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Air Preheater Field Inspection Guide

Vertical-Shaft Air Preheaters

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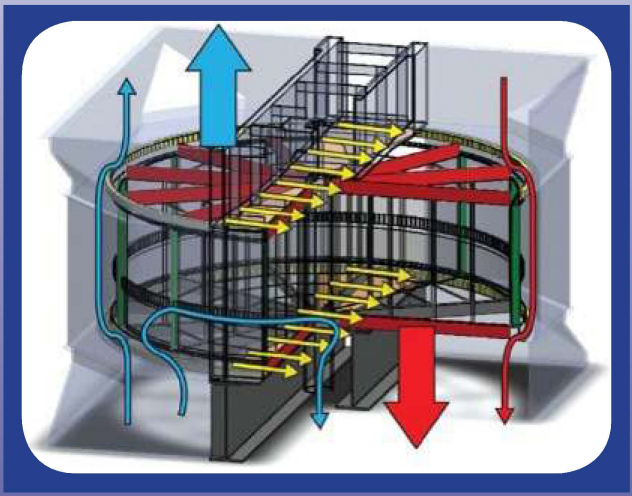

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Final Report, November 2016

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Abstract

From the feedback gathered by the Electric Power Research Institute (EPRI), we know that fossil fuel plants have had problems with the reliability and maintenance of their air preheaters. Accordingly, EPRI is publishing this field guide to help plant personnel inspect for degradation in preheaters. Because they are the most common type in fossil plants, vertical-shaft, rotating-plate, regenerative air preheaters are the focus. Stationary-plate and tubular air preheaters are not covered in detail, nor are air preheaters with a horizontal shaft.

Each section of the field guide is devoted to a group of components in the air preheater. For each group, the guide provides an inspection checklist of common degradation mechanisms and the specific locations of their occurrence. Photographs of the signs of degradation and failure supplement the checklists, serving as a visual tool to help engineering and maintenance professionals identify, document, trend, and troubleshoot problems. Safety guidelines are also presented.

To produce the field guide, EPRI drew from the operating experience of its members (including plant personnel, industry contractors, and other experts) and consulted the EPRI Preventive Maintenance Basis Database.

Keywords
Air preheater
Degradation
Failure mechanism
Inspection
Maintenance
Troubleshooting

Contents

1. Introduction

1.1 Purpose

The purpose of this field inspection handbook is to facilitate the visual inspection of various vertical-shaft air preheater components by providing numerous images of common failures to aid in their identification. The inspections suggested in this handbook are consistent with and encompass those recommended in the following EPRI documents:

- *Air Preheater Maintenance Guide*. EPRI, Palo Alto, CA: 2015. 3002006035.
- *Preventive Maintenance Basis Database (PMBD)*. EPRI, Palo Alto, CA: January 2016. PMBD Version 3.1.

1.2 Optimizing the Use of the Handbook

To optimize the use of the handbook, a hard copy of the document should be taken to the equipment and used as a "roadmap" for identifying various air preheater component failures based on the checklists and representative images provided. The handbook is specially designed to be a tool for less-experienced engineering/maintenance personnel, but may still be beneficial for those more experienced in air preheater inspections.

1.3 Safety Hazards and Precautions

Personnel inspecting air preheater components should be aware of the following safety hazards so as to prevent injury to personnel:

- Tripping hazards when entering/exiting the rotor assembly
- Confined space area
- Loose/broken walkways/ledges
- Damaged/corroded ladders (check prior to climbing)
- Slipping hazards

- Falling debris hazard
- Heat stress potential
- Sharp corners/eroded components are puncture/cut hazard

Prior to conducting inspections in or around the air preheater, use to following checklist to ensure the necessary safety precautions have been taken:

Air Preheater Inspection Safety Checklist	Y/N
Documentation of a confined space entry has been created	
An air quality test has been completed and is within limitations	
A copy of the confined space permit is at the job site	
Personnel have proper PPE (hard hat, gloves, eye protection, hearing protection, coveralls, etc.)	
The area being inspecting is properly lit and if not, flashlights are available	
A person will be outside doorway at all times while inside performing inspection	
If climbing is expected during inspections, proper fall protection equipment is worn, and the inspection of the equipment is current	
Personnel have proper qualifications	
A walkdown of Lock Out Tag Out on air preheater equipment has been performed	
LOTO has been signed	
No work is being performed above the area you are inspecting	
All material brought into the area is brought out (FME)	
FME guidelines have been reviewed	
Proper scaffolding or walkways/planking are in place and secure to stand/walk on	

2. Overview of Air Preheater Design and Operation

2.1 Introduction

An air preheater (APH) is generic terminology used to describe a device designed to preheat combustion air that is used in a fuel-burning furnace. The purpose of the preheater is to increase the thermal efficiency of the furnace. At fossil-fuel power plants, the air preheater increases the steam generator's thermal efficiency by preheating the combustion air with heat recovered from the hot combustion flue gases.

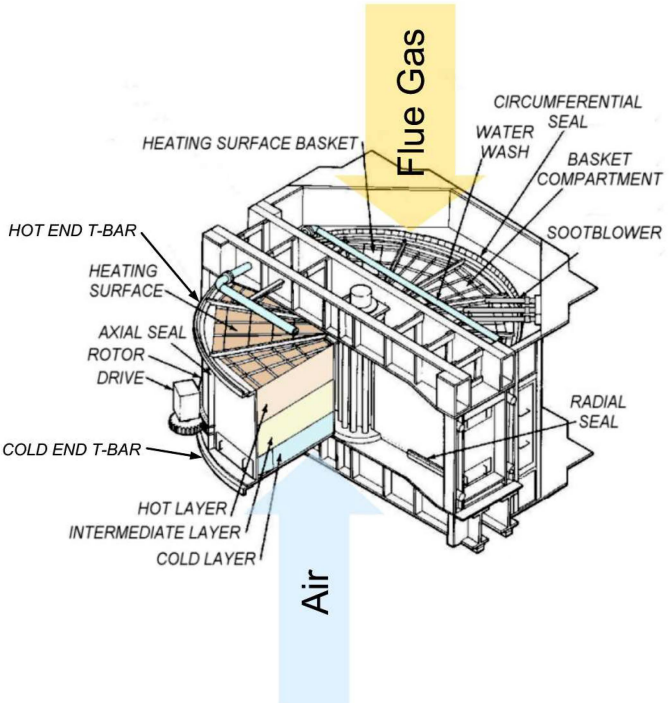
The incoming hot flue gas can transfer some of its heat in the air preheater assembly to preheat combustion air, and to preheat primary air to the coal pulverizers.

