CHAPTER 4

GAS TURBINES

4-1. Minimum maintenance activities for gas turbines

The tables located at the end of this chapter indicate items that must be performed to maintain the gas turbines at a minimum level of operational readiness. Due to the many variations in engine age and design that may be encountered, not all of the items listed will be applicable for all facilities. In addition, the timing of the maintenance schedule for major maintenance items can vary significantly based on the engine design and operating conditions. All maintenance must be performed in accordance with the engine manufacturer's published maintenance schedule and procedures for the specific engine installed. Maintenance actions included in this chapter are for various modes of operation, subsystems, or components. Table 4-1 provides maintenance information for gas turbines in standby mode. Table 4-2 provides maintenance information for gas turbines operating in short-term activities. Short-term activities are those scheduled maintenance activities with a frequency of 1,000 hours run time or less. Table 4-3 provides maintenance information for gas turbines operating in long-term activities. Long-term activities are those scheduled maintenance activities with a frequency greater than 1,000 hours run time.

4-2. Major equipment maintenance for gas turbines

Any maintenance that requires disassembly of the gas turbine is considered major maintenance. Personnel performing any of the major maintenance procedures listed in this chapter must be trained turbine engine mechanics. All maintenance must be performed in accordance with manufacturer's published maintenance procedures for the specific gas turbine installed.

a. Turbine engine overhaul. Overhaul of gas turbine engines should be based on readily detectable deterioration in performance of the unit. The following symptoms indicate the need for major maintenance.

(1) Continuously increasing exhaust temperatures

(2) Severe fouling of compressor blades

(3) Severe deposits on or deterioration of turbine blades and/or guide vanes

(4) Large particles on magnetic plugs

(5) Severe vibration

(6) Gradually decreasing runout time at engine shutdown

b. Maintenance support. The technical requirements for maintaining gas turbines are frequently beyond the capabilities of the staff at most facilities. For this reason, the option of contracting major maintenance from the manufacturer is both practical and economical. The manufacturer can provide trained staff on short notice to make needed repairs. The entire replacement of the engine can usually be accomplished in less than a day. This is based on having needed components on hand at the facility. Remote sites that are not easily accessible may not be able to exercise this option and must have personnel onsite trained to perform major maintenance.

4-3. Gas turbine performance trend analysis

Trend analysis is a valuable tool in predicting maintenance requirements and shall be used to determine impending problems and to schedule maintenance. Trend analysis consists of recording significant operating data and plotting that data versus engine hours and then analyzing the graphs for significant changes in performance. Operating data should be obtained under the same load and general operating conditions each time it is recorded. Data shall be taken at intervals not to exceed 250 hours (100 hours is preferred). Any significant change in recorded data should be verified by obtaining a second set of data. Various commercial software packages are available to aid in the planning of maintenance and analysis of malfunctions. These systems use field instrumentation to constantly monitor the status of the engine health. By storing this monitored data in a database during periods of normal operation, the system can identify changes in the operating behavior of the engine over long periods of time. Necessary adjustments and maintenance work can thus be planned on the basis of the engine condition. As a minimum, the following data shall be obtained and plotted.

a. Ambient temperature

b. Compressor discharge temperature

c. Exhaust temperature

d. Lube oil supply temperature

e. Lube oil return temperature

f. Inlet air pressure (downstream of filters)

g. Compressor discharge pressure

h. Exhaust pressure

i. Fuel pressure (before and after start)

j. Lube oil pressure (before and after filter)

k. Fuel consumption

l. Lube oil consumption

m. Governor rack or metering valve position

n. Lube oil analysis results, especially for trace metals

Table 4-1. Gas turbine – standby mode

Gas Turbine – Standby Mode	
Action	***Frequency***
WARNING! MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION MAY OR MAY NOT REQUIRE REMOVING AN ENGINE FROM ITS READY STANDBY STATE SO THAT THE ENGINE DOES NOT AUTOMATICALLY START IF A POWER FAILURE OCCURS. WHEN NECESSARY, OBTAIN CLEARANCE FROM OPERATOR AND VERIFY THAT CONTROLS AND ENGINE STARTING DEVICES ARE PROPERLY LOCKED OUT TO PREVENT POSSIBLE AUTOMATIC STARTUP OF ENGINE.	
Check and verify operation of pre-lube pump.	8 hrs
Check and verify operation of lube oil heating system.	8 hrs
Check and verify operation of starting air compressors, battery charger, or other starting system components.	8 hrs
Check and verify starting air pressure is correct, batteries are charged, and all other starting system components are in ready-to-start condition.	8 hrs
Verify that control power is available to the control system and all controls are in the proper position to allow automatic starting of the engines.	8 hrs
Check for any oil leaks.	8 hrs
Check for coolant leaks.	8 hrs
Check the day tank area for fuel leaks.	8 hrs
Check lube oil level, add if required.	week
Inspect air filter. Clean/replace if required.	week
Check starting air lubricator. Fill if required. Check level of hydraulic fluid in reservoir on hydraulic starting systems.	week
Check oil level in governor, add if required.	week
Record and report any discrepancies.	week

