

# MECHANICAL QUESTIONS & ANSWERS

## GAS TURBINES

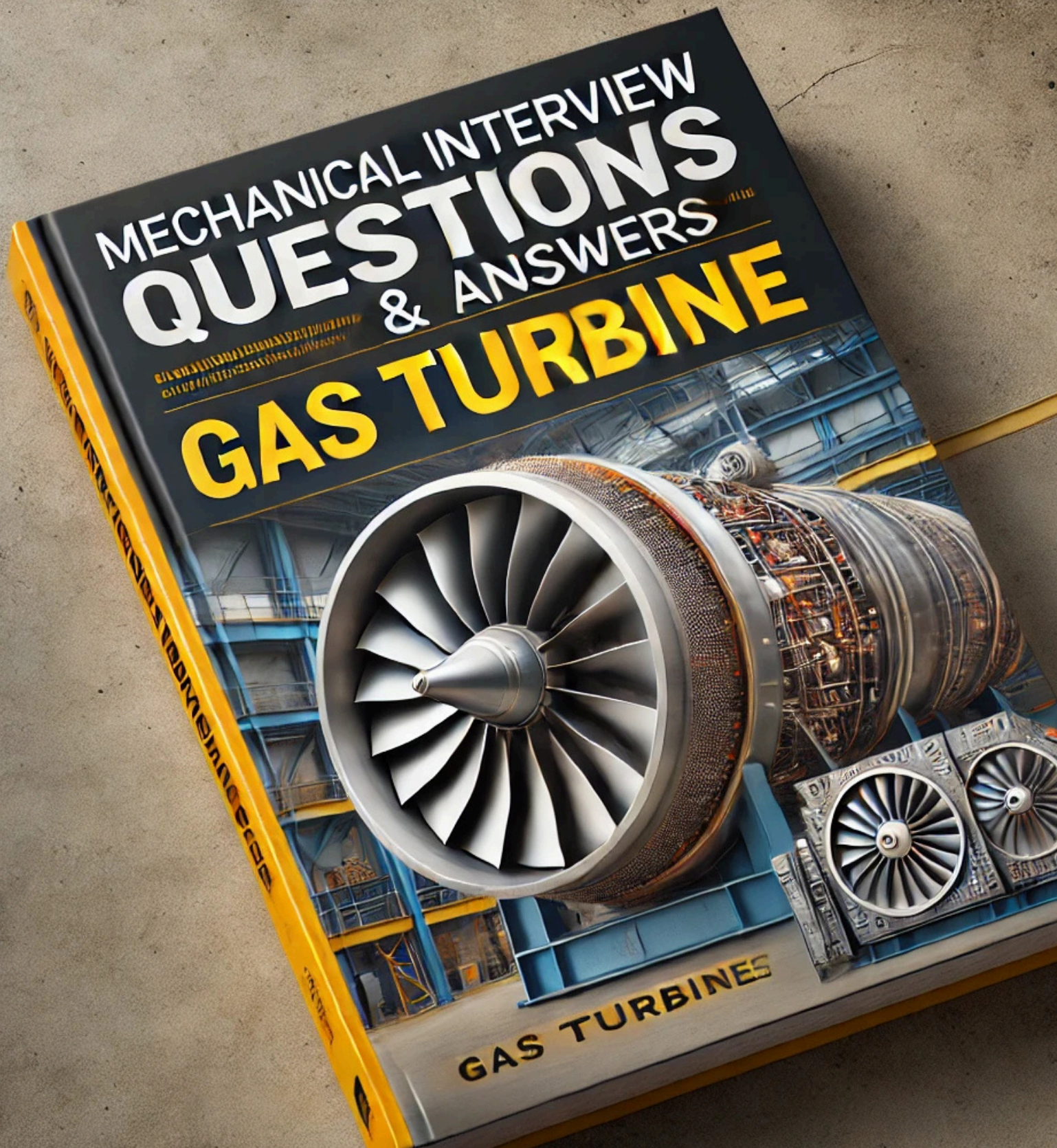


