderator Registration Number:				
Date:				
Time:	**09H00- 12H00**	**Duration:**	**1 Day (3 Hours)**	

INSTRUCTIONS TO CANDIDATES

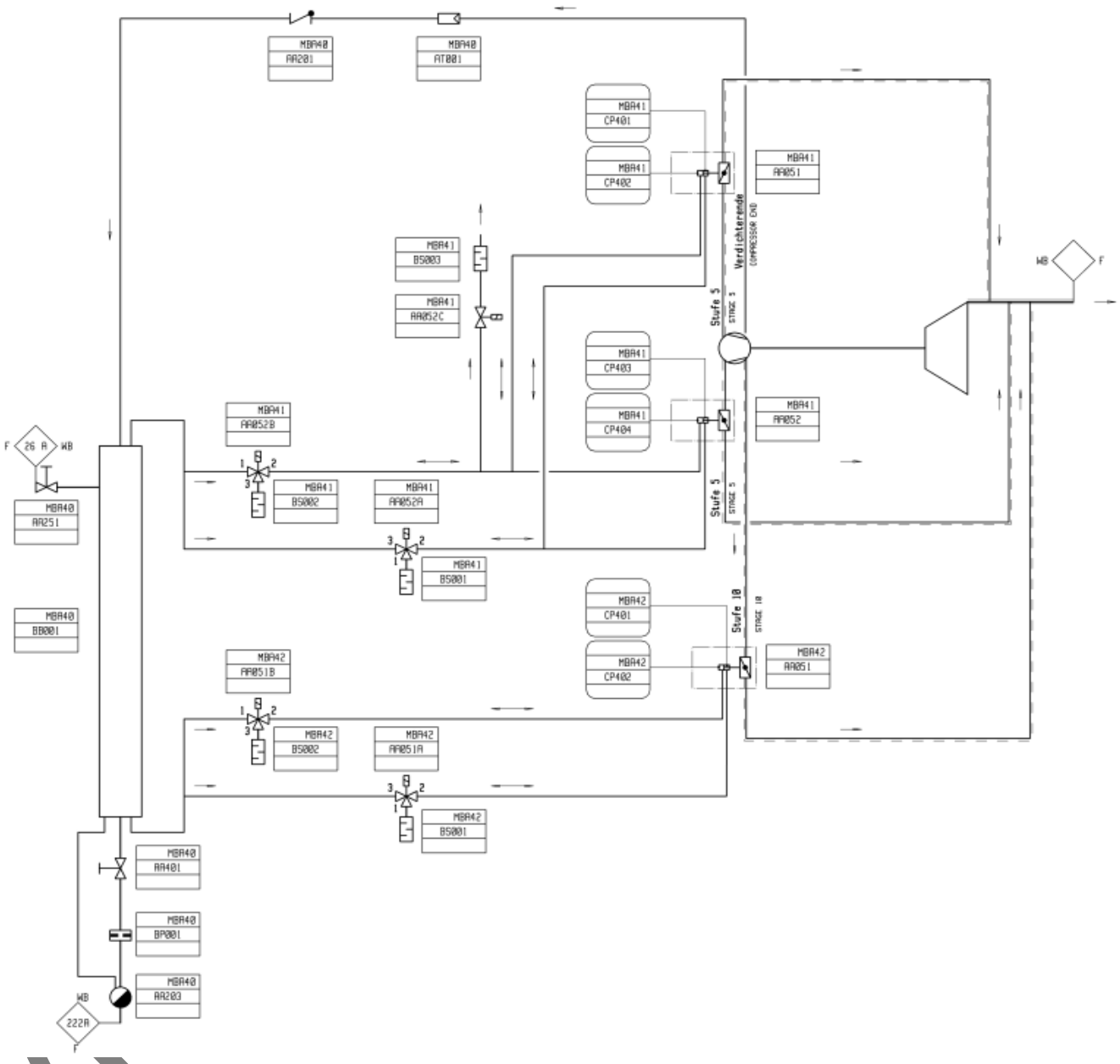
This question paper consists of 17 pages
Please read the questions carefully and then answer ALL the questions on the provided answer sheets.

PLEASE ENSURE THAT YOU ADHERE TO THE FOLLOWING INSTRUCTIONS:

- Cell phones are not allowed.
- Please use a **BLACK PEN**. No script will be marked if written in Pencil.
- Complete all your personal details in the space provided above.
- This is a closed book assessment; no reference material will be allowed, unless otherwise indicated.
- Carefully read through all the Scenarios and Questions and answer **ALL** questions
- Diagrams/sketches must be large, neat and FULLY LABELLED
- Read the instructions for each question before answering.
- Structure all written answers logically.
- Pass mark for this assessment is 50%
- Use the mark allocation for each written question to guide the length of your answer.
- If additional paper is used, ensure that you write your Personal Details on each page and clearly mark which question you are answering.
- The invigilators will supply you with a stapler to attach the additional pages to the ANSWER SHEET

Question 1: **[16 marks]**

1.1 Given the diagram (Blow-off system) provided below, analyse the and answer the questions that follow:



a) Identify the different components that make up the Blow-off System. (6 marks)

1. Air receiver with automatic drains trap√
2. Blow Off Valves√
3. Solenoid valves A and B√
4. Solenoid valves A, B and C√
5. Instrument piping√

6. Pipework from compressor stages to exhaust duct√

b) What is the function of the Blow-off system and the possible dangers to the Gas Turbine if components do not operate correctly? (4 marks)

The compressor is designed to operate at the rated speed of the generator√. At other speeds, known as critical speeds, the air flow across the front stages can stall√ and the air flow becomes unstable√ and pressure fluctuations can cause high vibration, high bending stresses and temperatures. The blow-off valves open to bleed air into the exhaust duct to prevent these pulsations√.

c) Using a P&I D diagram (Blow-off plant system given above), explain how the various Blow-off valves operate. (6 marks)

1. A signal from T-3000 causes solenoid valves√
2. Solenoid A and B to (de- energise) which allows air from the receiver to pass through solenoid valve√
3. Pressurise the "open" side of Blow off valves√
4. The "close" side of the blow-off valves are vented via their associated solenoid valves√
5. To assist with the opening of the Blow-Off valves, the associated solenoid valves will vent. √
6. When the Blow-Off valves are closed, the process is reversed√

Scenario 1: **[12 marks]**

1.2 Assume the unit is handed back to operations. You and your team are required to prepare the unit for stand-by for National Control. Assess and explain the role of the process controller highlighting communication with key stakeholders according to the standard operating procedures when the plant is ready to operate or cannot operate. (9 marks)

