Gas Turbine Maintenance Manual

Gas Turbine Maintenance, LLC

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chapter 1

INTRODUCTION

1.1 Welcome to the Gas Turbine World

Gas turbines regularly undergo a series of scheduled or unscheduled outages during their normal operating lives. It is our job to see to it that the work we do during the outages is of the highest quality so that we reduce the occurrence of unscheduled outages. Outages require one of three types of inspections: a combustion inspection, a hot/gas path inspection, or a major inspection.

While this Manual is being written as a step-by-step procedure, on a real job site you will find that many of these activities are going on at the same time.

1.1.1 Inspection Frequency

The frequency of inspections is usually based on the number of hours the unit has been in operation. The general sequence and frequency of the inspections is two combustion inspections followed by a hot/gas inspection. This set of three is then repeated until the five-year timeframe or maximum number of hours is reached, at which time a major inspection is done.

1.1.2 Combustion Inspection

The combustion section of the gas turbine is always removed, inspected, and reassembled during every outage. It is the first major step in each outage and is the first that will be covered in this manual.

A combustion inspection requires six men on each shift and takes about three days to complete.

1.1.3 Hot/Gas Path Inspection

This inspection includes a combustion inspection along with the inspection of the turbine, the accessory compartment, inlet, oil tanks, oil coolers, and exhaust.

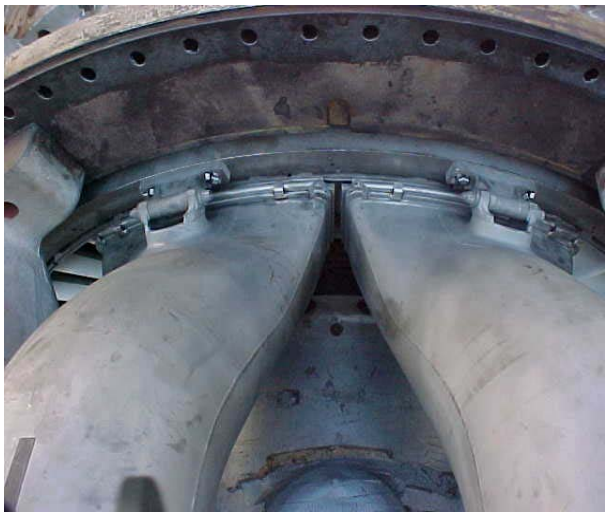
While the outage work scope will vary from plant to plant, this Manual will cover what typically is done in most plants.

Some plants will only do a visual inspection of the second- and third-stage nozzle segments and will only remove the nozzle segments if they see a problem.

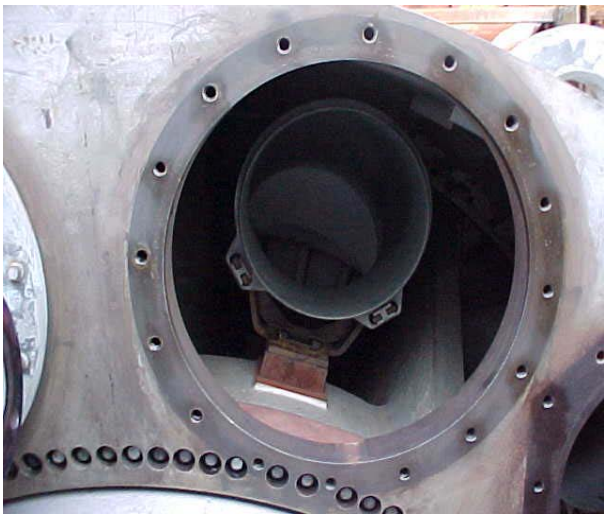
5. If there are two bolts in the aft bracket, make a guide pin out of a $^{5}/_{8}$-in. x 2-in. long bolt. This is done by cutting off the head of the bolt and grinding the cut end to a bullet point. After the pin has been made, place it in one of the boltholes and use it as a guide pin to make it easier to get the floating seals in place. Go to Step 6.

✓ The floating seals must be properly installed and the men working on the inside of the unit must check each seal they install for correctness. If even a single seal is missed, the machine will have to be reopened.