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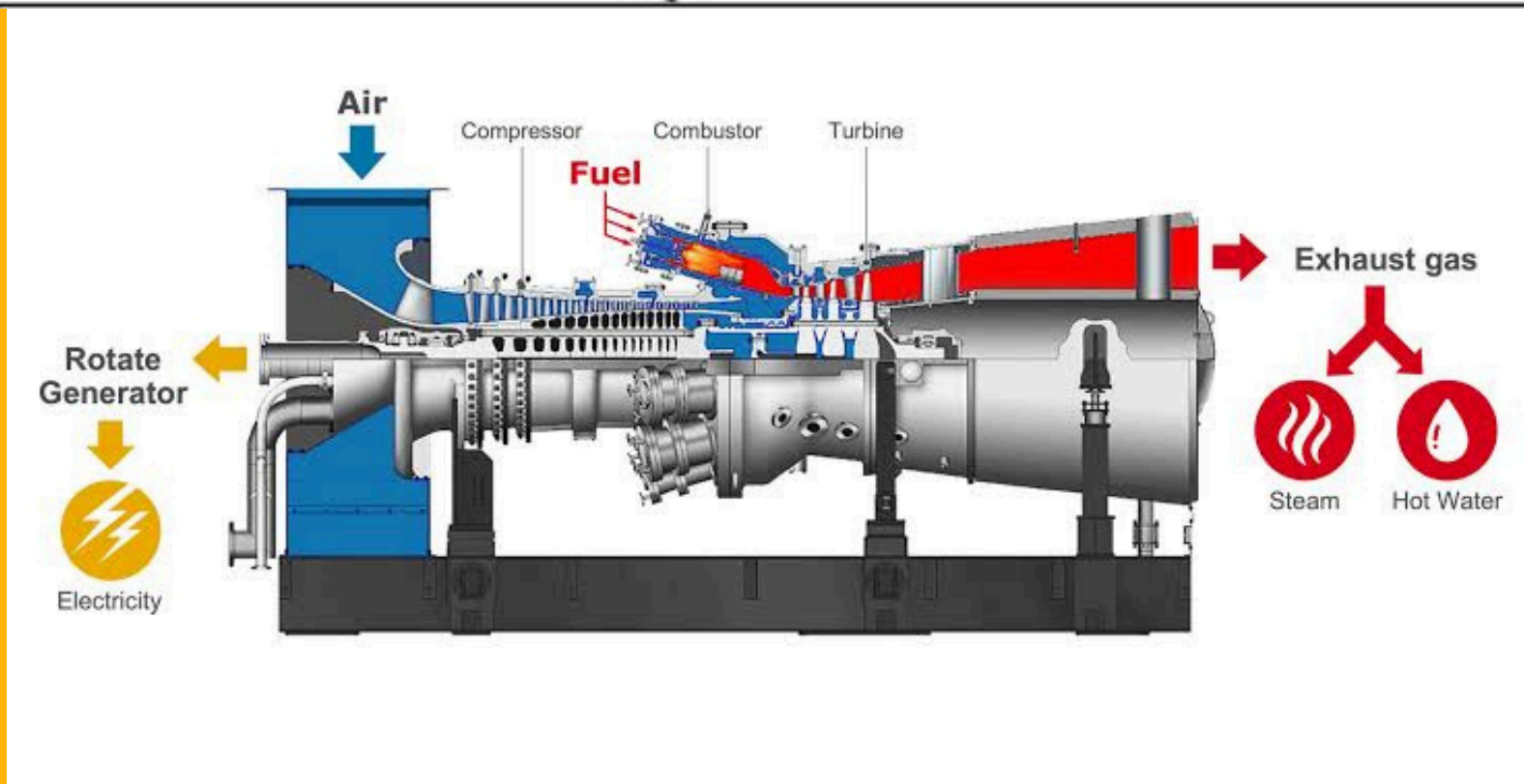
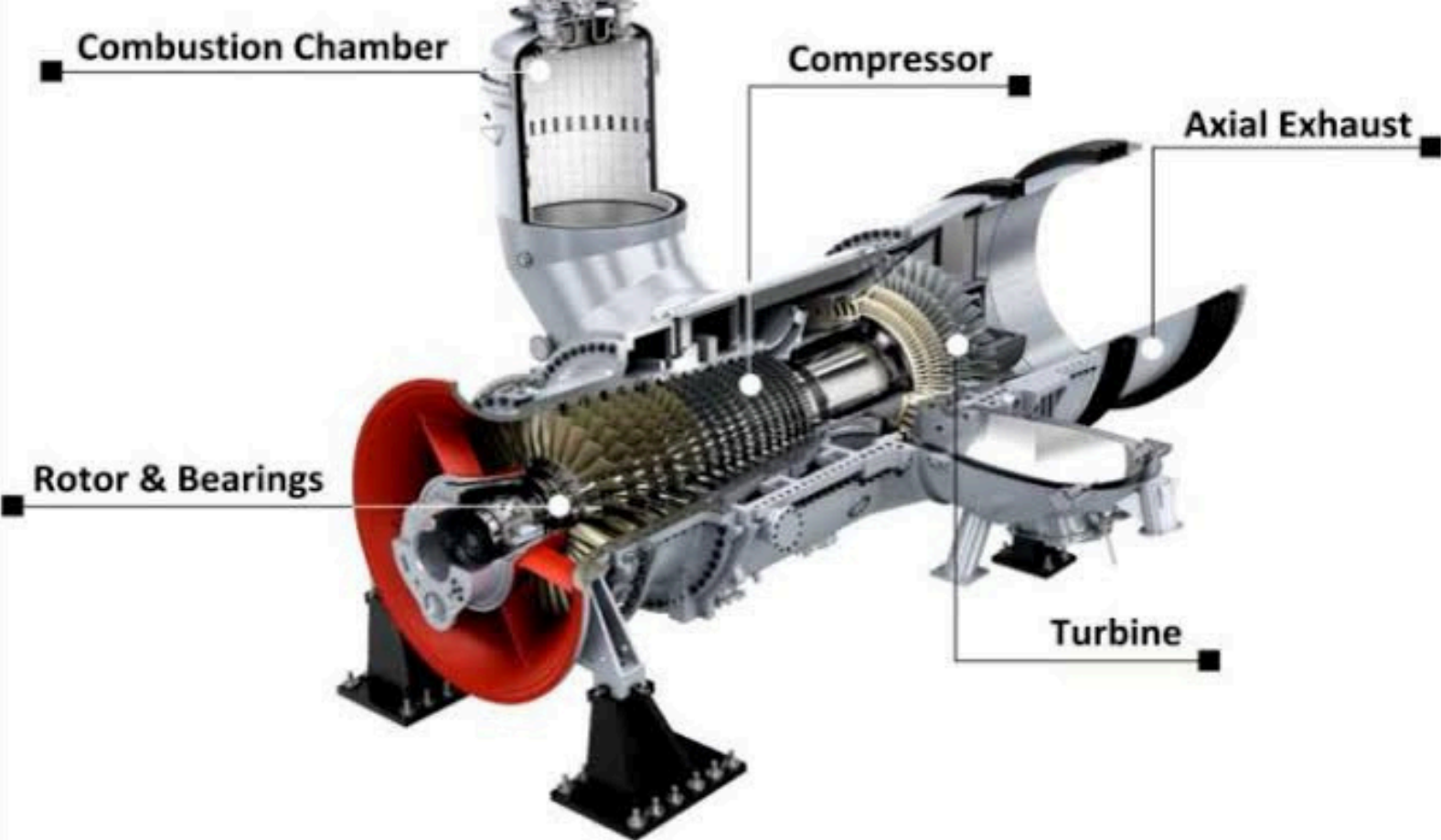
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What exactly is a gas turbine?