1. The controller must work with the stakeholders to ensure that the unit is stand-by for operation√
2. All stakeholders must be informed of the plant status which include inter alia: Plant managers, Operating and Maintenance Managers, Power Station Managers including National Control) √√√√
3. The process controllers or network controllers must ensure that their plant is on stand-by ready to generate power√ if the plant is running, they must ensure that this is real-time, which means that all is up-to-date√, when the plant needs to be run) √

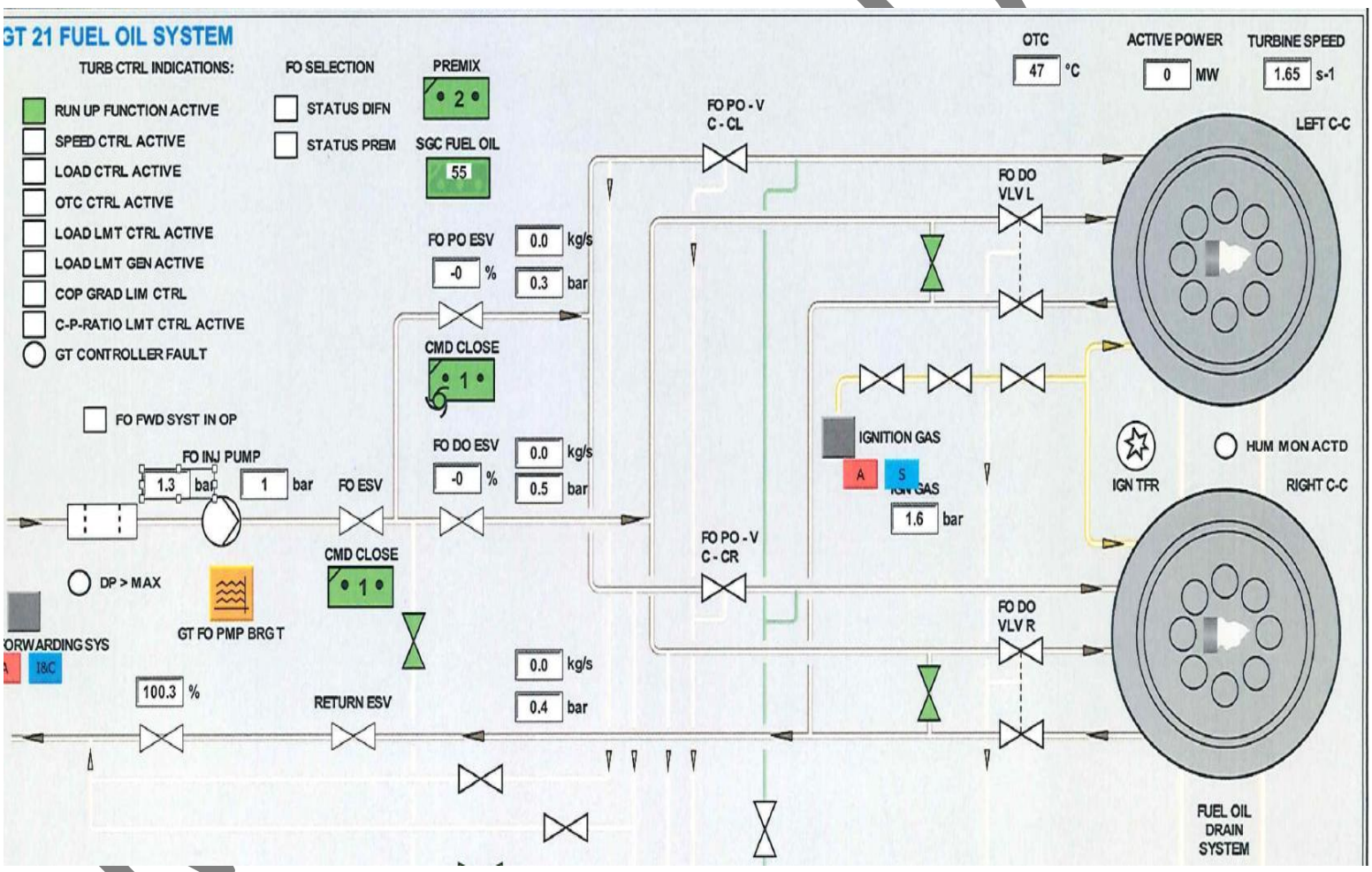
4. The controller must also communicate with the stakeholders using Energy Dispatch (ED) system√

b) Activities involved using the system: (3 marks)

1. Observe the requests from the stakeholders√
2. Update the system continually not to lose the income√
3. Communicate real-time information to the stakeholders√

Scenario 2:

1.3 Given the HMI schematic diagram, plant inspection sheet and relevant trends, analyse and interpret the data identifying any inaccuracies utilising the provided documentation. **[15 marks]**



Daily Operational Checks – UNIT 21								
	Ops Values	Mon.	Tues	Wed.	Thurs.	Fri.	Sat.	Sun.
Deluge Systems – SGA:								
Deluge Valve Control Pressure – SGF01CP501	> 6 Bar	7.16						
Deluge Valve Supply Pressure – SGF01CP502	> 6 Bar	7						
Deluge Foam Tank level – SGF01BB001	>75%	Yes						
Lube/Lift Oil – MBV:								
Level in tank OK MBV10CL001	Y/ N	Yes						
Any oil in Sight Glass?	Y/ N	NO						
C.W Outlet flow MBV	< 70 m3/h	65m3/h						
Oil Mist Separator Vacuum Press. MBV50CP101	neg -4 to -6 mbar	-512						
Lift Oil Filter in service	AT 01/02	01						
Lift Oil Pump Pres. MBV30CP502	> 130 Bar	150						
L.O. press. Before cooler and filter MBV21CP501	> 4 Bar	5						
L.O. press. After cooler and filter MBV26CP501	> 1.5 Bar	2						
L.O. Filter in service	AT 01/02	02						
Filter DP ok – MBV25CP001	% Red	0						
L.O. Cooler in service	AH 01/02	H02						
L.O. temp. before cooler MBV23CT511/521	< 60°C	50°C						
L.O. temp. after cooler MBV23CT512/522	< 50°C	48°C						
L.O. press. Cooler inlet MBV23CP511/521	5-5.2 Bar	502						
CW press. Cooler inlet MBV23CP513/523	4.8-5 Bar	5						
Hydraulic Skid – MBX:								
MBX02 CP501	150-170Bar	160						
MBX06 CP501	>0 Bar	1						
MBX04 CP501	150-170Bar	160						
MBX04 CP502	150-170Bar	160						
MBX03 CP501	150-170Bar	-						
MBX02 CP502	150-170Bar	160						
Level in tank MBX01CL501	> 75 %	77%						
Temp. in Tank MBX01CT501	20-55°C	40°C						