The two most common types of regenerative air preheaters installed at fossil-fuel power plants are the rotating-plate regenerative air preheater and the stationary-plate regenerative air preheater. The rotating-plate design was invented by Fredrik Ljungström, a Swedish engineer, and is often referred to as a Ljungström air preheater. The stationary-plate regenerative air preheater design is commonly known as a "Rothemühl" because Rothemühle is the German city where the original manufacturer produced them for many years.

As noted earlier, the guidance provided in this report primarily focuses on vertical-shaft rotating-plate regenerative type air preheaters due to their predominance in fossil-fuel power plants. As such, stationary-plate and tubular type air preheaters are not discussed in great detail, nor or air preheaters with a horizontal shaft.

2.2 Rotating-Plate Air Preheater Designs

The following figure illustrates a typical arrangement and components of a Ljungström vertical-shaft air preheater.

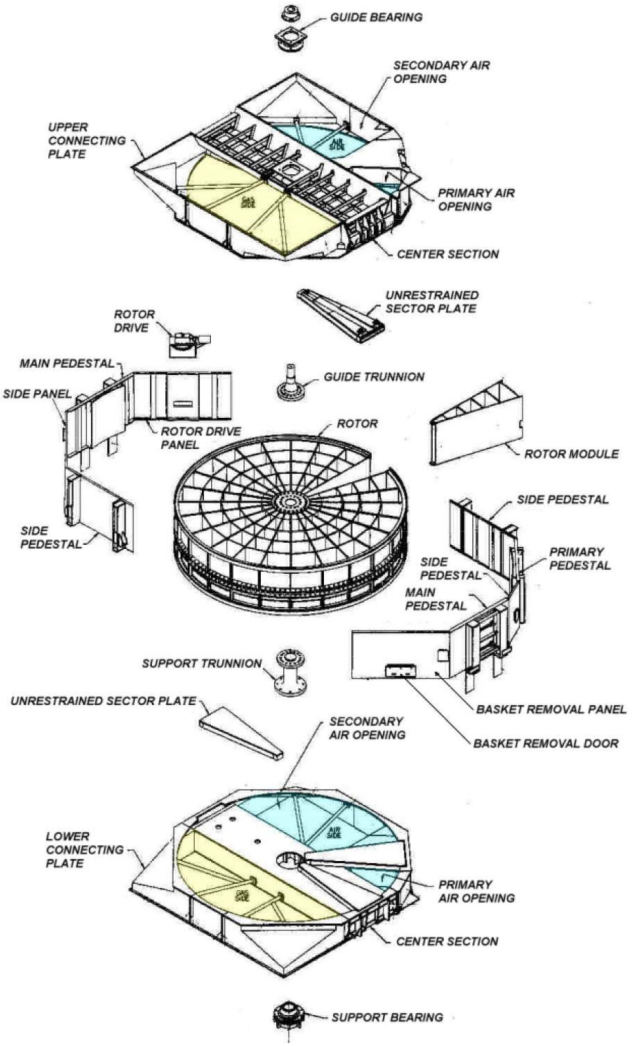


A vertical-shaft rotating-plate air preheater absorbs waste heat from flue gas, and then transfers this heat to incoming cold air by means of continuously rotating heat transfer elements of specially-formed metal plates. Thousands of these high-efficiency elements are spaced and compactly arranged within sector-shaped compartments of a radially-divided cylindrical shell, often referred to as the rotor. A typical rotating-plate air preheater design consists of a central rotating-plate element installed within a circular casing that is divided into sectors. The number of sectors can vary depending on how the circular rotating element is divided.

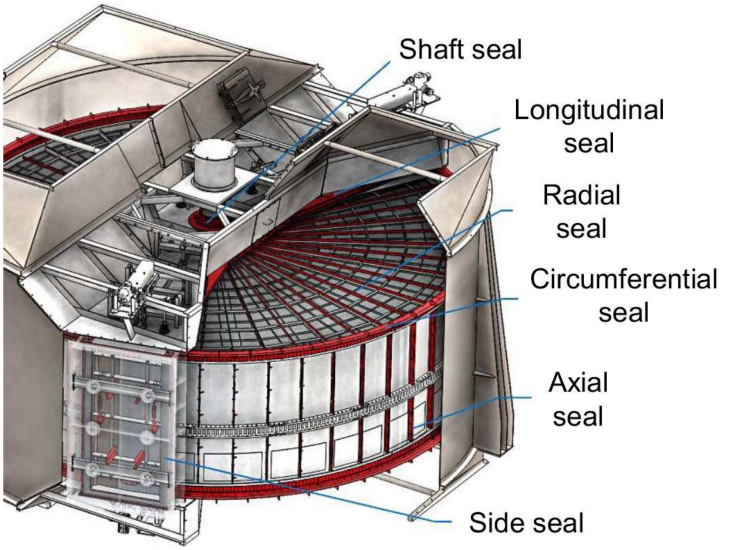
The housing surrounding the rotor is provided with duct connections at both ends, and is adequately sealed by radial and circumferential sealing members. These members form an air passage through one half of the preheater, and a gas passage through the other.