It's a four-step thermic machine that runs on admission, compression, combustion, and exhaust

In a gas turbine, how many stages are there?

Three phases

How many stages does the compressor have?

17 levels

What kind of compressor does the gas turbine have?

Compressor with axial flow.

How many bleed valves does the compressor have?

There are four bleed valves.

Air will be released through bleed valves at what stage of the compressor?

The compressor's eleventh stage.

Why are bleed valves required for air bleeding?

Protection against pulsation during start-up

When will these compressor bleed valves be shut off?

The speed relay (14HS) corresponds to a speed of 95 percent.

In gas turbines, what is the minimum and maximum IGV position?

34 DGA is the minimum and 85 DGA is the maximum.

When will IGV begin operations?

The speed relay (14HS) corresponds to a speed of 95%.

In frames # 9 and # 6, how many combustion chambers are there?

There are 14 combustion chambers in Frame #9 and 10 combustion chambers in Frame #6.

How many spark plugs are there?

2 pieces of spark plugs

### What does the crossfire tube serve?

A crossfire tube links all of the combustion chambers together. This tube allows flame to spread from the fired chambers to the unfired chambers.

### After igniting combustion chambers, how will spark plugs retract?

The spark plugs retract once the turbine rotor approaches operational speed, removing their electrodes from the hot flame zone.

### What are the locations of the transition pieces?

The aft end of the combustion chamber liners has transition pieces attached to it.

### What are the several stages of a gas turbine?

A row of fixed nozzles is followed by a row of rotatable turbine buckets in each stage. The kinetic energy of the jet increases with each nozzle row, resulting in a pressure decrease, and a portion of the kinetic energy of the jet is absorbed as useful work on the turbine rotor in each subsequent row of moving buckets.

### What are the locations of turning vanes?

Turning vanes are situated in the exhaust path of the exhaust hood and diffuser.

### What is the purpose of rotating vanes?

To reduce exhaust hood losses, turning vanes guide gases from an axial to a radial direction.

### Turbine legs provide what purpose?

Turbine legs help to keep the turbine and generator in line. The turbine's axial and vertical positions are maintained by support legs.

### Why is it necessary to cool the turbine legs?

Cooling water is routed through the jackets to help keep the turbine and generator aligned by reducing the thermal expansion of the supporting legs.

### How many different types of blades does the compressor have?

There are two types of blades. Blades for the rotor and stator.

### What role do rotor blades play in the compressor?

The force required to compress the air in each stage is provided by the rotor blades.

What role do stator blades play in the compressor?

The air is guided by the stator blades into the next rotor stage at the right angle.

Where will compressor air be utilized?

Purging, bearing sealing, pulsation control, and turbine cooling

Describe the rotor of the compressor.

The compressor rotor is made up of 15 separate wheels, two stud shafts with integral wheels, a speed ring, tie bolts, and the compressor blades.

What is the compressor stator like?

Inlet casing, forward compressor casing, aft compressor casing, and compressor discharge casing make up the stator (casing) region of the compressor section.

What is the location of the compressor inlet casing?

The gas turbine's forward end houses the compressor inlet casing.

The compressor inlet casing serves what purpose?

Its main job is to evenly distribute air into the compressor. It also supports the housing of the first bearing.

What is the location of IGV?

The compressor intake casing has inlet guiding vanes at the aft end.

What's in the compressor's forward casing?

The first four compressor stator stages are housed in the forward compressor casing.

What's in the aft compressor casing?

The 5th and 11th stages of the compressor are housed in the aft compressor casing.

Where does the extracted air go for the compressor's 5th and 11th stages?

This air is used for cooling and sealing, as well as starting and stopping pulsation control.

Explain how the compressor discharge casing works.

The compressor discharge casings' functions include containing the final seven compressor stages, forming both the inner and outer walls of the compressor diffuser, and connecting the compressor and turbine stators.

They also support the no. 2 bearing, the forward end of the combustion wrapper, and the first stage turbine nozzle's inner support.

### What kind of combustion system does a gas turbine have?

Type of reverse flow

### What is the location of spark plugs?

Nos. 13 and 14 combustion chambers

### What are the locations of flame detectors?

Nos. 4, 5, 10, and 11 are combustion chambers.

### What role does the combustion wrapper play?

The compressor discharge air flow is delivered to the combustion chambers through the combustion wrappers, which create a plenum. It serves as a supplemental support for the combustion chamber assembly.

The compressor discharge casing and the turbine shell, in turn, support the wrapping.

### Why are flame detectors necessary?

An indication of the presence or absence of flame must be given to the control system during the starting procedure.