6. When the seals are in place, install the aft bracket bolt, replace the guide pin with a bolt (if necessary), and tighten the aft bracket bolts. Make sure the aft bracket lock tabs are secure.



Transitions bolted into place and locked



Transitions with the wrapper on

7. Align the bull bracket and tighten the bolts. Do not lock the bullhorn lock tabs at this time; they will be locked after the assembly has been squared up.
8. Install the remaining transition pieces in the sequence described above. That sequence is 6, 5, 4, 7, the four stainless steel tubs, then transition pieces 3, 8, 9, 10, 1, and 2.

2.2.3 Square the Assemblies

Take a set of picture frame readings when all of the transition pieces have been installed, bolted up, and locked in place. The readings are taken at the four corners of each transition piece where the piece fits up to the first stage nozzle. These readings will ensure that the transition is square to the nozzle.

Once the transition pieces are square with the first stage nozzles, lock the bullhorn lock tabs. The foreman or TD must inspect the transition lock tabs, floating seals, and lock tabs on the side seal blocks and bullhorn.

✓

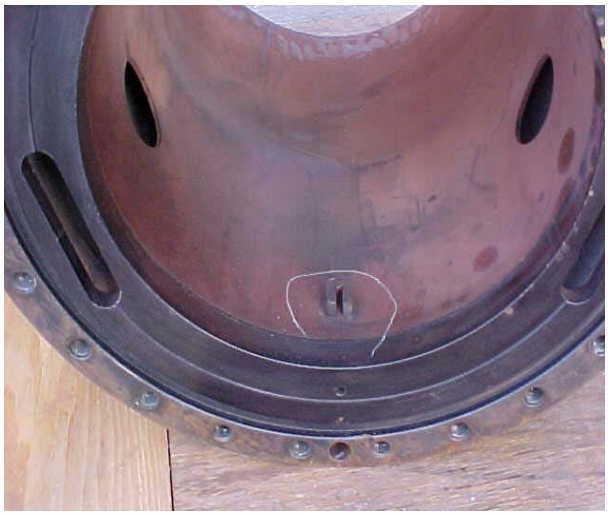
The inspection by the foreman or TD must be completed before any flow sleeves, liners, crossfire tubes, and clips are installed.

Inspect the complete combustion and tools for cleanliness.

2.2.4 Install the Liners

1. Install a new gasket on the No. 2 combustion can and bolt it in place.
2. Put all the flow sleeves back in place. Use the alignment dowel pins they go on to ensure proper alignment and installation.
3. Lay out the liners and record all serial numbers.

Inspecting the liners



The ears on the liners fit here

- The lowest serial number will be used in the No. 1 transition.
- The highest serial number will be used in the No. 10 transition.
- This assignment of serial numbers identifies the location of each transition piece in the machine.

4. Mark the assigned location on each part with a black magic marker.
5. Begin with the No. 1 combustion can. Install the following parts in the sequence shown:

chapter 3

HOT/GAS PATH INSPECTION

3.1 Turbine Inspection

The turbine inspection includes a complete combustion inspection (see Chapter 2). In this inspection, we will be removing the roof and all of the doors.

To be able to properly identify the parts of the turbine, mark all parts with a black magic marker in the same way for every job you do.