	Ops Values	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
Purge Water Skid – MBN:								
Tank Level OK	> 425 litre	Yes						
Ignition Gas stand – MBQ:								
Ign.Gas Pressure MBQ11CP502	9-15 Bar	16bar						
Leaks at Combustion Chamber Burners	Y/N	N						
Ign Gas Pipe Trace Heating	> 55 °C	75°C						
Fuel Oil Skid – MBN:								
F.O. Filter in service	AT 01/02	02						
Filter DP ok – MBN11CP001	% Red	0						
Pump Inlet Pressure MBN11CP501	> 4 Bar	1						
Pump Outlet Pressure MBN12CP501	100-120 Bar	0						
Pump Drive End Oil Level	> Red line	Yes						
Pump Drive End Bearing Temp MBN12CT105	< 85 °C	18°C						
Pump Non Drive End Oil Level	> Red line	Yes						
Pump Non Drive End Bearing Temp MBN12CT107	< 85 °C	20°C						
Premix Strainer DP - MBN16CP101	< 100 mBar	51						
Diffusion Strainer DP - MBN13CP104	< 100 mBar	2						
Main ESV Control filter indication- MBX78AT002	Red/Green	GREEN						
Premix ESV filter indication –MBX76AT002	Red/Green	GREEN						
Diffusion ESV filter indication-MBX75AT002	Red/Green	GREEN						
Return line ESV filter indication -MBX79AT002	Red/Green	GREEN						
Return line CV filter indication-MBX86AT002	Red/Green	GREEN						
Blow off & Combustion Chamber system : MBA & MBM								
Drain water condensate	Y/ N							

Generator Coolers: MPR								
Pump Suction Pressure MPR11/12CP501	3-4 Bar	1.9 Bar						
Temp after cooler MPR11/12CT501	< 40°C	18						
Pump Discharge Pressure MPR11/12CP502	5.5-6.4 Bar	4.6 Bar						
Press Expansion Tank MPR50CP501	3-4 Bar	3						
Lube Oil Coolers: MBV								
Pump Suction Pressure MBV23CP502/4	3-4 Bar	3.2						
Temp after cooler at pump MBV23CT501/2	< 50°C	20°C						
Pump Discharge Pressure MBV23CP503/5	5.5-6.4 Bar	5.8						
Press Expansion Tank MBV23CP501	3-4 Bar	3.5						
Generator /Turbine Enclosure LHS:								
C.W. Inlet Temperature MPR30CT501	< 40 °C	18°C						
C.W. Outlet Temperature MPR20CT501	< 50 °C	18°C						
C.W. Outlet Flow MPR20CF501	> 170 m3/h	190						
C.W. Outlet Pressure MPR24CP502	> 3.2 bar	3						
CO2 Fire Protection ok - Armed	Y/N	Yes						
Fire Detection Panel OK CYE10GE001	Y/N	Yes						
Munster's Dryer Temp. Generator side.	> 50 °C	Yes						
Munster's Dryer Temp. Turbine side.	> 50 °C	Yes						
UBA / PCC Rooms:								
Air conditioner - Active	Y/N	Yes						
Any alarms?	Y/N	Yes						
Battery room ventilation - ON	On/Off	ON						

	Ops Values	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.
Station Service Transformer: (BBT)								
Winding Temp.	< 110 °C	20						
Oil Temp.	< 95 °C	20						
Silica gel (Colour)	% Orange	Brown						
Generator Transformer: (BAT)								
Conservator tank Oil Level OK	Y/N	Yes						
Winding Temp.	< 110 °C	35°C						
Oil Temp.	< 95 °C	35°C						
Silica gel (Colour)	% Orange	Blue						
Covid -19 Requirements								
Turbine Hall - is Hand Sanitiser Spray available?	Y/N	/						
Generator Hall-is Hand Sanitisers Spray available?	Y/N	/						
General Comments:								
Synchronising relay tripped on CHA panel								
		Mon.	Tues	Wed.	Thurs.	Fri.	Sat.	Sun.
Performed By	Initials	TS						

Answers

1. Analyse and identify four (4) inaccuracies from the provided documentation (i.e. diagram, status of the plant and trends). Data is correctly analysed, interpreted and compared and the number of inaccuracies are identified correctly√

The inaccuracies to be identified from the Daily Operations Check Sheet are as follows:

a) Generator Cooling pressure is low√

b) The Ignition Gas pressure is very low at 2.6 √

c) Generator Cooling is at 1.9 when it is supposed to be between 3 and 4√

d) Synchronising relay tripped on CHA panel√

2. Log and raise a notification for deviation√√√√
3. Inform the person in charge of the plant about the inaccuracies identified Determine the corrective action to be taken to address the identified inaccuracies X4√√√√
4. Log the incident in the Shift Log and raise a notification for deviation in the system√√
5. Inform the supervisor regarding the action taken√
6. Gas leak on a Unit 21 1.6 bar√
7. Pump suction pressure 1.9 bar Low √
8. Alarm active – Synchronising relay tripped√
9. Silica gel brown (depleted)√

1.4 Evaluate and interpret the plant diagrams depicted below (Diagram A, B and C), and determine all resources required to enable the Gas Turbine Process Controller to give feedback to National Control on the plant status with examples. **[16 marks]**