As the rotor slowly revolves, the mass of elements alternately through the gas and air passages, heat is absorbed by the element surfaces passing through the hot gas stream. Then, as these same surfaces are carried through the air stream, they release the stored-up heat. This heat transfer greatly increases the temperature of the incoming combustion or process air.

The following figure illustrates an exploded view of a typical vertical-shaft rotating-plate preheater design.



The following figure illustrates the location of various types of seals around the vertical-shaft rotor assembly.



These seals are often generically referred to as “rotor” seals.

2.3 Rotating-Plate Air Preheater Components

The following table provides a listing of the major components associated with a vertical-shaft air preheater. The visual inspections and associated checklists are grouped by these major components.

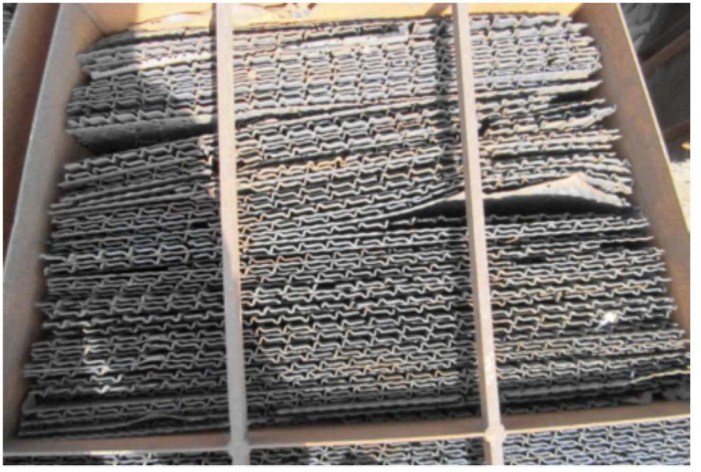
Major Air Preheater Component	Section
Heat Absorbing Elements	3
Rotor Support Thrust Bearings	4
Thrust Bearings Lubrication System	5
Radial Guide Bearings	6
Radial Guide Bearings Lubrication System	7
Radial Supports, Cages and Rotor Seal Plates	8
Rotor Drive Unit	9
Plate Cleaning Systems	10

3. Inspections of Heat Absorbing Elements

Visually inspect for the following failures and anomalies:

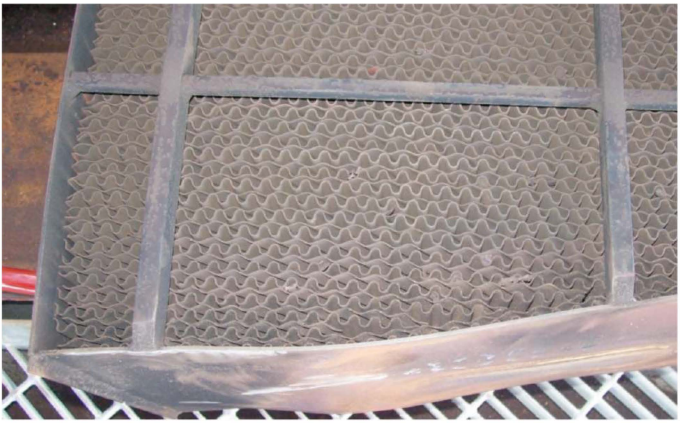
Inspections of Heat Absorbing Elements	SAT/UNSAT
Heating element wear or deformation	
Heating element plugging	
Heating element spiking/pockets	
Loose or dislodged heating element	
Loose or dislodged heating element shims	
Heating element erosion by the soot blower	
Basket and frame corrosion, erosion, cracking or deformation	
Basket movement	
Damage, corrosion, or deformation of basket support attachments	