### How do flame detectors function?

A flame sensor with a gas-filled detector makes up the UV flame sensor. The presence of UV radiation released by a hydrocarbon flame sensitizes the gas within this flame sensor detector. The amplifier impresses a D.C. voltage across the detector terminals.

If there is a flame, the ionization of the gas in the detector allows conduction in the circuit,

which activates the electronic and produces a flame output. In the absence of flame, the output will be the polar opposite, defining "on flame."

### What exactly is the purpose of the gasoline nozzle?

The purpose of the fuel nozzle is to distribute liquid or gas fuel into the reaction zone of the combustion liner in such a way that uniform quick and full combustion is achieved.

### What is the purpose of atomizing air?

To aid in the creation of a finely divided spray, atomizing air is combined with liquid fuel.

### What is transition pieces used for?

The hot gases are directed from the liners to the turbine's first stage nozzle by transition pieces. As a result, the hot gas flow is divided into 14 equal portions in the first nozzle area.

### What are the components of the combustion section?

Fuel nozzles, spark plug ignition, flame detectors, and crossfire tubes are all part of the combustion system.

### What are the components of the turbine section?

The turbine rotor, a turbine rotor, a turbine shell, nozzles, shrouds, exhaust frame, and exhaust diffuser are all part of the turbine section.

### What parts of the turbine rotor assembly are included?

Two wheel shafts, the first, second, and third stage turbine wheels with buckets, and two turbine spacers make up the turbine rotor assembly.

### What are diaphragms and what do they do?

Air leaking through the inner sidewall of the nozzles and turbine rotor is prevented by diaphragms. The nozzle diaphragms are attached to the inside diameters of both the second and third stage nozzle segments.

### What exactly is shroud?

Unlike the compressor blading, the turbine bucket tips run against annular curved segments called turbine shrouds rather than an inherent machined surface of the casing.

### What purpose do shrouds serve?

The shrouds' main purpose is to offer a cylindrical surface for reducing tip clearance leakage. The secondary purpose is to establish a high thermal barrier between the hot gases and the cooler shell.

The shell cooling load is considerably decreased, the shell diameter is controlled, the shell

roundness is maintained, and crucial turbine clearances are ensured by performing this duty.

### In a gas turbine, how many bearings are there?

Three bearings

What are the different types of bearings?

Ellipsoidal journal bearings.

What are the locations of these three bearings?

The inlet casing assembly's bearing-center No. 1 (Inlet to compressor)

Between the compressor and the turbine is the No.2 bearing-pressurized space. No. 3 Bearing in the exhaust frame assembly at the aft end of the turbine shaft.

What is the lubricating oil tank's capacity?

Approximately 12540 liters.

How does function coupling work?

Couplings are used to transmit shaft horsepower from the turbine to the generator and to send starting torque from the accessory gear to the gas turbine axial compressor.

What is the location of the accessory drive gear?

The gas turbine's accessory driving gear is placed at the compressor end.

What role does the accessory gear drive play?

Its job is to keep each gas turbine accessory running at the correct speed, and it also houses the primary lubrication oil pump and the turbine over-speed bolt trip mechanism.

What are the names of the auxiliaries that are driven by accessory drive gear?

The main lubrication oil pump, the main hydraulic pump, the main liquid fuel pump, and the main atomizing air compressor.

How will a gas turbine react to mechanical overspeed?

The over speed bolt, which actuates the trip upon over speed, is inserted in the main shaft of a high-pressure turbine over speed trip capable of mechanically dumping the oil in the trip circuits.



What is the speed at which a gas turbine will trip due to typical overspeed?

3210 RPM or 107 percent TNH

What is the maximum speed at which a gas turbine will trip due to electrical overspeed?

3300 RPM or 110 percent TNH

What exactly is the pour point?

The lowest temperature at which a fluid is seen to flow is known as the pour point.

What is flashpoint, exactly?

When a flame is passed over a test cup containing a fluid that has been heated at a consistent rate, the flashpoint is the temperature at which the fluid will flash but not burn.

What exactly is a fire point?

When a flame is passed over a test cup containing a fluid that has been heated at a continuous pace for at least 5 seconds, the temperature is called the fire point.