3.1.1 Remove the Roof

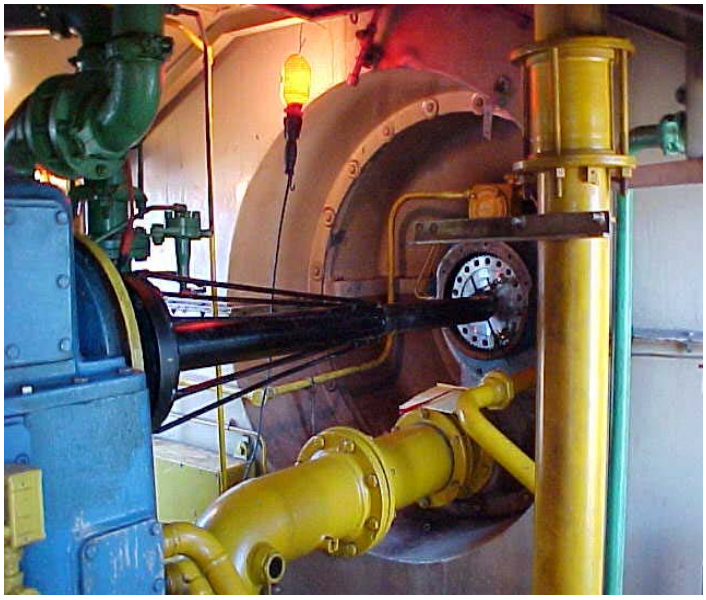
Above the Roof Parts

Before the roof can be removed, some of the outside piping, rain guards, and ductwork must be removed first.

Turbine compartment roof and demist oil piping

Only a few of the pipes will need to be removed from the roof. Most of the pipe can ride down with the roof section.

On most turbines the piping is for demist oil or steam lines. The demist oil lines come from the No. 2 bearing vent.



The alignment fixture from gear box to the turbine

4.3.2 Remove the Upper Half Cases

The roof and all enclosure doors have already been removed in the previous inspections just performed.

1. If this is a Frame 7E, or AE turbine, remove the inlet wall panel and the small piece above it to gain access to the inlet bellmouth upper half, then remove the roof. The inlet bellmouth parts will be removed later in the inspection process.
2. Remove the pigtail piping and fuel nozzles, then open the can doors and remove the liners, crossfire tubes and clips, and the six upper cans.
   - In the combustion inspection only the No. 2 can was removed but in the major inspection the upper six cans must come off in order to remove the wrapper and then the transition pieces.
3. Remove the floor plates that are bolted in the floor under the turbine.
4. Set jacks onto the turbine foundation under the cases. Set jacks to the GE specifications. The specs can be found in the gas turbine manuals that the plant will have for each machine.

CAUTION: DO NOT set the jacks on the belly pan as it is not strong enough to lift the turbine.

5. Set jacks under the following locations:
   - Inlet bellmouth
   - Forward compressor case

2. Before removing the two dowels in the inlet guide vane rack, screw in the jack bolt at the bottom center of the lower half of the Inlet Guide Vane (IGV) rack to hold the lower half in place.
   - If this bolt is not secured the lower half will slip down to prevent the removal of the IGV rack, lower half.
3. When lifting the upper half bellmouth, leave the upper half of the IGV rack on the bellmouth case.
4. To remove the inlet aft wall, cut the three horizontal bolts on each side (they are welded). The row of vertical bolts is just behind the IGV rack, welded inside the inlet on each side. When reassembling the unit, new bolts will be used and will be welded in place.
   - All bolting inside the inlet is welded to ensure the bolts can't come out and damage the turbine.
5. Remove the two through pipes that bolt to the forward and aft walls above the bellmouth.
6. Rig the bellmouth as close to the case as possible to lift. The bellmouth weighs 13,500-lbs.
   - This is the heaviest case on a Frame 7 machine.
7. Hook a 20-ft. long choker to the crane, feed it through the split, and rig to the case. Take the slack out of the rigging but do not try to lift the bellmouth yet.
8. Break the RTV seal on the case by putting two bolts, side-by-side, in both sides of the case.
9. Set a porta-power on top of the bolt heads to the lifting lug and jack the unit on each side until the seal is broken and the case starts to lift. Lift one side at a time. When both sides are free, complete the lift.

Remove the Inlet Elbow

When working on a Frame 7B or C machine, remove the inlet elbow, transition piece, expansion joint, and both forward and aft walls.

The elbow and transition piece together will weigh about 22,000 lbs. and are removed together.

1. Cut five pieces of angle iron for each side of the expansion joint. Set them between the two flanges of the joint and tack weld them in place. This will keep the expansion joint from collapsing when the inlet elbow and the transition piece are unbolted.
2. Unbolt the elbow and transition piece. Inspect the lifting eyes in the elbow for excessive rust. Repair the eyes if needed and then make the lift using two deadlegs and two chain falls.