Heating element wear or deformation

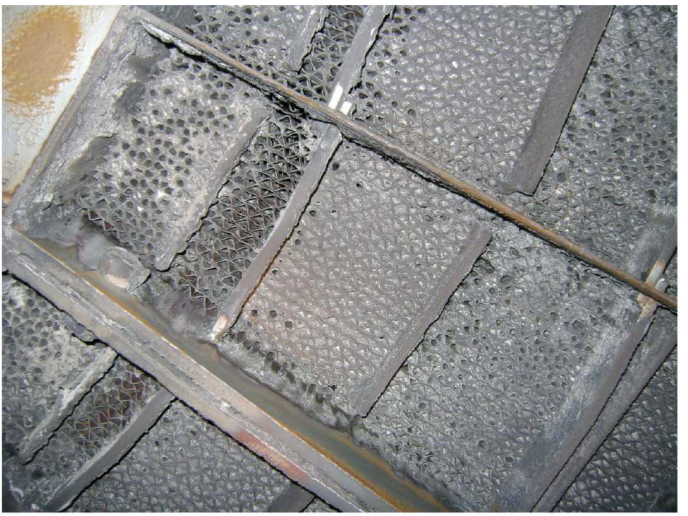


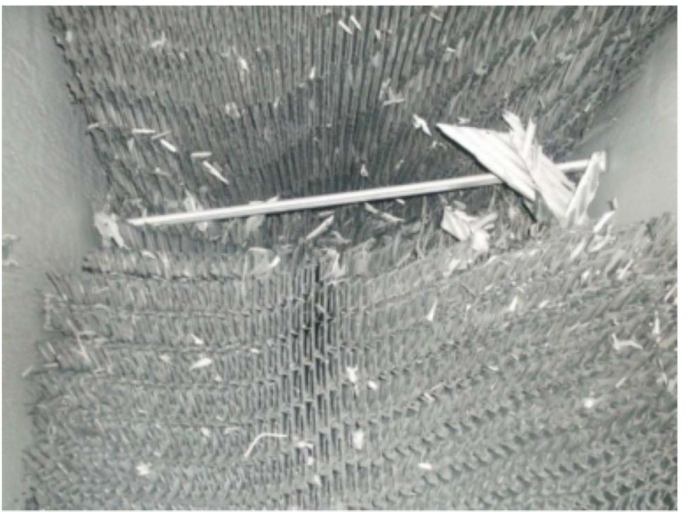
Heating element plugging

Heating element spiking/pockets



Loose or dislodged heating element



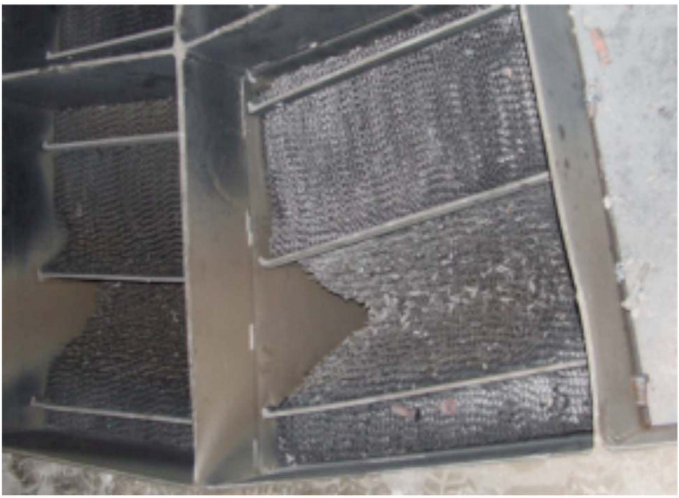


Loose or dislodged heating element shims

Note that loose or dislodged shims can cause basket movement and rotor damage, especially in horizontal air preheater designs.

Dislodged shims can also lead to damage downstream of the Air pre-heater. Inspection on downstream duct work could show evidence of missing heating element shims

Heating element erosion by the soot blower



Basket and frame corrosion, erosion, cracking or deformation

Basket movement

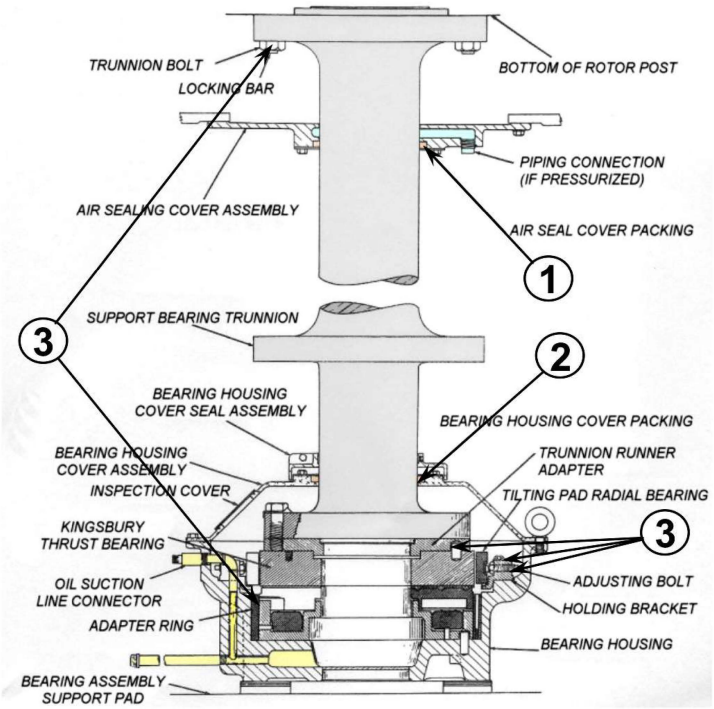
The above image illustrates a basket that moved due to a loss of shims and subsequently fell out of the bottom of a horizontal shaft APH.

Damage, corrosion, or deformation of basket support attachments

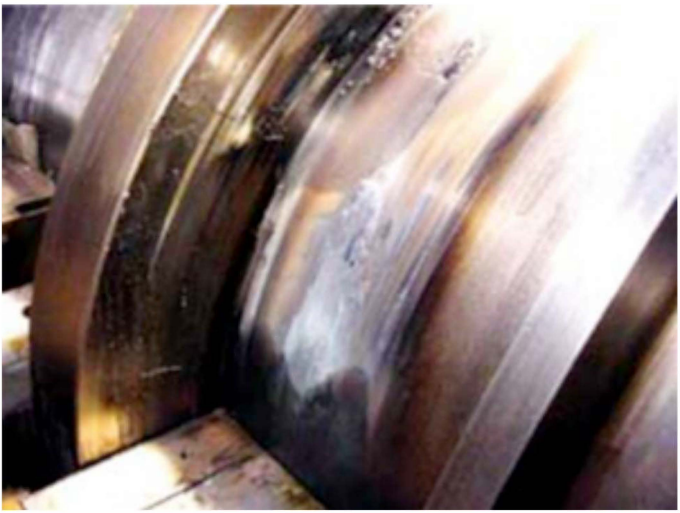
4. Support Thrust Bearings Inspections

Visually inspect for the following failures and anomalies:

	Support Thrust Bearing Inspections	SAT/UNSAT
1	Degradation, cracking or wear of packing in trunnion air seal cover	
2	Degradation, cracking or wear of trunnion-to-bearing housing packing	
3	Corrosion, wear, damage or looseness of internal components	



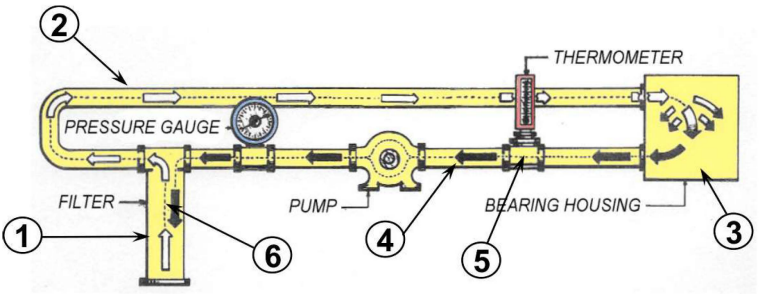
Wear of internal components (thrust bearing)



