COMBUSTION TURBINE LOSS PREVENTION INSPECTION

INTRODUCTION

This section identifies the features a combustion turbine loss prevention inspection should include. A loss prevention inspection program for any gas turbine should resemble the program outlined in this section; however, consult the manufacturer's literature or information about loss prevention inspection for a specific type of turbine or installation. PRC.6.1.2.1 describes features, operational concerns and terminology common to most combustion turbines. PRC.6.1.2.2 provides general combustion turbine loss prevention guidance.

Combustion turbines require a planned program of periodic inspection, supported by sound maintenance and repair programs. Inspections may take place with the unit in service or shutdown. If the unit is shutdown, inspections may take place with the unit intact or dismantled. Three types of dismantled inspections are generally recognized: combustion; hot gas path and major.

POSITION

Inspect combustion turbines in accordance with the manufacturer's recommendations. Ensure that inspections are performed and supervised by properly qualified persons using recommended inspection tools and procedures. Ensure that all conditions requiring attention are logged and corrected before the unit is returned to service. Develop and maintain complete records of all inspections in sufficient detail to permit subsequent inspectors to compare existing conditions with previous conditions. Use written descriptions, sketches, photographs and video tapes as appropriate.

Before and after any dismantled inspection, collect a complete set of operating data, including performance indices and vibration signature. Evaluate this data to ensure the inspection and any corrective action is effective and that the machine is not damaged during the inspection.

Inspection Planning

Before any inspection, consider the following:

- Define the scope. Consult the maintenance and operating logs, borescopic inspection results, vibration data and startup curves and previous inspection reports.
- Determine the spares required. Consult previous inspection results and the manufacturer for guidance.
- Provide proper tools and facilities. In addition to special dismantling and reassembly tools, consider cranes and jacks, scaffolding if needed, laydown and storage facilities, and supplemental fire and security needs.

- Ensure all required documents are available and up-to-date: piping schematics; elementary diagrams; control specifications; alignment standards and instructions; dismantling, inspection, repair and reassembly procedures; spare and renewal parts information; and forms for data collection.
- Ensure the organization needed to control all aspects of the work is established and communicated to all concerned. Ensure contractor personnel that responsibility to all applicable management loss control programs is clearly defined and understood.

In-Service Inspection

In-service inspections are performed during startup and operation. These inspections monitor the overall condition of the unit and its support equipment. Use predictive techniques including vibration monitoring, lubricant analysis and manufacturer-specified performance indices to detect any deterioration and permit timely shutdown for repair. In-service inspection includes visual inspection of the unit for abnormal conditions any time personnel are present. The following data, recorded as a function of operating hours, are the minimum required:

- Load vs. exhaust temperature
- Compressor discharge pressure
- Vibration
- Fuel flow and pressure
- Exhaust temperature
- Startup time

Daily, calculate the heat rate, output and compressor pressure ratio and plot them vs. time. Consult the manufacturer's instructions for proper procedures and calculations. If output decreases 5%, clean the compressor using a method recommended by the manufacturer. If at least 50% of the lost performance is not regained, inspect the compressor at the next opportunity for hard deposits or damage. Do not allow a 10% output decrease without taking prompt corrective action. Also, observe, record and plot the exhaust temperature spread daily.

Weekly, plot compressor operating points for several different power settings on a compressor map. If the operating point moves toward the surge line, evaluate the condition and correct. If the operating point crosses the surge line specified by the manufacturer, shut down the machine and correct the condition.

Routinely verify the operation and calibration of the exhaust temperature fuel limit and the over temperature trip system. Also, monitor filter differential pressures.

Exhaust temperature spread is an important indicator of problems in the hot gas path parts. Do not allow the temperature spread to exceed 100°F (38°C) or any lower critical value specified by the manufacturer, without taking corrective action. Investigate abnormal temperature spreads observed during startup even if the spreads disappear at high load. Do not assume thermocouple problems are the cause of the temperature spread.

Unless required more frequently by the manufacturer or if required by observed conditions, test and calibrate the following at least annually:

- Overtemperature and overspeed protection.
- Surge limit control and surge protection.
- Flame monitor.
- Temperature controls.
- Axial position monitor and protection.
- Generator protection.
- Vibration monitor and protection.

- Inspect, test and maintain fire protection systems in accordance with NFPA 25, NFPA 72 and other applicable NFPA standards.

Standby Inspection

Standby inspections are performed with the unit shut down but ready for service. These inspections maximize starting reliability. Inspect, test and maintain the unit including all its support systems, such as batteries, filters, fluid levels, relays and control devices. When abnormal conditions are found during operation or standby, use a borescope or eddy current probe to further explore the unit through openings provided for the purpose. When possible, make routine inspections with the borescope to monitor turbine blade and nozzle and compressor blade and coating condition.

Perform the following tests and inspections every 20,000 hr or as recommended by the manufacturer:

- Dismantle and inspect the compressor bleed valve.
- Thoroughly test and calibrate the control system.
- Overhaul couplings and check unit alignment.
- Dismantle, inspect and calibrate mechanical overspeed trip devices.
- Dismantle, clean and inspect the lubricating oil system, including pumps, filters, sumps, coolers and instruments.

Combustion Inspection

Combustion inspections are performed with the unit shutdown to change out and service the fuel nozzles and associated fuel-burning parts. Scope of work for a combustion inspection normally includes the following parts, as provided: fuel nozzles; combustors; liners; cross-fire tubes and transition pieces. Inspect and test fuel manifold and combustion casing drain valves. Leak test all fuel shutoff valves and dual fuel system check valves. During the combustion inspection, examine the first stage turbine nozzles directly and the rest of the turbine with a borescope. Inspect thermocouple harnesses, pressure sensors and connecting tubing, and vibration instruments and their wiring. Use information developed by this inspection to help schedule the next hot gas path inspection. Perform additional inspection and repair as needed. Service and replace liquid fuel nozzles only as sets.

Inspect and clean all parts; look for unusual wear, hot spots, burning, cracks and failing welds. In transition pieces, look for seal cracks and seal wear. Use liquid penetrant inspection methods to examine transition pieces and combustion chambers and liners.

Hot Gas Path Inspection

Hot gas path inspection includes all parts examined during a combustion inspection plus the complete turbine, including diaphragm packing and nozzle thermocouples. Inspecting the turbine generally requires lifting the turbine-section casing and possibly the first stage nozzles. Otherwise, nozzles and blades are not generally removed unless conditions warrant. Take and record a complete set of turbine clearance readings during any hot gas path inspection.

In addition to the combustion inspection activities, visually inspect all nozzles and blades for erosion, corrosion, cracks and foreign object damage. If applicable, inspect for trailing edge bowing, cooling hole plugging and freedom of operation of moving parts.

Clean and inspect the first stage nozzle using liquid penetrant methods.

Major Inspection

A major inspection or overhaul is a “flange-to-flange” inspection of the entire unit, lifting casings and other wise dismantling as needed to ensure a complete inspection. Inspect all parts for rubs, cracks, warping, corrosion, fretting or thermal deterioration.

In addition to the combustion and hot gas path inspection activities, clean and inspect the compressor for fouling, erosion, corrosion, cracks and foreign object damage. Clean all seals and bearings and inspect for wear, proper clearance, fouling, leaks, wiping, scoring or deterioration of babbitt. Inspect journals and seal fits for wear and scoring.

Remove, clean and inspect turbine blades using liquid penetrant methods and any more advanced nondestructive testing recommended by the manufacturer. Use these methods to inspect the turbine wheel blade attachment.

Inspect exhaust casings, particularly welds and expansion joints, for erosion, corrosion and cracking.