What does the GE gas turbine's coded identification mean?

The overspeed mechanism will employ the number 12.

23 for the heating device 20 for the solenoid valve

The temperature switch is number 26.

The limit switch is 33, the vibration detector is 39, and the manual switches are 43.

45 for the fire alarm, 49 for overload protection, and 63 for pressure switches

The servo valve costs \$65.

77 for the speed sensors and 71 for the level detecting system

90 for the modulating valve and 88 for the electrical motor

The pressure transmitter is 96.

Why should a gas turbine start moving gear after a shutdown?

The rotor should be spun immediately after a shutdown, after the turbine has been in the fired mode, to provide uniform cooling.

When the turbine rotor is uniformly cooled, it eliminates rotor bowing and the rubbing and unbalance that can occur when subsequent starts are tried without a cool down.

After a shutdown, how long will turbines continue to turn gear?

According to the cooldown timer, at least 14 hours have passed.

Why does the turbine compartment fan (SSBT) turn off so quickly?

To prevent the turbine from rapidly cooling.

When will the turbine compartment fan (SSBT) continue to operate after the flame has been extinguished?

It will cut off if the flame is turned off, and it will restart after 1 hour.

How long will the turbine compartment fan (SSBT) operate once the flame has been extinguished?

The temperature in the till wheel compartment reaches 148 degrees.

What happens if the accessories are turned off while the unit is still warm?

The shaft line will continue to cool, but it will bow, causing significant vibration and possibly bearing damage on the next start-up.

Identify specific parameters that should be noted or altered during unit synchronization with the system grid.

Machine speed, system voltage, and power factor are all factors to consider.

How many air compressor extractions are used?

5th, 11th, and 17th extractions

What is the temperature of the gas flowing from the combustion chamber to the exhaust plenum?

The hot gases from the combustion chamber expand into the 14th transition piece, which attaches to the aft end of the combustion chamber liners and directs them to the machine's three-stage turbine section.

Each stage consists of a row of fixed nozzles followed by a row of rotatable buckets. The kinetic energy of the jet is increased in each nozzle row, resulting in a pressure drop, and a portion of the kinetic energy jet is absorbed as useful work on the turbine rotor in each subsequent row of moving buckets.

The exhaust gases are routed into the exhaust hood and diffuser after passing through the third stage buckets. The gases then flow via the exhaust plenum.

### In a gas turbine, what sorts of spark plugs are available?

Spark plugs with high voltage, retractable electrodes, spring injected, and pressure-retractable varieties are available.

### What purpose does the transition component serve?

The hot gases are directed from the liners to the first stage nozzles by the transition piece.

### The size of the turbine buckets increases from the first to the third stage.

#### Why?

The larger annulus area necessary to handle the gas flow due to the pressure reduction caused by energy conversion in each stage necessitates increasing the bucket size.

### What does the term "wheel space" mean?

The wheel space is the area between the turbine wheel with the bucket and the stator that leads into the main gas stream.

### How does air cool the wheel space?

Air travels through the high pressure passage seal at the aft end of the compressor rotor to cool the first stage front wheel area.

The compressor discharge air that goes through the stage 1 shroud and then secondary inward

through stage 2 nozzles vanes cools the second stage forward wheel space, while cooling air departure from the exhaust frame cooling circuit cools the third aft wheel area.

### What is the purpose of the cooling system for the turbine shell, and why is it necessary?

Turbine shell cooling is provided by three exhaust frame cooling fans (88TK).

The shrouds and nozzles' axial and radial locations are controlled by the turbine shell. It calculates turbine clearances and the nozzles' relative position to the turbine buckets. The position is crucial to the functioning of a gas turbine.

### Turbine nozzles serve what purpose?

Turbine nozzles direct the expanding hot combustion gas's high-velocity flow against the turbine buckets, causing the rotor to rotate.

How many nozzle segments were made up of the first, second, and third stage nozzles?

18 segments, 16 segments, and so on.

In the bearing # 1 assembly, how many bearings are there?

Bearing # 1 had three bearings in it.

Journal bearing, active thrust bearing, and inactive thrust bearing

Is there a load coupling between the turbine shaft and the generator?