5. Thrust Bearings Lubrication System Inspections

Visually inspect for the following failures and anomalies:

	Thrust Bearings Lubrication System Inspections	SAT/UNSAT
1	Foreign matter in filters	
2	Leakage of system piping	
3	Sludge in bearing sump	
4	Cracks, deformation, corrosion and leaks of internal piping	
5	Internal or external leakage of cooler	
6	Dirty or clogged oil filter cartridges	



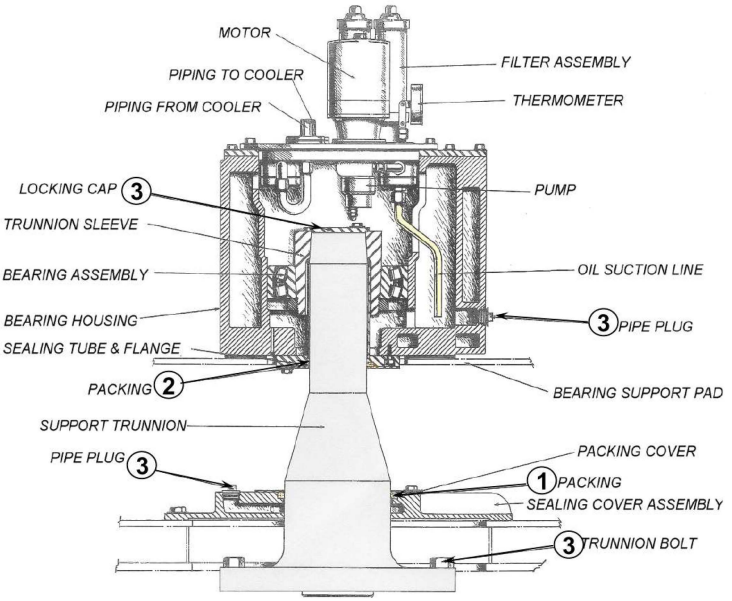
Foreign matter in filters

Leakage of system piping

6. Radial Guide Bearings Inspections

Visually inspect for the following failures and anomalies:

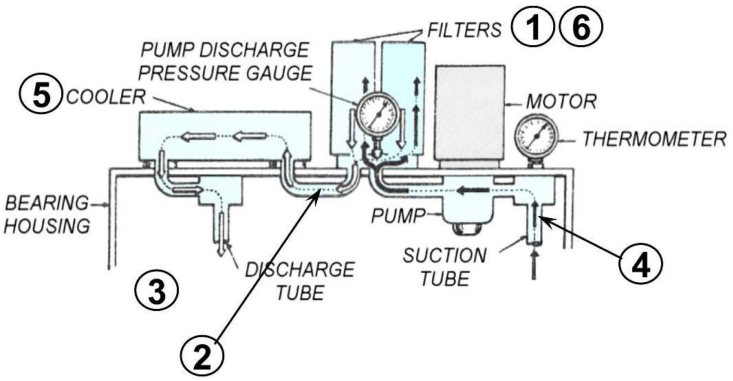
	Radial Guide Bearings Inspections	SAT/UNSAT
1	Degradation, cracking or wear of packing in trunnion air seal cover	
2	Degradation, cracking or wear of trunnion-to-bearing housing packing	
3	Corrosion, wear, damage or looseness of internal components	



7. Radial Guide Bearings Lubrication System Inspections

Visually inspect for the following failures and anomalies:

	Radial Guide Bearings Lubrication System Inspections	SAT/UNSAT
1	Foreign matter in filters	
2	Leakage of system piping	
3	Sludge in bearing sump	
4	Cracks, deformation, corrosion and leaks of internal piping	
5	Internal or external leakage of cooler	
6	Dirty or clogged oil filter cartridges	



Foreign matter in filters

Leakage of system piping

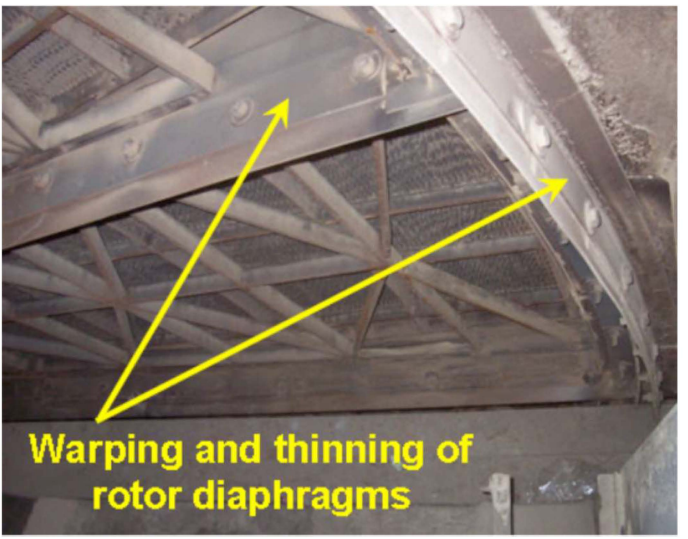
8. Radial Supports, Cages and Rotor Seal Plates Inspections

Visually inspect for the following failures and anomalies:

Radial Supports, Cages and Rotor Seal Plates Inspections	SAT/ UNSAT
Cracking or erosion of rotor post to diaphragm welds	
Warping, cracking or thinning of the rotor diaphragm	
Cracking, corrosion or erosion of the grating, welds, supports, and blocks	
Cracking, thinning or circumferential deformation of the shell plate	
Looseness and detachment of the pin rack from the shell	
Excessive wear and corrosion of the pins	
Loss of pinion gear contact with the rails	
Loss of pinion contact with the pin rack	
Oil leakage around the pin rack	
Excessive pinion gear wear	
Excessive pin rack pin wear (> 3/16 inch)	
Corrosion or physical deformation of the rails	
Excessive wear and thinning of the housing and connecting plates	
Erosion or corrosion of housing and connecting plates	
Deformation, warping, weld cracking of housing and connecting plates	
Expansion and distortion of housing and connecting plates	
Improper clearance of rotor seals	
Inadequate contact of rotor seals with seal plates or sealing surfaces	
Excessive wear, physical damage, cracking, warping, erosion, corrosion or deformation of rotor seals	
Thinning and looseness of rotor seals	
Detachment or looseness of rotor seal fasteners	