Table 4-2. Gas turbine – operating mode, short term activities

Gas Turbine – Operating Mode, Short Term Activities	
Action	***Frequency***
WARNING! THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION MAY OR MAY NOT REQUIRE REMOVING AN ENGINE FROM ITS READY STANDBY STATE SO THAT THE ENGINE DOES NOT AUTOMATICALLY START IF A POWER FAILURE OCCURS. WHEN NECESSARY, OBTAIN CLEARANCE FROM OPERATOR AND VERIFY THAT CONTROLS AND ENGINE STARTING DEVICES ARE PROPERLY LOCKED OUT TO PREVENT POSSIBLE AUTOMATIC STARTUP OF ENGINE.	
Inspect engine and listen for any unusual noise. Check for fuel oil and lube oil leaks.	hr
Note and record any excessive vibration.	hr
Check and record the data indicated on the engine instrument panel. Note any unusual readings and investigate.	hr
Check lube oil level in sump (Also check level in reduction gear if it is a separate system).	8 hrs
Check oil level in governor.	8 hrs
Check fuel strainers for water and drain if required.	8 hrs
Check day tank level.	8 hrs
Check lube oil and fuel filter pressure drop and change filters as required.	day
Inspect air filters and replace as required.	day
Inspect exterior of engine and auxiliary components for broken lock wires, loose nuts or bolts, and general security of installation.	250 hrs[1]
Check control linkage for freedom of movement, wear, and tightness of connections.	250 hrs[1]
Check for unusual noises in gears, bearings, couplings, and pumps.	250 hrs[1]
Check for excessive vibration of couplings, shaft extensions, and housing.	250 hrs[1]
Remove and inspect magnetic plugs for accumulation of metal particles. Also perform continuity check.	250 hrs[1]
Check operation and calibrate speed and temperature control system.	250 hrs[2]

Table 4-2. Gas turbine – operating mode, short term activities (continued)

Gas Turbine – Operating Mode, Short Term Activities	
Action	***Frequency***
Inspect engine mounts for cracks or decrease in vibration isolation.	500 hrs[3]
Inspect electrical harness leads and cables for cracks or other signs of wear.	500 hrs[3]
Check fuel manifold drain valve for proper operation.	500 hrs[3]
Inspect igniters and liner supports.	500 hrs[4]
Inspect fuel nozzles for carbon or other damage. If one or more nozzles need replacement, replace full set. If contamination is found, replace high pressure fuel filter.	500 hrs[4]
Inspect first stage turbine blades and vanes.	500 hrs[4]
Inspect combustion liners.	500 hrs[4]
Inspect thermocouples and wiring.	500 hrs[4]
Check contact pattern of reduction gear teeth.	500 hrs[4]
Verify proper operation of all safety shutdown controls and alarms. Immediately repair any defective items.	1K hrs[3]
Inspect bleed valves. Check valves for air leaks.	1K hrs[3]
Inspect engine inlet and compressor assembly.	1K hrs[3]
Grease/lubricate auxiliary pump bearings.	1K hrs[3]
Clean breather element on reduction gear.	1K hrs[3]
Inspect igniters and liner supports.	1K hrs[5]
Inspect fuel nozzles for carbon or other damage. If one or more nozzles need replacement, replace full set. If contamination is found, replace high pressure fuel filter.	1K hrs[5]
Inspect first stage turbine blades and vanes.	1K hrs[5]
Inspect combustion liners.	1K hrs[5]
Inspect thermocouples and wiring.	1K hrs[5]

[1] Monthly for Standby Units.
[2] Perform at the first 250 hours.
[3] Every 6 months for Standby.
[4] Perform at the first 500 hours.
[5] Perform at the first 1000 hours.

Table 4-3. Gas turbine – operating mode, long term activities

Gas Turbine – Operating Mode, Long Term Activities	
Action	***Frequency***
WARNING! THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION MAY OR MAY NOT REQUIRE REMOVING AN ENGINE FROM ITS READY STANDBY STATE SO THAT THE ENGINE DOES NOT AUTOMATICALLY START IF A POWER FAILURE OCCURS. WHEN NECESSARY, OBTAIN CLEARANCE FROM OPERATOR AND VERIFY THAT CONTROLS AND ENGINE STARTING DEVICES ARE PROPERLY LOCKED OUT TO PREVENT POSSIBLE AUTOMATIC STARTUP OF ENGINE.	
Inspect igniters and liner supports.	2K hrs[1]
Inspect fuel nozzles for carbon or other damage. If one or more nozzles need replacement, replace full set. If contamination is found, replace high pressure fuel filter.	2K hrs[1]
Inspect first stage turbine blades and vanes.	2K hrs[1]
Inspect combustion liners.	2K hrs[1]
Inspect thermocouples and wiring.	2K hrs[1]
Check operation and calibrate speed and temperature control system.	2K hrs[1]
Take lube oil sample for test and analysis; change lube oil if indicated by test results.	4K hrs[2]
Replace lube oil filter; filter should be replaced based on maximum recommended pressure differential.	4K hrs[2]
Check reduction gear tooth wear.	4K hrs[2]
Replace low and high pressure fuel filters; filters should be replaced based on maximum recommended pressure differential.	8K hrs[2]
Inspect fuel nozzles.	8K hrs[2]
Check the following items on the reduction gear; tooth pattern and wear, bearing clearances, end play, and alignment. Check lube oil spray nozzles and internal tubing.	8K hrs[2]
Calibrate all instrumentation.	8K hrs[2]

[1] Every 9 months for Standby.
[2] Every 12 months for Standby.