Coupling is hollow.

What exactly is an axial flow compressor?

The general direction of air movement is axial in axial flow.

What is the relationship between pressure and velocity in a compressor?

The pressure is increased from stage to stage by reducing the air velocity generated from the rotation of the rotor blade row in the stator blade row; as a result, whirling air velocity reduces and air pressure rises on the stator's fixed blade.

How much of the air is used for both thermal insulation and combustion?

The remaining 20 to 30% compressed air is used for burning, with 70 to 80 percent used for thermal insulation.

How much power is absorbed or consumed by the axial compressor?

53% of the overall output of the machine

Which elements influence the gas turbine's performance?

Steam injection, load, ambient pressure, ambient temperature, and humidity rate

How will lowering the ambient temperature enhance generator output?

Because the density of the inlet air increases as the temperature drops, the compressor delivers a higher mass flow into the combustor, increasing the generator output.



### How can increasing atmospheric pressure affect generator output?

As the pressure rises, the air density rises, and the compressor delivers more mass flow. Flow into the combustor to improve the generator output.

### How can the output of a generator be measured?

Two wattmeters attached to the proper sockets on the generator control panel are used to measure the generator output.

### What are the standard requirements for maximizing the machine's output?

- ☒ 15 degrees Celsius ambient temperature
- ☒ 1.0132 bar atmospheric pressure
- ☒ 60 percent relative humidity

### What factors can influence the output of a generator?

- ☒ The input duct is losing pressure.
- ☒ Ambient temperature, pressure loss in the exhaust duct.
- ☒ Pressure in the atmosphere.

### What is the name of the location where we may perform the baroscopic test?

- ☒ Stages 4, 12, and 17 of the compressor
- ☒ Trailing edge of the first, second, and third stage nozzles
- ☒ Leading edge of 2nd and 3rd stage nozzles 1st, 2nd, and 3rd stage buckets 1st, 2nd stage bucket trailing edge
- ☒ Transition pieces and liners

### What are the offline water wash interlocks?

- 1 The machine has to be broken.
- . The temperature differential between the water wash and the wheel space must not
- 2 exceed 67 degrees Celsius.
3. The maximum temperature in the wheel space must not exceed 149 degrees Celsius.

### What are the online water wash interlocks?

- ☒ The IGV must be completely operational.
- ☒ The temperature of the water in the wash tank should be around 70 degrees Celsius.
- ☒ The turbine must be operating at full capacity and not in the process of being shut down.
- ☒ The temperature outside must be at least 10 degrees Celsius.

What factors influence the heat rate of a gas turbine?

- ☒ Temperature outside
- ☒ Loss of pressure in the inlet duct
- ☒ The exhaust duct is losing pressure.

What is the chemical makeup of natural gas?

- 1 89.55 percent of CH<sub>4</sub> (methane)
- . 5.68 percent of C<sub>2</sub>H<sub>6</sub> (ethane)
- 2 3.94 percent CO<sub>2</sub> (carbon dioxide)
- . 0.14 percent of C<sub>3</sub>H<sub>8</sub>
- 3 0.11 percent C<sub>4</sub>H<sub>10</sub> 0.06 percent C<sub>6</sub>H<sub>14</sub>
- . 0.03 percent C<sub>5</sub>H<sub>12</sub> 0.50 percent nitrogen (nitrogen)
- . 5

How can we determine the combustion chamber's firing temperature?

The firing temperature is calculated from the recorded CPD and FSR, as well as the exhaust temperature and pressure ratio across the turbine.

What variables can result in a high temperature in the wheel space?

Any of the following factors could result in a high wheel space temperature.

- ☒ Cooling air liner restriction
- ☒ Turbine seals wear out.
- ☒ The turbine stator is distorted excessively.
- ☒ Thermocouples are not positioned correctly.
- ☒ The combustion system is not working properly.
- ☒ External pipework has a leak.
- ☒ Excessive exhaust inner diffuser distortion
- ☒ For offline water wash, which circuit or system must be isolated?
- ☒ Circuit for atomizing air
- ☒ Circuit for cooling air
- ☒ Closing the air circuit.