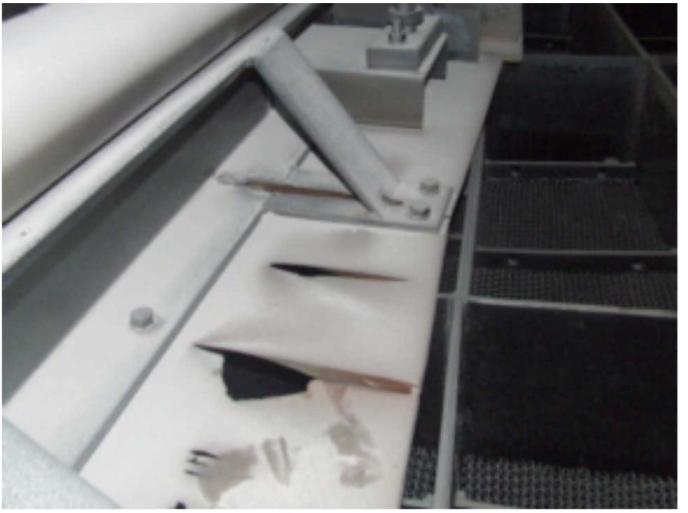
Cracking or erosion of rotor post to diaphragm welds

Warping, cracking or thinning of the rotor diaphragm

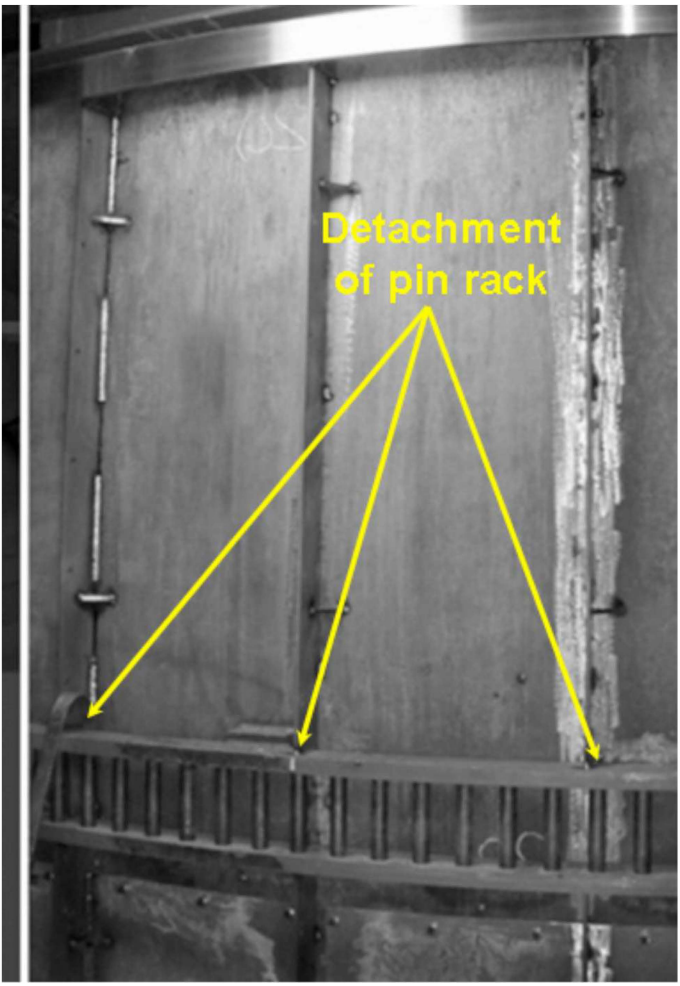


Cracking, corrosion or erosion of the grating, welds, supports, and blocks

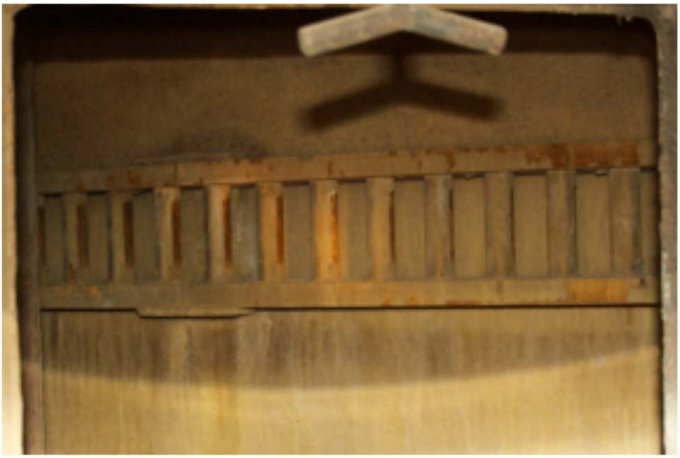
Cracking, thinning or circumferential deformation of the shell plate



Looseness and detachment of the pin rack from the shell



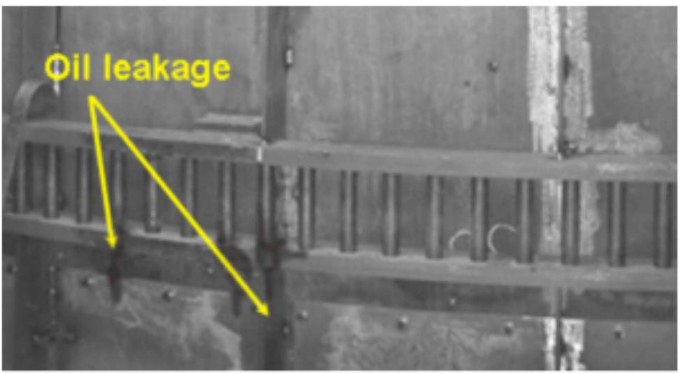
Excessive wear and corrosion of the pins