Diagram A

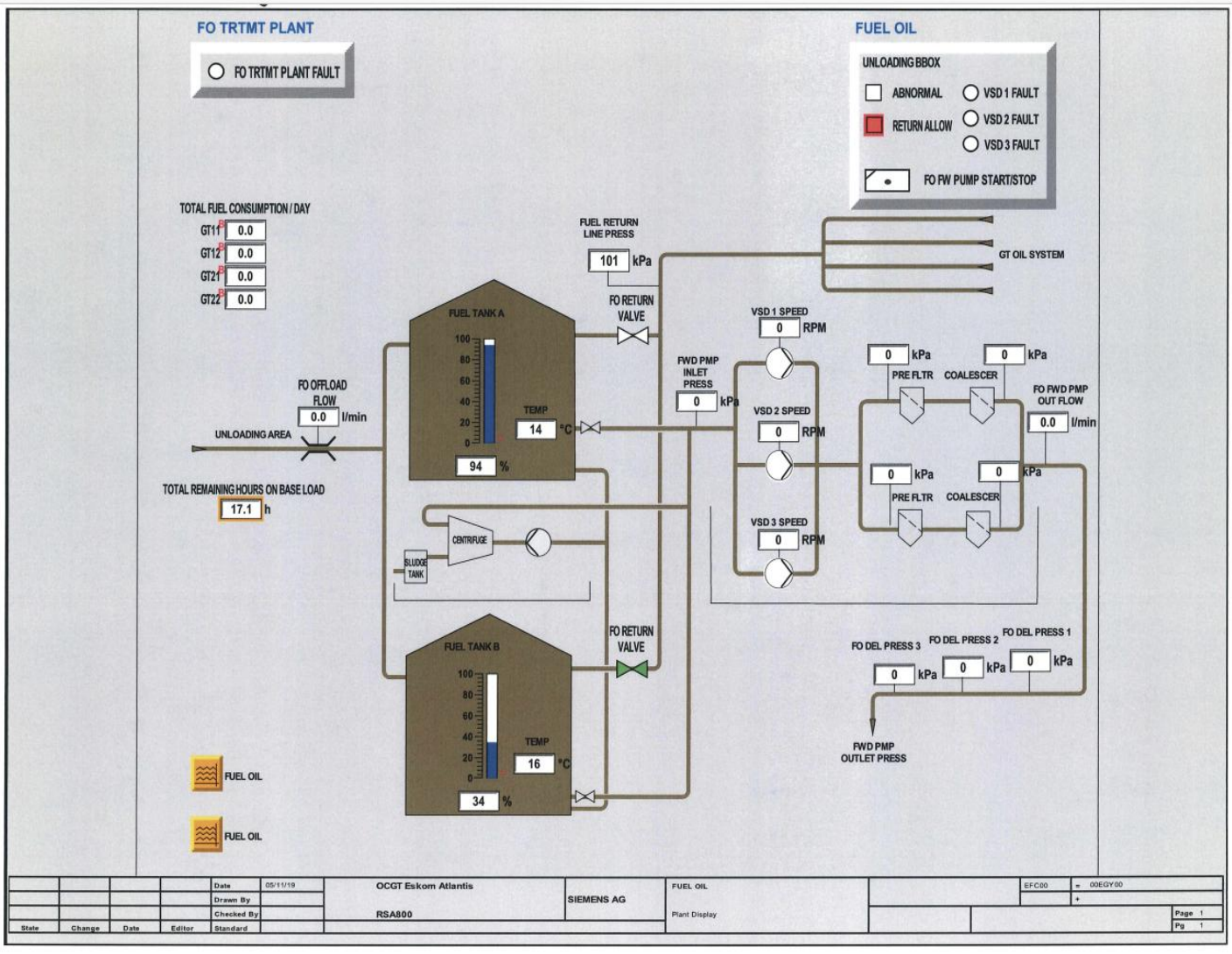


Diagram B

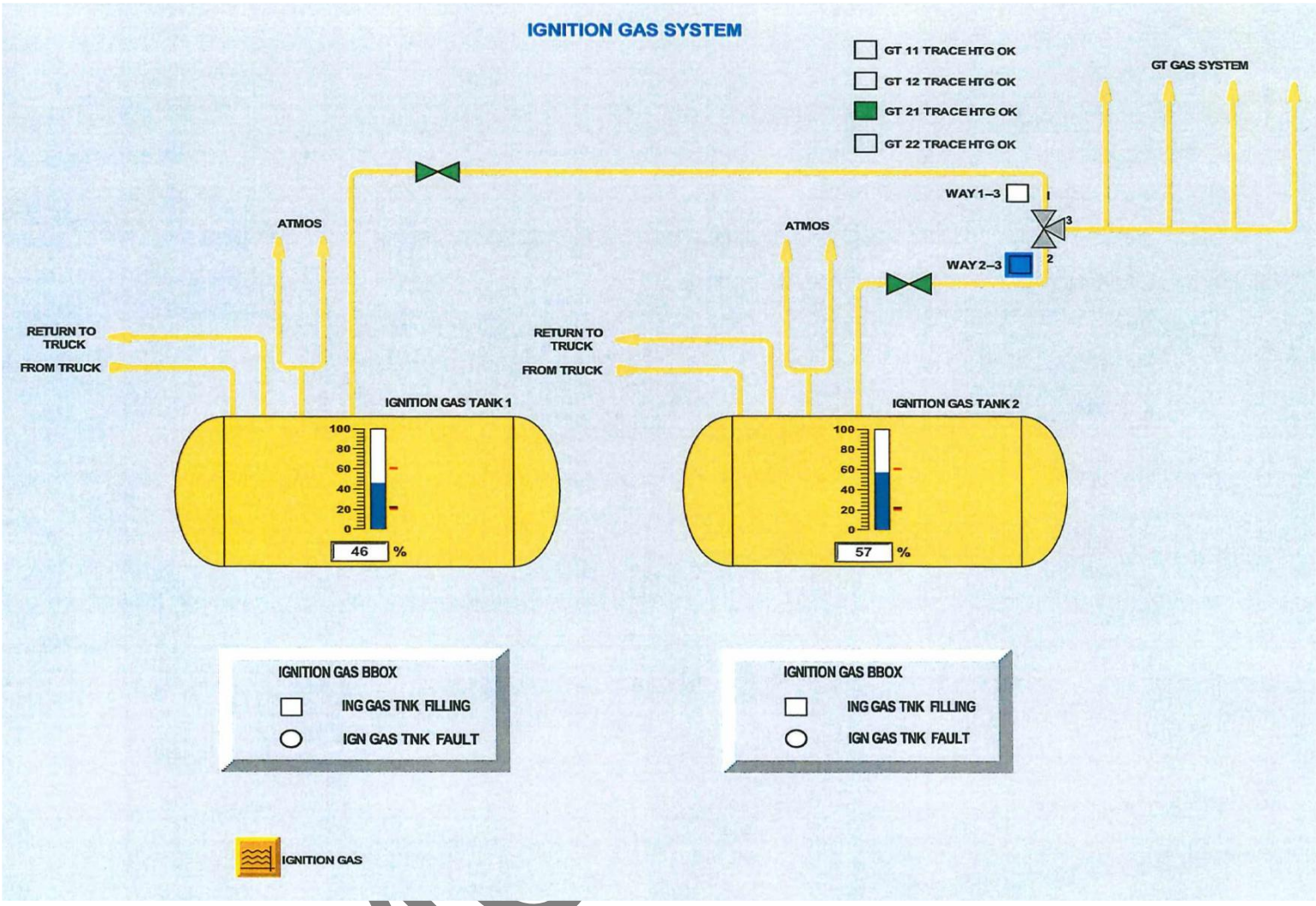
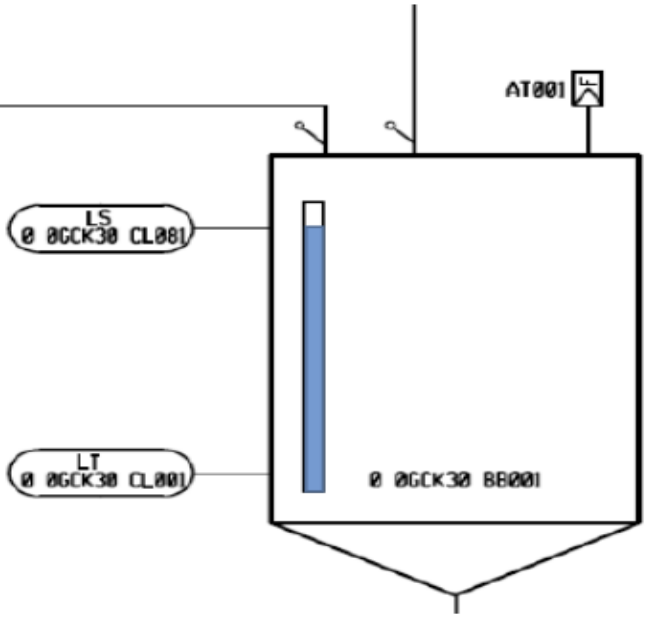