3. Before you remove the rigging, bolt two pieces of 12-ft.-long angle iron to the inlet elbow for legs so that the whole unit is stable and will not tip over. Then set the inlet on the ground just the way it came off.

Remove the Expansion Joint

To remove the expansion joint and forward and aft walls, leave the expansion joint bolted to the walls, as it's easier to handle than if the parts were separate. The assembly weighs about 2,000 lbs.

1. Unbolt the assembly from the inlet wings.
2. Unbolt the walls from the wings and accessory house.
3. Lift the expansion joint and walls together.
4. Use the same rigging of two deadlegs and two chain falls that was used for the inlet elbow.
5. Hook two nylon chokers to the I-beam that is in front of the inlet elbow and goes completely across, from column to column. The feet welded to the inlet sets on this I-beam. Unbolt the six bolts on each end from the columns and lift the beam out.

The rest of the inlet bellmouth is the same as the frames 7EA and E, including the IGV rack, actuator arm, the jack bolt that holds the lower IGV rack, the dowels, and all the bolting.

Use the same steps to break the seal on the case, but it's not necessary to rig that close because there's plenty of room once the elbow has been removed.

Use the Johnson bars or guide pins to make these lifts even though there are no fits to worry with. The weight of this bellmouth is 13,500 lbs.

4.3.3 Remove the Forward and Aft Compressor Cases

In some units the two cases are made as a single unit while in others they are separate pieces. It is just as easy to remove them together as a single 6,000-lb. unit. There are no vertical dowels to be removed if the bellmouth has been removed.

Remove the eight horizontal dowels, install the guide pins, and make the lift using two deadlegs and two come-alongs.

Remove the Compressor Discharge Case

This case will weigh about 11,000 lbs. If this is a Frame 7EA machine, there will be no strut arm dowels but there will be six horizontal dowels. All other models have six horizontal and eight strut arm dowels/bolts.

1. Attach two deadlegs to the lifting lugs on the upstream end and two 3-ton come-alongs on the downstream end. Set the chokers around the upper strut arm on each side and back to the come-alongs.
2. Use jack bolts to lift the case at least two inches before using the crane.

3. Because the case has fits to the inner barrel, support ring, and strut arms to turbine shell the lift should be a slow one. Keep the case as level as possible and always use guide pins or Johnson bars.
4. Set the case on the ground on its end with the strut arms down. This will make it easier and faster to clean and inspect the stator blades.

4.3.4 Remove the Turbine Shell

This case weighs about 12,500 lbs. The turbine shell has one vertical and four horizontal dowels. The vertical dowel is located on the top right hand side, going to the exhaust frame case. Examine the shell carefully as the vertical dowel may have been moved to the other side during an outage because of a broken case.

1. Attach two deadlegs and two 3-ton come-alongs to the shell.
2. Use jack bolts to lift the case until it is free of all second and third stage nozzle segments.
   - It will be easier to lift the turbine shell with the compressor discharge case off. Once you clear the second and third stage nozzle segments, it should be free.
3. Set the turbine shell on the ground with the third stage nozzle segments up.
4. Remove the second and third stage nozzle segments the same way it was done for the hot/gas path inspection in Chapter 3.

4.3.5 Remove the Exhaust Frame

The exhaust frame weighs about 10,000 lbs. and the same rigging is used as in the previous lift.

Remove the four horizontal dowels and bolts. There are no vertical dowels.

Remove four dowels plus the horizontal and vertical bolting located in the load tunnel. The bolts and dowels are at the No. 3 bearing.

Remove the Diffuser

The diffuser weighs about 3,750 lbs. It has no dowels, and may either be made as a single piece or in two pieces. The diffuser hooks to the exhaust frame with clamping rings. The single piece diffuser is normally not removed during a major inspection.

1. Remove the bolts on the horizontal outside and in the load tunnel by cutting them. When installing the diffuser, new bolts will be welded in place.
2. Use a single choker around the top center of the diffuser upper half between the fins to lift the unit on an even keel.