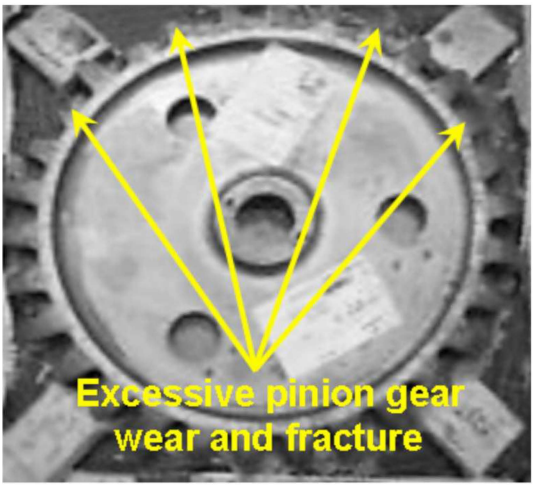
Loss of pinion gear contact with the rails

Loss of pinion contact with the pin rack

Oil leakage around the pin rack



Excessive pinion gear wear



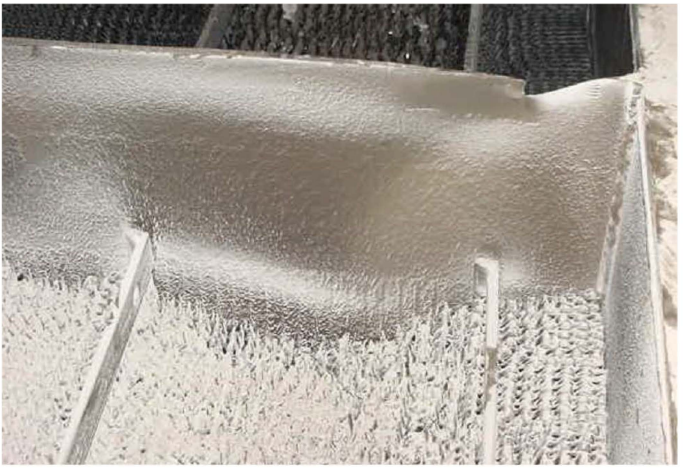
Excessive pin rack pin wear (> 3/16 inch)

Note: Wear on both sides of the pins can result from the air preheater being out of balance.

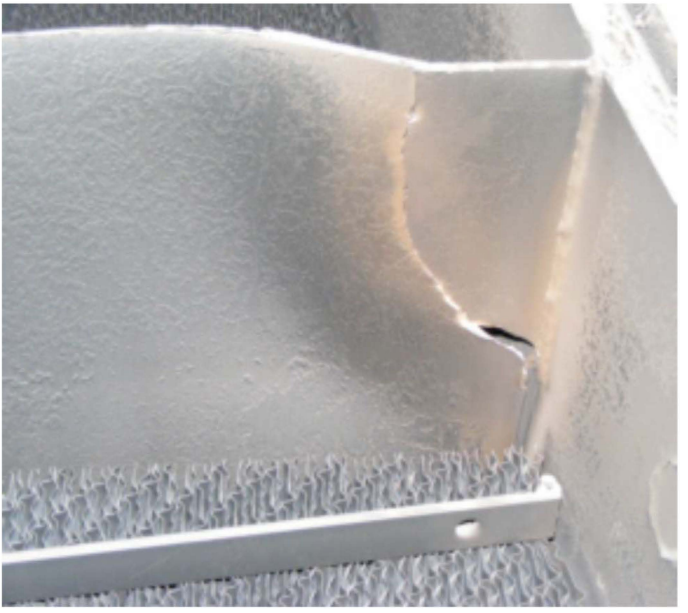
Corrosion or physical deformation of the rails

Excessive wear and thinning of the housing and connecting plates

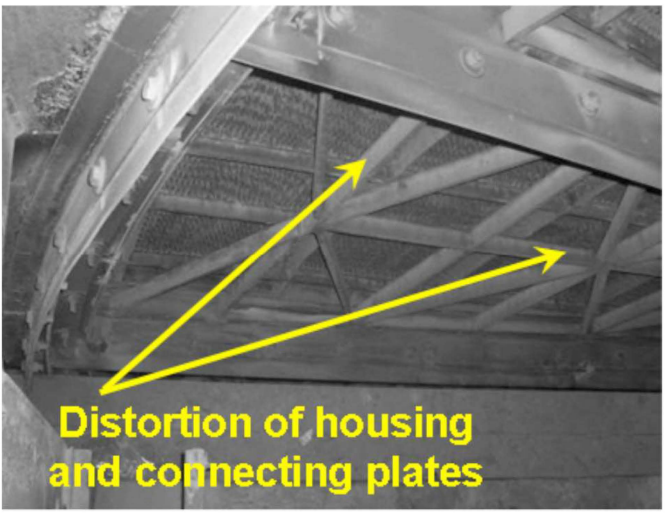
Erosion or corrosion of housing and connecting plates



Deformation, warping, weld cracking of housing and connecting plates



Expansion and distortion of housing and connecting plates

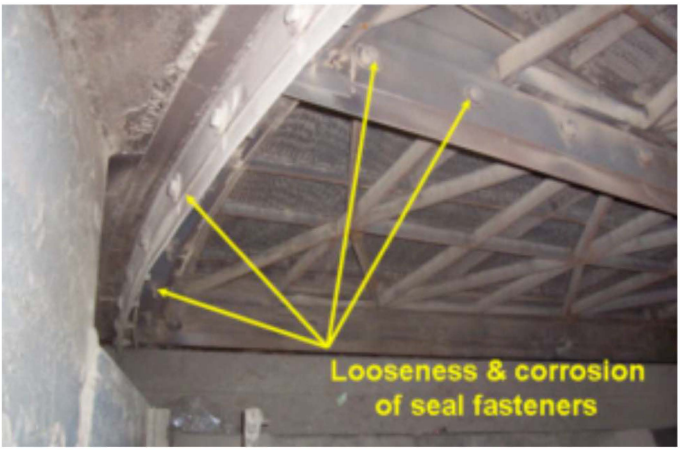


Improper clearance of rotor seals and inadequate contact of rotor seals with seal plates or sealing surfaces