Diagram C



Answers:

1. The process controller must show understanding√ of the planning process√ i.e staff - project management team√
2. They must maintain constant contact√ with the team to understand the maintenance plan√ coordinate and participate in the activities of the team√√
3. Facilitate/expedite raw resources planning√
4. Ensure the re-instatement of the plant planning√ and determine raw resources required √ to generate energy/power√ onto the national grid√ which include diesel and other relevant resources such as LPG gas and de-mineralised water) √
5. The controller must also give relevant instructions√ to their power plant staff √ to confirm units prepared and ready to meet National Control needs√.

Scenario 3: **[6 marks]**

1.5 Given an out-of normal condition, explain the applicable steps to manage or troubleshoot the problem to avoid a risk to people, plant, production, or material.

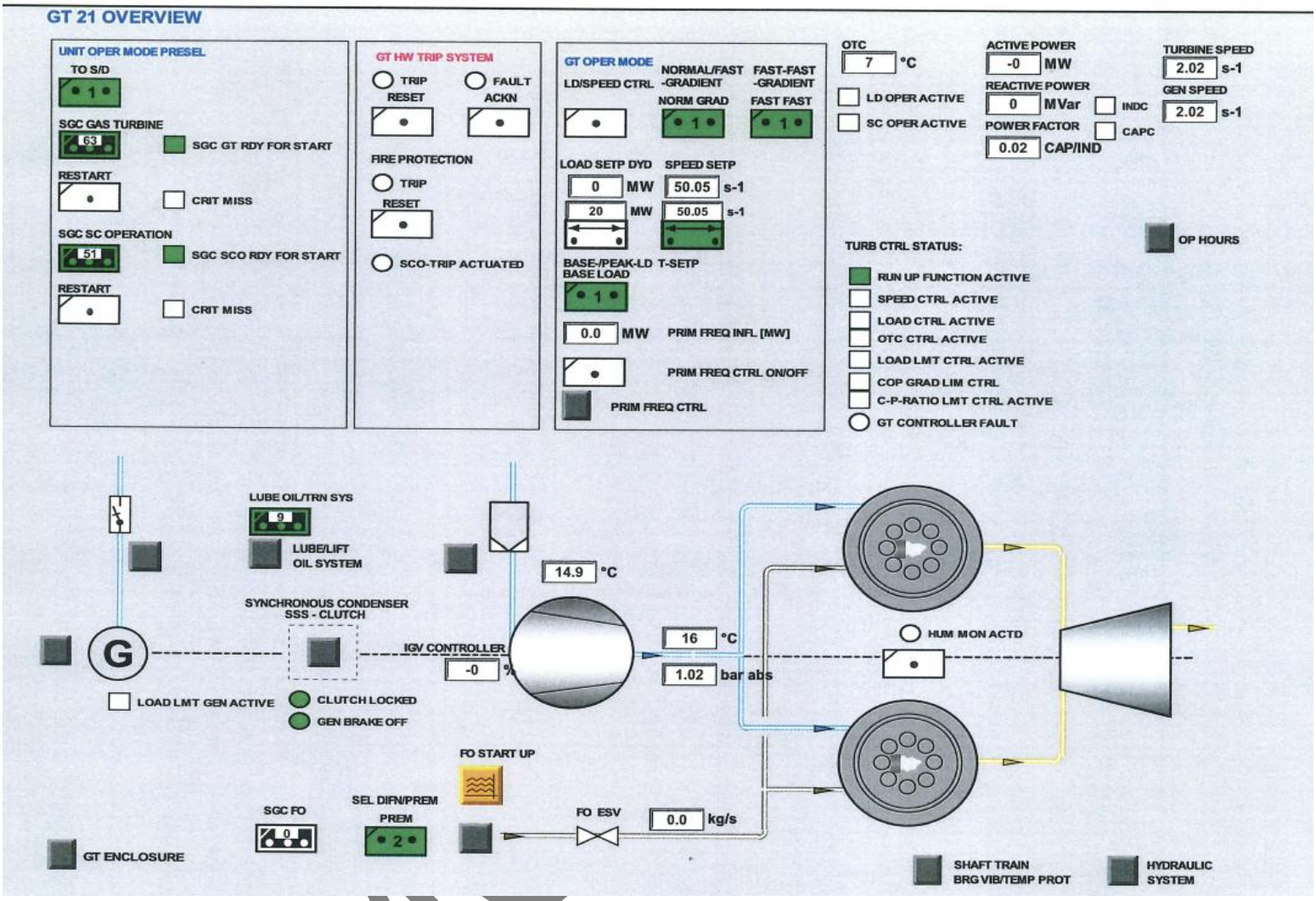
Answers OON Process

1. The OON condition may require the locking of plant items; in such conditions operating locks must be used. √
2. A risk assessment must be conducted for every OON prior to recording the OON via FLIP. A person from the Operating Department must be consulted during the risk assessment. √
3. All OON conditions must be recorded via the electronic OON register in FLIP from which it will receive its unique sequential number after it has been Accepted. √
4. The following information must be noted in the OON: the affected system, plant defect notification number, reference to the risk assessment, reason for OON condition, the date of OON implementation and the name of the person requesting the OON condition to authorise the entry. Plant simulations must be Authorised by the applicable Supervisor or Manager where applicable√.
5. The Shift Supervisor / Shift Manager must Authorise the OON by signing acceptance of the reported OON in FLIP after which its unique number will be added electronically√