Excessive wear, physical damage, cracking, warping, erosion, corrosion or deformation of rotor seals

Thinning and looseness of rotor seals

Detachment or looseness of rotor seal fasteners



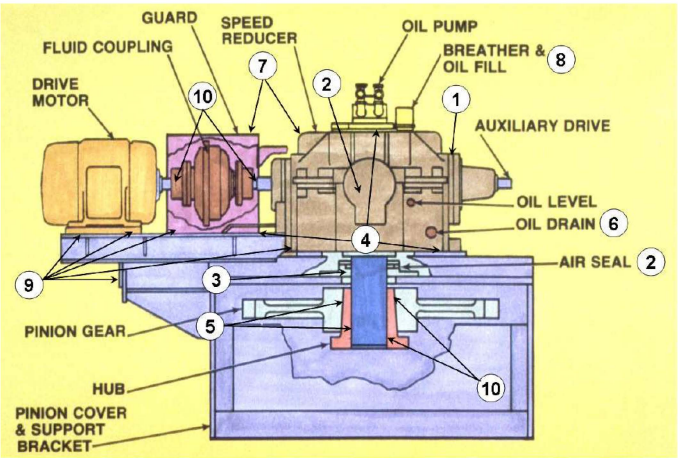
9. Rotor Drive Unit Inspections

Visually inspect for the following failures and anomalies:

	Rotor Drive Unit Inspections	SAT/UNSAT
1	Wear or degradation of oil seals and gaskets	
2	Wear and damage to gears	
3	Wear and damage of roller element bearings and seals	
4	Signs of leaking lubricant, if present	
5	Wear and integrity of mating surfaces	
6	Evidence of wear particles and water in lubricant	
7	Evidence of unusual or excessive wear and damage	
8	Wear and damage of non-metallic parts	
9	Damage or galling of bolting	
10	Damage or unusual wear of shaft, keys, and keyway	

Note that some inspections of the rotor drive unit assembly require the unit to be disassembled. The following schematic should be used to identify possible locations of the failure mechanisms and inspection points noted above.

Rotor Drive Unit Assembly

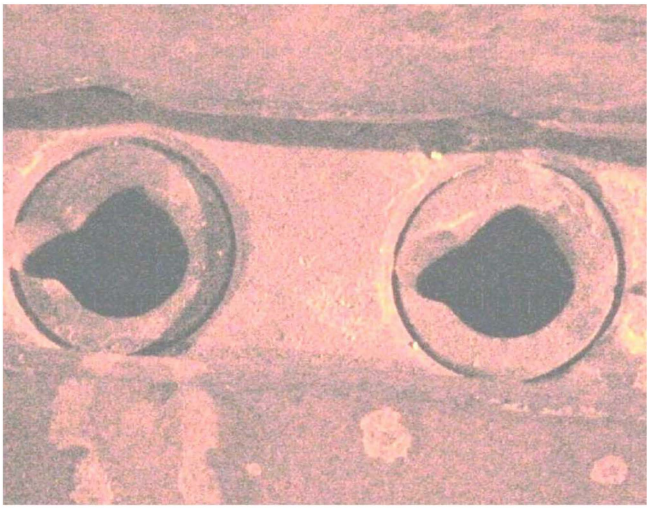


10. Plate Cleaning Systems Inspections

Visually inspect for the following failures and anomalies:

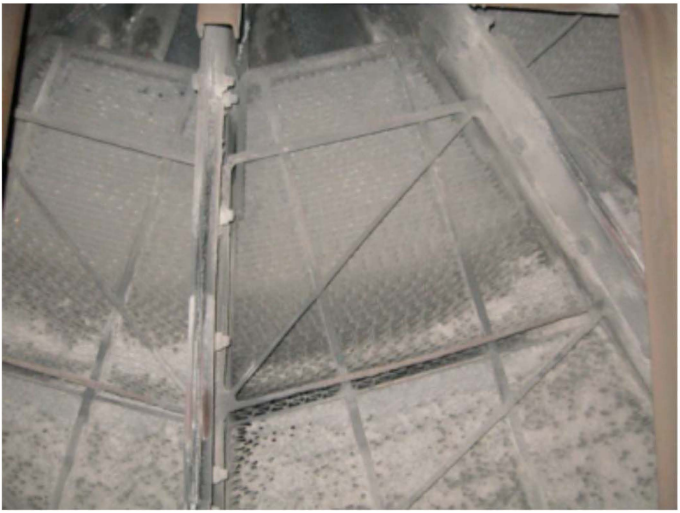
Plate Cleaning Systems Inspections	SAT/ UNSAT
Cracking, plugging, deformation or corrosion of soot blower nozzles or cleaning/washing nozzles	
Evidence of inadequate traverse of soot blower or cleaning/washing equipment	
Leakage, corrosion, and physical deformation of soot blower piping	
Corrosion and physical damage of the cleaning/ washing device	

Cracking, plugging, deformation or corrosion of soot blower nozzles or cleaning/washing nozzles



Note: Nozzle failures for water cleaning/washing systems may include wear or corrosion that affect flow and direction of the washing stream.

Evidence of inadequate traverse of soot blower or cleaning/washing equipment



Leakage, corrosion, and physical deformation of soot blower or wash piping

Leakage, corrosion, and physical deformation of soot blower or wash piping

Corrosion and physical damage of the cleaning/washing device

Comments and Notes on As-Found Conditions

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