6. The Shift Supervisor shall update the Control Room white board information or Electronic information system where applicable and ensure that the OON is captured into the particular shift log. The Shift Supervisor must inform all relevant shift personnel of the accepted OON condition. √
7. When the OON condition has been cleared and the system returned to normal, the OON must be electronically Cleared in FLIP by the Originator. The Control Room white board or electronic

information system, where applicable, shall be updated for that particular item and a retraction noted in the relevant operating log. √

Question 2: **[30 marks]**

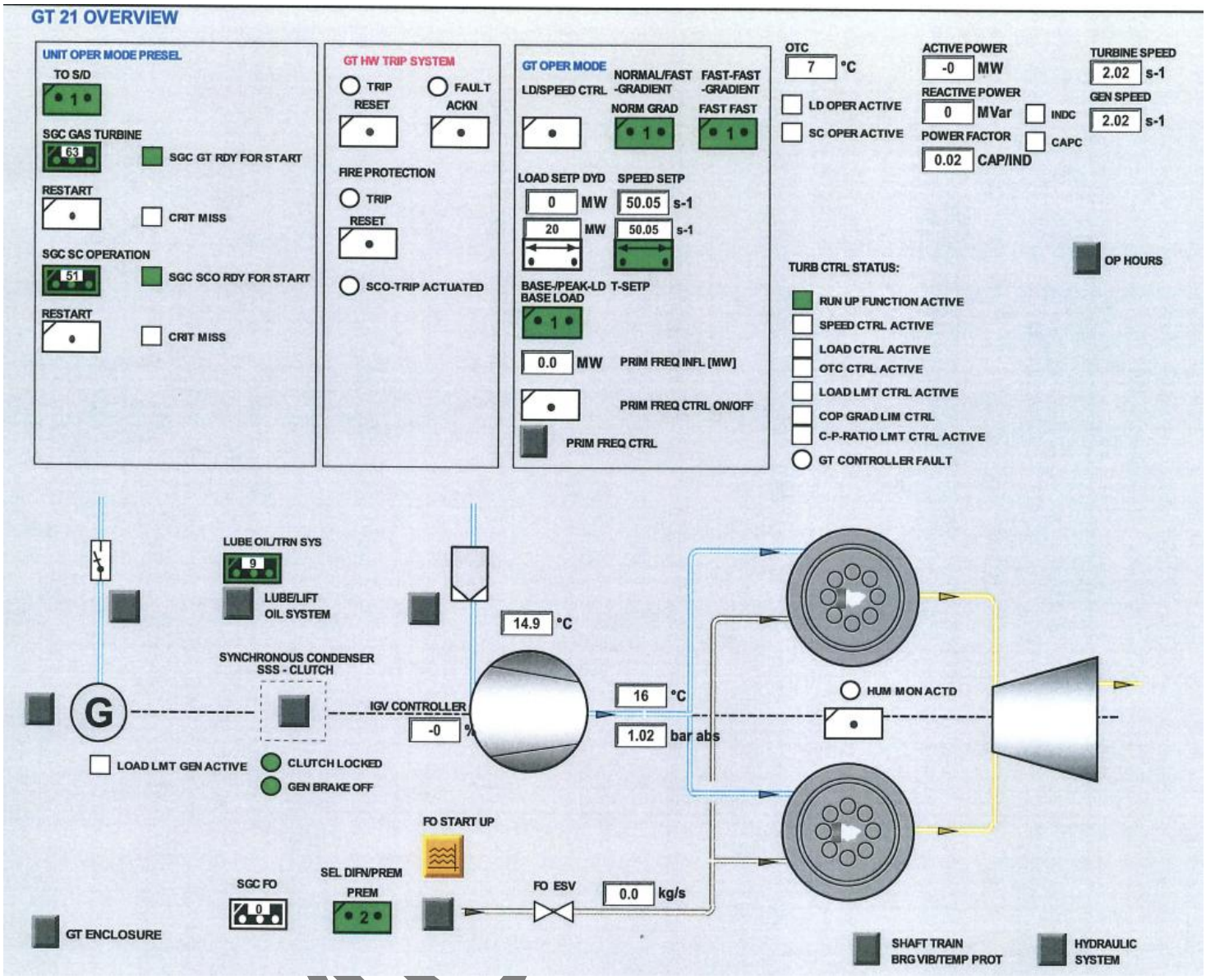
2.1 Analyse the diagram provided below (Diagram A: Turbine System) and answer the questions that follow:



a) Identify and explain the purpose of the major components of a gas turbine unit. (4 marks)

1. Air Intake system drives the turbine √
2. Compressor builds up the pressure and pre-heats the air to the combustion chamber√
3. Chamber heats the air going to the turbine√
4. Turbine√

b) Analyse the diagram provided below and identify the inter-dependencies and the turbine plant status of the drawing provided considering the required temperatures, flow pressures and plant status on the diagram. (8 marks)



1. The Air Intake system is 14.9√
2. The compressor outlet is 16 degrees and 1.20 bar√
3. Fuel oil emergency supply valves flow is 0.kg per second√
4. Turbine speed is 2.02 hz√
5. Turbine control status ready to start√
6. Generator breaker open√
7. Load set point at 20 megawatts √
8. The Inlet Guide Vane at 0%√

c) Explain the operating philosophy with respect to the utilisation of air from the intake through to the turbine. (12 marks)

Answers:

Air enters the system through the filter housing above the unit and into the air intake, which feeds directly into the compressor blades√. A suction effect is created by the compression section of the unit√. As the air is compressed and moves forward, it creates a low-pressure area behind it√. This results in additional air moving into the compression zone√. At the same time, the air that has already passed through the compressor blades has increased significantly in pressure√ and slightly in temperature√.

The next zone through which the air passes is the combustion region where the fuel/air mixture is ignited√. As the resultant gas flows through the chamber, it is exposed to very high temperatures from the burner flames which increase the temperature further√. It is now at a high temperature and pressure and therefore has a large amount of potential energy√. The next stage of the cycle is the turbine itself√. With its current properties, the gas moves quickly through the turbine driving the blades√. The final stage is release into the atmosphere through the exhaust stack√. Eventually the exhausted gas will return to the same state as the ambient environment√.

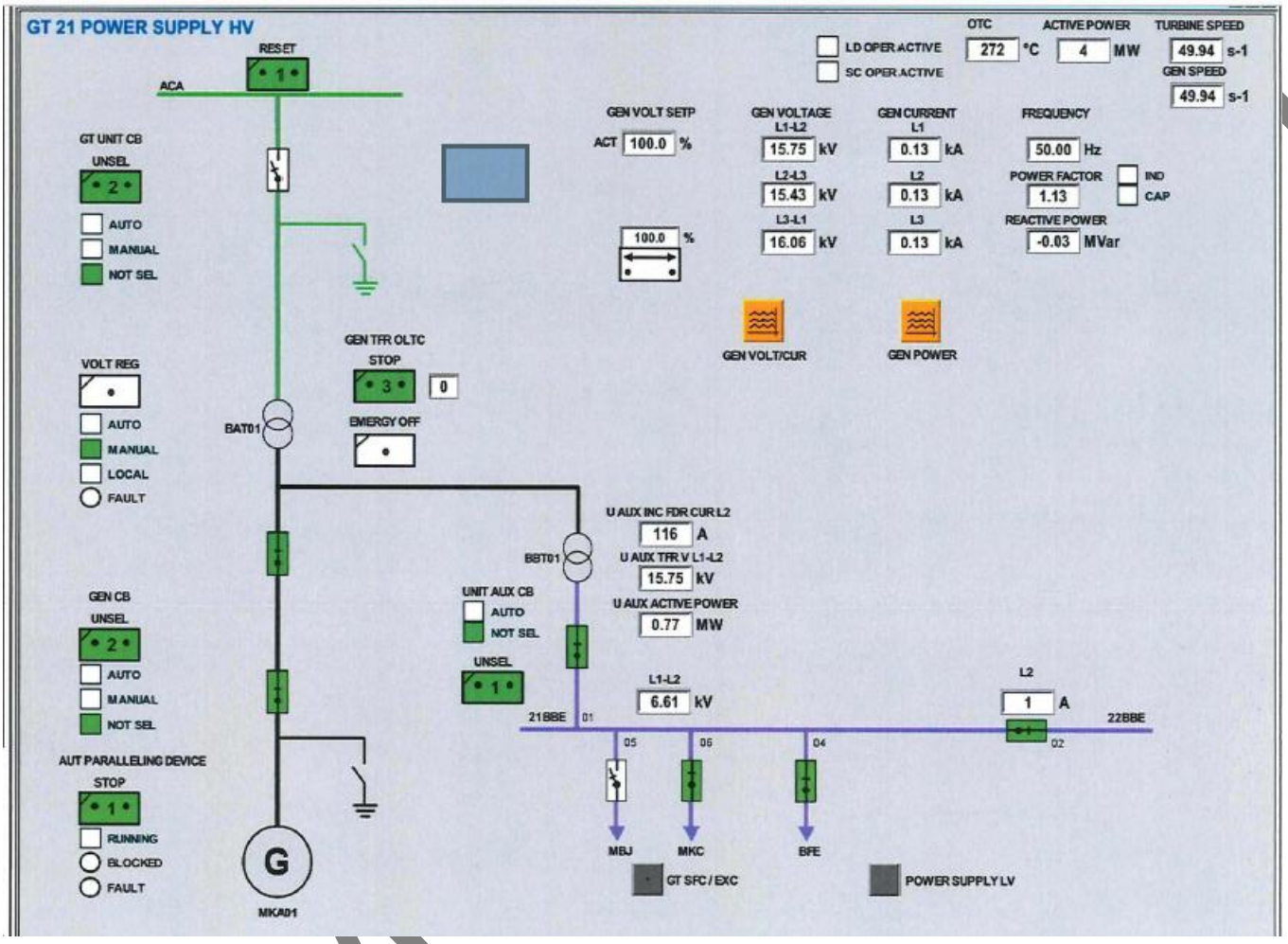
d) Describe how you would log and communicate incidents and appropriate actions taken during normal, out-of-normal and emergency conditions according to the applicable standard operating procedures. (6 marks)

Answers

a) Log-in on shift (i.e two people) √
b) Perform a notification raise indicating the priorities (e.g Priority 1,2 or 3) √
c) Decide which should go to the SAPQIM system√
d) Complete a one-page report indicating actions taken√
e) Log in all operations (out-of normal, normal and emergency conditions are logs in√
f) Log in Permit-To-work or High voltage regulations√

Question 3: **[8 marks]**

3.1 Examine and interpret the schematic layout below and explain the current status of the plant and explain how the flow of the current towards the busbars will be. Also indicate in your answer if there will be power supply to the busbars given current condition of the drawing.



Answers:

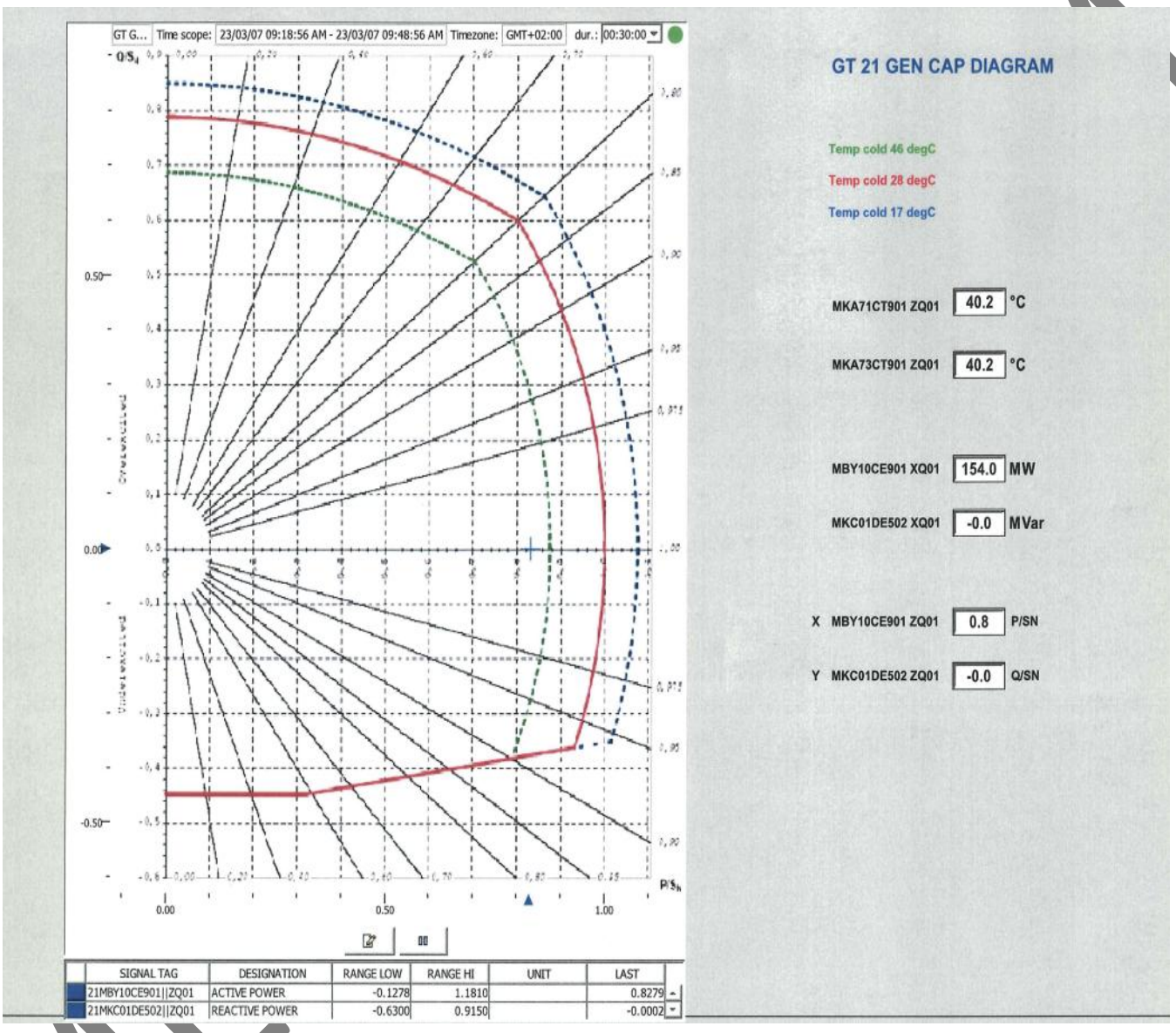
If the unit goes into island mode, the controller must contact National Control√ or National Control will contact the controller√. They need to analyse and interpret the condition properly stating the current status√ and flow of the to the busbars√.

National Control will request the re-synchronisation the unit to enable the unit to go back to full load (the unit must NOT run in island mode for longer than ten (10) minutes√ to avoid unnecessary of fuel). √

The process to be followed to resolve the problem if the 400Kv breaker trips – de-loads to 4 megawatts which results in running the unit in island mode√ – solution will be to re-synchronise to the grid by closing the 400Kv breaker and load machine to full load√

Scenario 1: **[12 marks]**

3.2 Given the diagram below, assume the National Control has commenced loadshedding due to unavailability of coal plant units. The power factor is fast deteriorating, analyse and interpret the diagram and indicate what actions would you take to resolve the problem.



Answers

In order to restore the plant to an acceptable status, the controller would need to assess certain variables within the capability chart√√, current megawatt output√√, active power and reactive power√√, temperatures/cooling on the generator√√ and take necessary steps to correct the abnormalities according to the operating and maintenance manuals√√ and implement the approved procedures√√.

Scenario 2:

3.3 The temperature protection circuit of the compressor bearing has responded because one of the three temperature measurements are too high causing the gas turbine to trip.

Evaluate and explain how you intervene to correct the situation. **[10 marks]**

1. Observe the shutdown procedure of the gas turbine
2. Ensure the proper turning gear operation of the gas turbine
3. Check the bearing temperature measurements for correct function
4. Check the lube oil supply of the affected bearing on site, for example temperature and pressure)
5. Inspect the affected bearing for damage
6. Check the lube oil purity for any foreign particles
7. Ascertain the cause of excessive bearing temperature and rectify it before the next start-up of gas turbine

Scenario 2: **[25 marks]**

3.4 You are in a Control Room and an audible alarm is sounded indicating a fire incident that has occurred in the vicinity of the Combustion Chamber at a specific Unit. Given this scenario, please answer the following questions in response to the incident that has occurred:

a) Explain what happens and the possible impact to production on a Gas Turbine Unit and indicate any Five (5) possible damages that may occur in case of fire in the vicinity of the Combustion Chamber. (5 marks)

1. All control and instrumentation equipment will be damaged; √
2. Power supply to the Burner Solenoids will be damaged; √
3. Gas and Burner Piping will need replacement√ including pipe and combustion lagging depending on the degree of the fire√
4. Should the fire be uncontrolled, further damage will affect the turbine√, the exhaust stack√, including the fuel injection pump with control valves√
5. The entire Combustion Chamber will be damaged and require replacement √
6. The Unit must be shutdown resulting in a loss of production or a partial load loss can be incurred√.

b) What appropriate actions would you take to address the problem? (20 marks)

1. The Controller must send the Operator to investigate the pending incident; √
2. The Controller must inform National Control that there is possible fire on top the chambers and state that the Field Operator has been instructed to investigate the probable fire incident to take appropriate action in accordance with Standard Operating Procedures √√
3. The Controller must inform Security Services to take appropriate action in accordance with Standard Operating Procedures√
4. The Field Operator has investigated√ and confirm√ the incident so that the Unit must be shut-down immediately; √
5. The Controller must activate the fire alarm√ and alert the Emergency Services to take an appropriate action√
6. The Controller must inform National Control√ of the Unit shut-down√ to safeguard the plant√ and personnel√
7. The Controller will inform the Field Operator to shut-off the gas√ and the diesel supply valves to the Unit√
8. National Control will request a Unit that is available√
9. The Controller will log the incident in the Shift Log√ and inform his/her Plant Manager √
10. The Controller must coordinate the fire emergency proceedings√ according to safeworking procedures and applying the set communication protocols√

TOTAL MARKS: / 150

END OF PAPER